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Word Concreteness And Mediation Instructions In Paired-associate Learning

John Charles Yuille

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WORD CONCRETENESS AND MEDIATION INSTRUCTIONS

IN PAIRED-ASSOCIATE LEARNING

by

John Charles Yuille

Department of Psychology

Submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy

Faculty of Graduate Studies
The University of Western Ontario
London, Canada
July, 1967
ABSTRACT

This study investigated the effects of noun concreteness and imagery and mediation instructions on paired associate learning. The effects of these variables on the latency of mediator discovery was also examined. Predictions concerning the interaction of these two variables were made for both dependent variables from a mediation hypothesis which stresses the role of imagery in associative learning.

Lists of 16 pairs of nouns each were constructed by varying the concreteness and imagery of the stimulus and response terms. The nouns were chosen from a population of words for which concreteness and imagery ratings had been obtained. The lists were homogeneous with respect to concreteness, a list containing one of four combinations of stimulus and response abstractness-concreteness, that is, concrete-concrete, concrete-abstract, abstract-concrete or abstract-abstract.

Subjects were given one of three sets of instructions concerning learning techniques. One group (imagery set) was instructed to link each pair with an image; the second (verbal set) to use words or phrases to link each pair; and the third group was asked to use simple repetition.
The subjects tested individually, practiced their technique with one of the concrete-concrete or abstract-abstract lists. During this phase, the latencies of the discovery of mediators were obtained for the imagery and verbal set groups. After the practice session each subject learned one of the four types of lists of pairs, having four learning and recall trials.

The prediction of a set by concreteness interaction during the mediation phase was supported. Subjects asked to use images took significantly longer to find mediators with abstract-abstract pairs than those with concrete pairs. The discovery of mediators by the verbal set group was unaffected by concreteness.

The predicted interaction of imagery and verbal set groups and concreteness during recall was not obtained. However, the repetition group had lower recall and were less affected by variation in concreteness than were the other two groups during the early trials. Concreteness of the stimulus and the response facilitated learning in all conditions, the effect of stimulus concreteness being greater. The type of practice pair had no effect on learning.

The results were considered in terms of alternative explanations. It was concluded that the interpretation best suited to the data was that, although many forms of mediation are operative, imagery may be the most effective method of mediating associations between familiar nouns.
ACKNOWLEDGMENTS

The writer wishes to express sincere thanks to his wife, Ingrid, for her constant encouragement and support, and for the typing of the manuscript. This research was supported by grants to Dr. Paivio from the National Research Council of Canada (Grant APA-87) and the University of Western Ontario Research Fund.
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INTRODUCTION

The study of the acquisition of paired-associates has been concerned, to a great extent, with mediation. Mediation refers to the use of some device or aid to link the stimulus and response members of a pair. Various explanations have been proposed concerning the methods which subjects use to mediate such associative connections. The theoretical mechanisms can be roughly classified into verbal and nonverbal types. Some authors (e.g., Bousfield, 1961; Cofer, 1966; Underwood and Schulz, 1960) have postulated a verbal-associative process. The subject links two words by either strengthening pre-experimental stimulus-response links, forming verbal units, making a sentence using the two words, using a common associate to link the two, and so on. The other view proposes that mediation is essentially nonverbal. For example, Osgood (1961) has suggested that mediation effects are a function of similarity of meaning of the items where meaning is defined as a non-verbal response. Also, Paivio (e.g., 1965) has hypothesized that non-verbal imagery may mediate the learning of paired-associates.
The purpose of this investigation was to examine the relative efficiencies of verbal and nonverbal (imagery) mediation with different lists of pairs of nouns. It is assumed that both processes are used in human learning and can be separated experimentally.

The following survey of the literature includes an examination of the relationships of stimulus attributes to imaginal and verbal mediation and a review of studies concerned with subjects' reported mediation in associative learning. Verbal mediation is discussed first followed by a section concerned with imagery as a mediator and, finally, studies dealing with both processes are reviewed.

**Verbal Mediation**

Verbal mediation refers to the linking of two words by forming a word or phrase, using some common associate, or some other verbal technique. Experimental evidence for the existence of verbal mediation has come from two sources: studies relating stimulus attributes to mediation and from subjects' mediation reports.

**Stimulus Attributes and Verbal Mediation** Underwood and Schulz (1960) suggested that two stages are involved in PA learning. The first stage involves the subject learning the response member of the pair (the response learning stage) and then linking the response to the stimulus (the associative stage). Underwood and Schulz presumed that the associative phase involves verbal mediation. This
hypothesis was developed in order to explain the results of earlier studies concerned with meaningfulness, \( m \). Noble (1952a) developed a technique to measure \( m \) in terms of the number of written verbal associates an item elicits per unit time. Studies in which \( m \) has been varied have found that it is positively related to serial acquisition (e.g., Noble, 1952b), PA learning (e.g., Cieutat, Stockwell & Noble, 1958) and performance on a mediation paradigm task (e.g., Horton, 1964). Underwood and Schulz then postulated their two stage idea stating that the higher the \( m \) of the response, the less response learning the subject is required to do and that the \( m \) of both stimulus and response increase the likelihood of finding some common associative verbal link.

Related to the Underwood and Schulz associative probability hypothesis is the interference paradox. While the higher \( m \) of the members of a pair might facilitate the discovery of a link between them it should also increase the probability of interfering interitem associations. Barnes and Schulz (1966) have found supporting evidence for both facilitating and interfering effects of \( m \). They obtained poorer recall for high \( m \) - high \( m \) than low \( m \) - high \( m \) pairs at short recall intervals and the reverse for longer intervals. They suggested that the longer time allows the subject to sort through the interfering associates.

Although verbal mediation has apparently been linked
most directly to \( m \), other word attributes have also been related to mediation. Underwood and Schulz, after a series of studies related to their hypothesis, suggested that the frequency of occurrence of a word is the fundamental characteristic lying behind the \( m \) dimension. Furthermore, Smythe (1967) suggested that \( m \) is not a potent variable when manipulated for nouns. It appears possible that the obtained \( m \) effects are due to some other variable, perhaps, non-verbal imagery. The \( m \) and frequency of occurrence values of the words used in this study will be controlled.

**Reported Verbal Mediation.** Recently, investigators have been concerned with direct attempts at examining verbal mediation. Underwood and Schulz (1960) found that following PA learning, subjects reported using mediators for 73% of the pairs and that learning was significantly higher for the items for which mediators were reported than for non-mediated items. Bugelski (1962) similarly found that subjects reported mediators for 67% of the pairs. He developed five categories to classify the mediators (for nonsense syllable pairs), which included, the formation of a meaningful word or words from the syllables, the use of phrases, employing abstract analysis, and using vague associations. Both of these studies also found that reported mediation tends to decrease over trials suggesting the possibility that mediation is necessary during the early stages of learning but is by-passed after
acquisition.

Martin, Cox and Boersma (1965) also obtained post-experimental questionnaire information from subjects concerning the mediators they used during learning. They classified the reported mediators into one of seven categories on a complexity continuum and found that the more complex the reported strategy the better the learning. In a subsequent study using elementary school students as subjects, Martin, Cox and Bulgarella (1966) found that more complex strategies were reported at grade 6 and 8 than grade 4. In addition, experimenter-supplied strategies significantly enhanced learning at all three grade levels.

A recent series of studies reported by Montague are similar to those conducted by Martin. Kiess and Montague (1965) questioned subjects at various stages in learning and found that "natural language mediators (NLMs)" play an important role in PA learning. Montague, Adams and Kiess (1966) further reported that recall was higher for items to which NLMs had been originally formed as compared to "rote pairs" (No NLMs). A study by Montague and Wearing (1967) is directly relevant to Martin's research. Montague and Wearing had judges rate the complexity of NLMs using the Martin scale. Complex NLMs were found to be associated with fewer errors in learning. However, some of the mediation categories were infrequently used.
and Montague and Wearing suggest that a dichotomy (NIM vs. Rote) is sufficient for classifying learning strategies.

Paivio, Yuille and Smythe (1966), in a study manipulating the concreteness ($C$) of noun stimuli and responses, found that subjects reported verbal mediation for 43% of the abstract-abstract pairs but for only 17% of the concrete-concrete pairs. This suggests that $C$ might influence verbal mediation.

The evidence reviewed up to this point has suggested that verbal mediation is operative in verbal learning and appears to facilitate the acquisition and retention of paired-associates. The word attributes which affect this type of linking are not known, although some indices of meaning (e.g., Noble's $m$, concreteness) as well as frequency and familiarity have been suggested as possible variables.

Imaginal Mediation

The term imaginal mediation is used here to refer to the linking of two nouns by forming a "mental picture" of the objects or events suggested by the two words. As in the case of verbal mediation, support for mediating imagery as a learning aid has come from two sources: the manipulation of stimulus attributes and the study of reported mediation. These will be reviewed separately.

Stimulus Attributes and Imaginal Mediation. One noun attribute, concreteness, has been related to imaginal mediation largely in the work of Paivio and his associates.
Paivio (1963) hypothesized that the speed of formation of imaginal links is a function of the ease with which individual nouns arouse mental images.\footnote{Individual persons will differ in the ability to use imagery as well and it may be similarly assumed that the extent to which one uses imagery will be a function of his learning history (c.f. Roe, 1960). However, individual differences in imagery (or verbal) ability will not be investigated in this study.} It is assumed that, through contiguous association with referent objects, nouns develop the "capacity" to elicit a response similar to that evoked by the object(s). The imaginal aspect of this response is conceived as a sensory experience similar to perception but not based on stimulation of a sense organ. That is, the neurophysiological response present when an image occurs is similar to that present when a real object is perceived by the sense organs (Oswald, 1962). For example, the noun "Table" will elicit an image of a table, this "mental picture" response being similar to the perceptual response elicited by the object table. Nouns will differ in their "ability" to evoke images as a function of previous associations. Concrete nouns, due to their association with (environmental) objects, will tend readily to elicit mental pictures, while abstract nouns will do so less readily because they have not been consistently associated with specific referents. Thus, one difference (and perhaps the major one) in meaning between concrete and abstract nouns is the imagery evoking capacity of the former. It
is the "ability" of a noun to elicit an image which makes it psychologically concrete.

It must be noted that an interest in the image evoking capacity of words is not new. In fact, the origin of psychology as an experimental science involved, in part, an interest in this phenomenon. The major concern of the Structuralist and Wurzburg schools was the importance of mental imagery in thought processes while investigators like Galton (1883) looked for individual differences in imaging ability. The majority of the early investigations, however, suffered from a number of shortcomings. Imagery was generally not operationally defined but rather its existence was implicitly assumed, and a reliance on the classical introspective method made for few viable results. The results of a few well controlled and properly designed studies (e.g., Betts, 1909, Davis, 1932) were lost in a mass of weak ones. Because of this paucity of good research (and the change in emphasis encouraged by Watson's behaviorism) the concept, imagery, fell into disrepute for almost three decades.

With the concept of the image recently attaining a new respectability (see, for example, Holt, 1964), research concerned with imagery reappeared. A series of

---

2 The reappearance of the concept (during the 50's) was instigated in part by physiological research when investigators became embroiled in a controversy concerning central nervous activity correlates of imagery (e.g., Short, 1953; Barrett,
studies of direct relevance to the present investigation began with a study by Lambert and Paivio (1956). They found that adjective-noun word groups were learned more easily when the nouns preceded rather than followed the adjectives. They suggested that the results might be a function of the capacity of nouns to act as "conceptual pegs" on which to "hang" responses. Paivio (1963) further suggested that the usefulness of a noun as a "conceptual peg" depended on its concreteness. Specifically, he hypothesized (the imagery hypothesis) that pairs of concrete nouns, because they readily elicit images, should be easier to learn than abstract noun pairs and this differential effect should be greatest on the stimulus side of the pairs. The stimulus superiority was predicted because the subject must recall the response when presented the stimulus alone and the concrete noun stimulus might act as a "peg" on which to "hang" the response via an imaginal mediator. Partial support for the hypothesis was obtained, concrete noun-adjective pairs were recalled better than abstract noun-adjective pairs. In a subsequent study (Paivio, 1965) the differential effect of noun concreteness was contrasted on both the stimulus and response side.

2 cont'd

1956; and Oswald, 1957). The relationship of eye movements to dreaming (e.g., Antrobus, et al., 1964) and patients reporting imagery upon cranial stimulation (Penfield & Jasper, 1954) also added to this re-emergence of the concept image.
of pairs. Using the four possible combinations of stimulus-response concreteness, pairs were recalled in increasing order of difficulty, concrete-concrete (C-C), concrete-abstract (C-A), abstract-concrete (A-C), and abstract-abstract (A-A). These results provided inferential support for the imagery hypothesis, the significant superiority of C-A over A-C pairs in particular illustrating the relative contribution of concreteness on the stimulus and response side of pairs. The generality of this latter finding is indicated by similar results obtained with grade school children as subjects (Paivio & Yuille, 1966).

The above supporting evidence encouraged further research designed to provide more direct information concerning the nature of the effective variable(s) underlying the concreteness effect. The suggestion that imagery is the effective variable has been indirectly supported by a number of studies. Concrete nouns were found to exceed abstract nouns in rated imagery (Paivio, 1965; Paivio, Yuille & Smythe, 1966; Paivio, Yuille and Madigan, 1967). In the Paivio et al., (1967) study, for example, groups of subjects rated sets of a total of 925 nouns on a 7 point scale ranging from 1 - image aroused with difficulty, or not at all to 7 - image aroused easily. The same 925 nouns were also rated in terms of concreteness, 1 - very abstract to 7 - very concrete. The correlation
between rated concreteness and rated imagery was .83. Furthermore, Paivio (in press), in a study factor analyzing the correlations between item attributes and PA learning scores, obtained a concreteness-imagery factor on which three indices of noun imagery, and measures of concreteness and tangibility loaded highly. The learning variables, especially scores for items as stimuli in PA learning, also loaded on this factor while not loading on other semantic factors. Thus, measures of imagery and concreteness defined a common factor and were the best predictors of learning. Also, Paivio (1966) found that when subjects were instructed to press a switch when an image occurred to a noun, shorter latencies of imagery arousal were obtained for concrete than for abstract nouns (and these latencies correlated highly with scale ratings of imagery).

**Reported Imaginal Mediation.** One study has appeared in which reported imaginal mediation was examined in PA learning. Paivio, Yuille and Smythe (1966) asked subjects after completion of the learning and recall trials, to indicate whether they used a verbal, imaginal or no mediator to link each pair. Consistent with the imagery hypothesis, significantly more subjects reported using imaginal mediators for C-C pairs (64%) than for A-A pairs (16%). Conversely, a large number of subjects (59%) indicated that some verbal link was used for A-A pairs. In addition, those subjects reporting the use of a mediator (either imaginal or verbal)
to link a pair had higher recall scores than those reporting no use of a mediator.

The evidence reviewed up to this point suggests that both imaginal and verbal processes may be operative in verbal learning. Further support for this contention is found in a number of recent studies in which the experimenter has attempted to manipulate mediation. Jensen and Rohwer (1963), using retarded subjects, found that instructions to make up a sentence using the stimulus and response in each pair resulted in faster learning of a list of pairs than when subjects named the stimulus and response. In a second experiment reported in the same study, they found that verbal mediators supplied by the experimenter also facilitated performance. Wallace, Turner and Perkins (1957) found that individuals, when instructed to link the members of a pair with a visual image, could learn up to 500 pairs with 99% retention. Similarly, Reese (1965) and Marshall (1965) found that making either verbal or pictorial compounds of noun pairs made them easier to learn than simply presenting nouns as pairs. Martin and Dean (1966) found that mediation instructions increased reported mediation and the pairs reported as mediated were learned significantly faster. McNulty (1966) reported similar results. Hulicka and Grossman (1967) and Smith and Noble (1965) both used instructions to mediate pairs with a mental image and found these instructions facilitated learning.
Sufficient evidence exists to conclude that mediation facilitates learning and recall and that more than one type of mediation is functional. The latter conclusion, however, has not generally been accepted. Some authors (e.g., Bousfield, 1961) have suggested that only verbal mediation is operative in verbal learning and most investigators have concerned themselves only with verbal mediation. An important task remains, then, to discover some situation where the two types of mediation might be separated and compared. A recent study by Yuille and Paivio (in press) attempted to do this. They gave each subject one of two mediation sets: 1) link each pair with a mental picture (I set) or 2) link each pair by a word or phrase (V set). After receiving the instructions, a list of pairs was visually presented, one pair at a time, 4 pairs each of C-C, C-A, A-C and A-A pairs. For each pair the subject was instructed to press a switch when he found the appropriate mediator. Thus latency of discovery of imaginal and verbal mediators was obtained. Yuille and Paivio hypothesized that if the two processes (imagery and verbal) are functional and if concreteness, particularly of the stimulus term, affects imaginal mediation, then latency of discovery of imaginal mediators should be greater for abstract than for concrete nouns while verbal mediation latencies should be less affected by concreteness. This prediction was confirmed. A significant stimulus concreteness by mediation set
interaction indicated that latency of discovery of imaginal mediators was longer for abstract stimulus than concrete stimulus pairs, while discovery of verbal mediators was relatively unaffected by stimulus concreteness. Similar instructions have been given to subjects learning pairs of nouns to see if the effect obtained with a mediation latency study would be found in the learning situation. Yarmey and Thomas (1966), for example, instructed their subjects to use imaginal mediators to learn A-A pairs and verbal mediators to learn C-C pairs. The former set facilitated learning while the latter set appeared to interfere but since the study involved in incomplete factorial design, i.e., they did not have subjects learning C-C pairs under an I set and A-A pairs under a V set, no conclusions can be made from their study. Paivio and Yuille (1967) instructed one third of their subjects to use imaginal mediation, a third to use verbal mediation and a third to learn the pairs by rote repetition. All subjects were given C-C and A-A pairs to learn. Although mediation instructions facilitated learning, the expected interaction of imaginal vs. verbal mediation set and noun concreteness was not obtained, and it was suggested that instructions, when presented to a group, do not adequately control subjects use of mediation. Subjects post-learning mediation reports supported this suggestion indicating a pattern similar to that obtained by Paivio, Yuille and Smythe (1966) in the absence of mediation instructions.
The present study was in part an attempt to induce more persistent mediation sets.

One additional aspect of the mediation problem should be noted at this point. Two recent studies have revealed that repetition interferes with learning. Nodine, Nodine and Thomas (1967) reported that repetition of the pair during the interpair interval reduced the number of correct responses compared to no repetition. Reynolds, (1967) found that overt but not covert repetition interferes with learning. These data are consistent with the notion that mediation facilitates associative learning and that overt repetition interferes with the subjects attempts to mediate.

In the present study, each subject practiced either imaginal or verbal mediation with a list of 16 pairs and then learned a second list. This practice session was designed to establish a strong set to use the appropriate mediator. Concreteness of the pairs was varied in the practice lists (each subject practiced on a list of either C-C or A-A pairs) to determine if the nature of the material with which a subject rehearses a technique affects his ability to use it. After the practice list, the subject learned a list of either C-C, C-A, A-C, or A-A pairs. Each list was homogenous to avoid within-list contrast effects. Subjects in a third group were instructed to use, and practiced using, rote repetition to learn each pair. This was an attempt to prevent mediation and thus
represents a control group.

The following predictions were made concerning the results of the mediation phase:

1) From the results of the Yuille and Paivio (in press) study and the imagery hypothesis, it is expected that mediation latencies will not differ under the I and V sets for C-C pairs, while the imaginal mediation latencies will be significantly longer than the V set latencies with A-A pairs.

2) Latencies of mediator discovery will not differ between C-C and A-A pairs for subjects given the V set.

The predictions for the results of the learning phase were:

1) From previous findings (e.g., Paivio, et al., 1966) and the imagery hypothesis it is expected that noun concreteness, particularly of the stimulus term will facilitate learning of paired associates.

2) From the imagery hypothesis, it is predicted that variation in concreteness of the stimulus will affect subjects required to use imaginal mediation but not subjects given the verbal set, and the latter group will learn A-A and A-C pairs better than subjects given the imagery set.

3) Subjects given either mediation set will perform equally well in learning C-C and C-A pairs.

4) From previous studies cited above, it was expected that subjects given either the verbal or imaginal set will have higher recall scores (regardless of the type of pair)
than subjects given the repetition set.

5) The mediation sets should have their strongest effects on the first learning trial. This would be reflected in an interaction of set by trials.
METHOD

Subjects

Two hundred and forty introductory psychology students (128 males, 112 females) served as subjects.

Paired-Associate (PA) Lists

The nouns used to construct the PA lists were selected from a pool of 925 nouns for which concreteness (C), and imagery (I) ratings and meaningfulness (m) data are available (Paivio, Yuille and Madigan, 1967). These data were obtained from university students following procedures detailed by Paivio et al. The I ratings were obtained from thirty subjects rating each noun on a 7 pt. scale. The defining ends of the scale were labelled 1, Low Imagery and 7, High Imagery, with high noun I defined in terms of the ease of evoking a sensory image. Concreteness of each noun, defined in terms of the directness of sensory reference (cf. Gorman, 1960), was rated by thirty different subjects on a 7 point scale. The defining ends of the scale were 1, Highly Abstract and 7, Highly Concrete. Production m (Noble, 1952a) data were obtained in such manner that a total of 24 subjects associated 30 seconds to each noun. The correlations between the three attributes for the total sample of nouns
are: $C$ and $I$, .83; $C$ and $m$, .56; and $I$ and $m$, .72.

In order to construct the lists, 128 nouns, $64$ High $I$, Concrete and $64$ Low $I$, Abstract, were selected from the pool, with the restriction that all nouns were of comparable $m$ and frequency of occurrence ($F$) values (Thorndike and Lorge, 1944). Since $I$ and $C$ are theoretically linked and have been found to have similar effects and load highly on a common dimension, they covaried in this study. The mean values for $I$, $C$, $m$, and frequency of occurrence (Thorndike and Lorge, 1944) for the concrete and abstract nouns appear in Table 1. The nouns and their respective attribute values are listed in Appendix A. Two lists of 16 pairs each consisting entirely of concrete nouns were constructed by randomly pairing the $64$ concrete nouns. These lists are designated CCl and CC2. Two C-C lists were required because some subjects practiced their set with C-C pairs and subsequently learned a C-C list. Two A-A lists were needed for the same reason. The $64$ abstract nouns were used to form two 16 pair lists of abstract-abstract pairs, designated lists AA1 and AA2. Finally, 32 of the abstract and 32 of the concrete nouns were paired to form two lists of 16 concrete-abstract pairs each. These lists are titled CA1 and CA2. The pairs in each of the six lists thus formed were "turned over" so that each stimulus noun became a response and vice versa. In the case of lists CA1 and CA2, this resulted in two lists of abstract-concrete (A-C) pairs. The six original
TABLE 1
Mean I, C, m and F values and standard deviations
for 64 concrete and 64 abstract nouns

<table>
<thead>
<tr>
<th></th>
<th>I</th>
<th>C</th>
<th>m</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete</td>
<td>X</td>
<td>6.34</td>
<td>6.73</td>
<td>5.74</td>
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<tr>
<td>Nouns</td>
<td>SD</td>
<td>.19</td>
<td>.27</td>
<td>.36</td>
</tr>
<tr>
<td>Abstract</td>
<td>X</td>
<td>3.08</td>
<td>2.69</td>
<td>5.48</td>
</tr>
<tr>
<td>Nouns</td>
<td>SD</td>
<td>.37</td>
<td>.84</td>
<td>.39</td>
</tr>
</tbody>
</table>
lists are presented in Appendix B.

Each pair in the resulting 12 lists was typed in pica capitals, photographed and mounted as a transparent slide. Also, the stimulus term of each pair alone was photographed for use during the recall trials of the PA learning phase.

**Apparatus**

The apparatus consisted of a slide projector mounted behind a rear projection screen. The slide-change mechanism of the projector was connected to a relay controlled by an interval timer. This timer also operated a relay connected to a clutch-driven clock. These connections allowed the interval timer simultaneously to start the clock and expose a slide, as well as stop the clock and remove the slide. A two-stage interval timer was used so that both the exposure time and interstimulus interval could be controlled. A switch, which stopped the clock when pressed, also was wired into the circuit.

**Procedure**

The procedure consisted of two phases: mediation practice, and PA learning. Each subject heard a set of tape recorded mediation instructions, followed by a practice session during which he was to practice the instructed technique with a list of 16 pairs (mediation phase). Then he was required to learn a different PA list (learning phase). This is essentially a transfer paradigm, but unlike the usual design the procedure
involved transfer of a mediation set. This design should promote maximum usage by the subject of his instructed mediation technique especially since all subjects were tested individually.

Mediation phase. The experimental session began with the subject being presented one of three sets of tape recorded instructions. The imagery set (I set) asked the subject to link each pair of nouns with a mental image -- "for example the pair 'garden-money' might be linked by a picture of a garden with money growing on it". The verbal set (V set) instructed the subject to link each pair with a word or phrase -- "for example, with the pair 'garden-money', you might use 'garden vegetables earn money'." The third set of instructions (R set) told the subject to repeat each pair of words (out loud) a number of times. The latter set constituted a control condition and was used in lieu of a no-set control because uninstructed subjects are known to rely spontaneously on mediators (e.g., Paivio et al., 1966). Eighty subjects received each set. The complete instructions for each set are included in Appendix C.

After viewing three practice pairs to familiarize him with the procedure, the subject was presented each of 16 pairs of one of the CC1, CC2, AA1 or AA2, original or "turned over" lists (120 subjects were presented a CC list, 120 subjects were presented an AA list). In other words one half of the subjects practiced their instructed technique
with C-C pairs, the other half with A-A pairs. During the practice session subjects given the I or V sets were asked to press a switch when they found the appropriate mediator. This stopped the clock and allowed the experimenter to record the latency of discovery of each mediator. After pressing the switch the subject gave a brief description of the mediator he used. These descriptions were recorded on tape. Each pair was projected on the screen for 16 seconds. The inter-pair interval was 5 seconds. Subjects given the R set repeated each pair while it was on screen.

**FA learning phase.** Upon completion of the mediation phase, the subject was required to learn a different list (one of the CC, CA, AC or AA lists). This phase consisted of four alternating learning and recall trials. During a learning trial, each pair appeared on the screen for 4 seconds with an inter-pair interval of 1 second. On recall trials, the stimulus member of each pair was presented for 7 seconds, each, with an interstimulus interval of 1 second. On these trials subjects stated the responses they remembered. Forty subjects learned each type of list.

All combinations of mediation set, type of practice pair, and type of learned pair were included in a factorial design comprising 24 cells with 10 subjects in each cell. A matrix description of the design is given in Table 2. The design involved 240 subjects since no repeated measures were involved with these factors. A subject was randomly assigned
### TABLE 2

Summary of factorial design employed in this study

<table>
<thead>
<tr>
<th>Mediation Set</th>
<th>Practice Pair</th>
<th>Learned Pair</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C-C</td>
<td>C-A</td>
<td>A-C</td>
</tr>
<tr>
<td>I</td>
<td>10*</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>A-A</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>V</td>
<td>C-C</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>A-A</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>R</td>
<td>C-C</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>A-A</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

* Indicates the number of subjects in each cell.
to a cell and received either I, V or R set instructions, practiced with either C-C or A-A pairs, and subsequently learned one of the four types of lists.

Post-Experimental Questionnaire

After completion of the PA learning phase each subject was asked to complete a two-page questionnaire. The first page contained two seven point scales. On the first scale the subject indicated how easy or difficult he found the instructed mediation technique. The defining ends of the scale were 1 - Very Difficult to 7 - Very Easy. The subject indicated how often he used the instructed technique on the second scale, defined by the limits 1 ("none of the pairs"), to 7 ("all the pairs"). The 16 pairs the subject had learned were typed in a column on the left hand margin of the second page of the questionnaire. Instructions asked the subject to write a brief description of how he linked each pair during learning.
RESULTS

The data for the subgroups within each cell that received the "turned over" and alternate lists (e.g., lists CC1 or CC2) were collapsed in all the analyses reported below.

The interpretation of significant interactions was facilitated by using \( t \) tests to compare the appropriate means. All the \( t \) tests reported in this section used the procedure outlined by Gardner (1966).

The Fmax test for homogeneity of variance was performed on the data of each analysis of variance and the Fmax is reported in each summary table. In some cases the homogeneity assumption was violated. Corrections were not made for this since the effects obtained were highly significant as well as consistent with past findings. Also, Norton (1953) has shown that extreme violation of the assumptions of analysis of variance do not have a great effect on the distribution of F ratios.

Mediation Phases

During this phase subjects practiced their instructed technique with either C-C or A-A pairs of nouns and the latency of mediator discovery was obtained from subjects given the I and V sets. The mean latencies for each type
of pair for the two sets given in Table 3.

In order to determine the effects of concreteness and mediation set on the latency of mediator discovery a 2 x 2 analysis of variance was performed on the mean latency for each subject and is summarized in Table 1, Appendix D. The design involved two levels of set (I and V) and the two types of pairs. There were 40 subjects in each cell. A significant main effect of type of pair \( F = 26.76, p < .01 \) suggests that mediators were found more rapidly for C-C than for A-A pairs, regardless of set. This interpretation of the main effect is qualified, however, by the significant interaction, \( F = 8.87, p < .01 \) illustrated in Figure 1. Employing t-tests to compare cell means it was found that subjects instructed to find imaginal mediators required significantly longer for A-A than C-C pairs \( t = 5.76, p < .01 \), while the pair attribute did not effect subjects given the V set \( t = 1.57, p > .10 \). This interaction supports the prediction that variation of the concreteness of pairs will affect the discovery of imaginal but not verbal mediators. This represents a replication of the similar finding reported by Yuille and Paivio (in press).

**PA Learning Phase**

Total recall scores for each trial were computed for each subject. The means of these scores for each experimental condition are presented in Table 4. A 2 x 2 x 3 x 2-x 4 analysis of variance was performed on these scores.
<table>
<thead>
<tr>
<th>Pair</th>
<th>Set I Mean</th>
<th>S.D.</th>
<th>Set V Mean</th>
<th>S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-C</td>
<td>6.92</td>
<td>1.76</td>
<td>7.47</td>
<td>3.01</td>
</tr>
<tr>
<td>A-A</td>
<td>10.11</td>
<td>2.26</td>
<td>8.34</td>
<td>2.40</td>
</tr>
</tbody>
</table>
Latency of Mediator Discovery as a Function of Instructional Set and Type of Pair.  $F=8.87, p<.01$
The factors involved were 2 levels each of stimulus and response C, 2 types of practice pairs, 3 instructional sets and 4 trials. The results of this analysis are summarized in Table 2, Appendix D. The main effects and interactions which do not involve the trials variable will be discussed first, followed by an examination of the effects of trials.

The main effects of stimulus C (F = 222.47, p < .01) and response C (F = 106.88, p < .01) indicate that concreteness of either member of a pair facilitated recall in all conditions. The larger F ratio obtained for the stimulus variable is consistent with past findings (e.g., Paivio, 1963; Paivio et al., 1966) and with the imagery hypothesis. The effect of C of both members of a pair is further demonstrated by the interaction of the stimulus and response variables (F = 64.92, p < .01). This interaction, illustrated in Figure 2, reveals that variation in response C was more effective when the stimulus was abstract. This interaction reflects the particularly poor recall for subjects learning A-A pairs.

The other significant main effects involved the set variable (F = 13.09, p < .01) and trials (F = 1150.92, p < .01). As predicted, subjects given the I and V sets had higher recall for all types of pairs than subjects using repetition. This can be interpreted as supporting the suggestion that repetition interferes with mediation. Finally, the recall of all subjects improved as a function of trials.
<table>
<thead>
<tr>
<th>Type of Practice Pair</th>
<th>Set</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C-C</td>
<td>12.10</td>
<td>14.80</td>
<td>16.00</td>
<td>16.00</td>
</tr>
<tr>
<td></td>
<td>A-A</td>
<td>12.40</td>
<td>15.30</td>
<td>15.70</td>
<td>15.90</td>
</tr>
<tr>
<td>Type of Learned Pair</td>
<td>C-C</td>
<td>11.50</td>
<td>15.30</td>
<td>15.80</td>
<td>15.90</td>
</tr>
<tr>
<td></td>
<td>A-A</td>
<td>11.70</td>
<td>15.00</td>
<td>15.80</td>
<td>15.90</td>
</tr>
<tr>
<td></td>
<td>C-C</td>
<td>5.00</td>
<td>11.70</td>
<td>14.70</td>
<td>15.70</td>
</tr>
<tr>
<td></td>
<td>A-A</td>
<td>5.40</td>
<td>12.40</td>
<td>15.00</td>
<td>15.80</td>
</tr>
<tr>
<td></td>
<td>C-C</td>
<td>10.40</td>
<td>14.50</td>
<td>15.90</td>
<td>16.00</td>
</tr>
<tr>
<td></td>
<td>A-A</td>
<td>8.90</td>
<td>14.20</td>
<td>15.60</td>
<td>16.00</td>
</tr>
<tr>
<td></td>
<td>C-C</td>
<td>9.60</td>
<td>12.30</td>
<td>14.40</td>
<td>15.50</td>
</tr>
<tr>
<td></td>
<td>A-A</td>
<td>7.70</td>
<td>13.90</td>
<td>15.70</td>
<td>15.80</td>
</tr>
<tr>
<td></td>
<td>C-C</td>
<td>5.50</td>
<td>12.30</td>
<td>14.60</td>
<td>15.20</td>
</tr>
<tr>
<td></td>
<td>A-A</td>
<td>6.90</td>
<td>12.50</td>
<td>15.70</td>
<td>16.00</td>
</tr>
<tr>
<td></td>
<td>C-C</td>
<td>8.90</td>
<td>13.80</td>
<td>15.40</td>
<td>15.80</td>
</tr>
<tr>
<td></td>
<td>A-A</td>
<td>7.20</td>
<td>12.70</td>
<td>15.10</td>
<td>15.90</td>
</tr>
<tr>
<td></td>
<td>C-C</td>
<td>7.50</td>
<td>12.10</td>
<td>14.10</td>
<td>14.70</td>
</tr>
<tr>
<td></td>
<td>A-A</td>
<td>6.40</td>
<td>10.70</td>
<td>12.90</td>
<td>14.20</td>
</tr>
</tbody>
</table>

TABLE 4
Mean total recall scores for each type of learned pair, practice pair and set, separately for each trial.
<table>
<thead>
<tr>
<th>Type of Practice</th>
<th>R</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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<td>A-A</td>
<td>5.70</td>
<td>10.90</td>
<td>14.00</td>
<td>14.70</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of Learned Pair</th>
<th>I</th>
<th>C-C</th>
<th>1.90</th>
<th>5.30</th>
<th>7.60</th>
<th>10.40</th>
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<tbody>
<tr>
<td></td>
<td>A-A</td>
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<td>5.30</td>
<td>8.30</td>
<td>10.60</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of Learned Pair</th>
<th>V</th>
<th>C-C</th>
<th>3.20</th>
<th>5.40</th>
<th>7.80</th>
<th>10.60</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A-A</td>
<td>3.20</td>
<td>6.00</td>
<td>8.80</td>
<td>10.30</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of Learned Pair</th>
<th>A</th>
<th>R</th>
<th>C-C</th>
<th>1.70</th>
<th>6.30</th>
<th>8.90</th>
<th>11.00</th>
</tr>
</thead>
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<tr>
<td></td>
<td>A-A</td>
<td>1.20</td>
<td>3.80</td>
<td>6.20</td>
<td>10.70</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 The standard deviations range from 0 (cells where all subjects obtained perfect scores) to 4.57.
Figure 2

Mean Total Recall as a Function of Stimulus and Response C. F=6492, p<01
The remainder of the significant effects involve interactions with trials. These effects involve complex interactions which may be best understood by examining recall separately for each trial. Thus, a brief summary of the effects is now given followed by a more detailed examination of the results for each trial. The stimulus by trials (F = 21.59, p < .01), response by trials (F = 7.14, p < .01) and stimulus x response x trials (F = 12.27, p < .01) interactions illustrate the decreased recall differences between the four types of pairs as a function of trials. The set variable also interacted with trials (F = 23.54, p < .01); subjects given the I and V sets had superior recall when compared to subjects given the R set on trials one and two, but this difference had disappeared during the last two trials. The interactions of the stimulus and response variables with set and trials were also significant (F = 5.94, p < .01 and F = 3.16, p < .01, respectively). The concrete-abstract difference on both sides of pairs affected recall more for subjects instructed to use imagery or verbal mediators than subjects given the R set. This effect was found only on the first trial. The four way interaction of stimulus x response x practice pair x trials (F = 2.72, p < .05) is discussed below.

To fully understand these trial effects, a separate analysis of recall scores for each trial was performed. These results are described below with reference to the appropriate interaction in Table 2. Each analysis involved
a 2 x 2 x 3 x 2 design, 2 levels each of stimulus and response C, 2 levels of practice pair, and three levels of set.

**Trial 1.** The F ratios for the recall scores of this trial are given in Table 3, Appendix D. These results show that subjects instructed to use imagery and verbal links recalled more pairs than subjects given the R set (F = 39.66, p < .01). Both stimulus C (F = 153.23, p < .01) and response C (F = 65.47, p < .01) facilitated learning and the stimulus-response interaction is significant (F = 15.18, p < .01). All four types of pairs differed significantly from each other (t ≥ 2.40, p < .02). Recall for the different pairs, in decreasing magnitude, was C-C, C-A, A-C and A-A.

The interaction of stimulus C and set (F = 7.47, p < .01) is shown in Figure 3. The superiority of recall for subjects given the I and V sets, compared to the R set, was more pronounced with pairs of concrete than abstract stimuli. Contrary to expectations, subjects given the V set did not perform better with abstract stimulus pairs than subjects asked to use imagery to mediate. Also, it should be noted that with concrete stimulus pairs subjects given the I and V sets did not differ (t = 1.32, p > .10). The interaction of response C and set (F = 6.18, p < .01) exhibits the same pattern as the stimulus C interaction.

**Trial 2.** The summary of the analysis for this trial appears in Table 4, Appendix D. Again three of the main
Mean Recall Scores as a Function of Instructional Set and Stimulus C (Trial One). F = 7.47, p < .01
effects are significant, stimulus C (F = 208.69, p < .01), response C (F = 94.84, p < .01), and set (F = 11.67, p < .01), with the differences the same as those obtained on the first trial. The stimulus-response interaction was also significant (F = 56.60, p < .01). In this case, however, recall for C-C and C-A pairs did not differ (t = 1.00) but was superior to the recall for A-C and A-A pairs (t = 3.22, p < .01). This reveals that variation in response C had no effect when the stimulus was concrete.

On this trial, the interactions of set with stimulus and with response concreteness are not significant (nor are these interactions significant in the subsequent trials). This change from the first trial suggests that by the second trial variation of noun C affected subjects given the R set as much as those given the I and V sets. This clarifies the description of two of the interactions reported in Table 2, i.e., stimulus C x set x trials (F = 5.94, p < .01) and response C x set x trials (F = 3.16, p < .01). Obtaining the interactions on the first trial confirms the suggestion that the effects of set would be strongest on the first trial.

**Trial 3.** The F ratios for this trial are given in Table 5, Appendix D. The stimulus C (F = 179.91, p < .01) and response C (F = 92.35, p < .01) main effects were obtained. The effect of the set variable is no longer significant on this trial (or on the fourth trial). By the third trial subjects instructed to use repetition performed
as well as those given the I and V sets. This change after two trials explains the obtained set x trials interaction (F = 23.54, p < .01).

The significant stimulus $C \times$ response $C$ interaction (F = 81.94, p < .01) exhibits the same pattern as in Trial 2. Variation in response $C$ affected recall only when the stimulus term was abstract.

**Trial 4.** Table 6, Appendix D, presents the summary of this analysis. The stimulus $C$ (F = 166.60, p < .01) and response $C$ (F = 65.71, p < .01) main effects and the stimulus-response interaction (F = 59.10, p < .01) were significant. These three effects are all due to one difference, recall was lower for A-A pairs than the other three types (t = 8.10, p < .01). Recall for C-C, C-A and A-C pairs did not differ from each other (t ≤ 1.53).

The observation that recall differed for all four types of pairs on the first trial while on the last trial only A-A pair recall differed from the others accounts for the stimulus $C \times$ trials (F = 21.59, p < .01), response $C \times$ trials (F = 7.14, p < .01), and stimulus $C \times$ response $C \times$ trials (F = 12.27, p < .01) interactions found in Table 2, Appendix D.

The type of pair with which a subject practiced his instructed technique apparently had no effect on recall of the subsequent list. This variable had no significant effects in any of the trials analyses. In the overall analysis, or of the 15 F ratios involving this variable
only one, a four way interaction \( (F = 2.72, p < .05) \), was significant. The interaction is not interpretable and will be ignored in the discussion section. The possibility exists that the single significant F obtained was due to chance and it appears reasonable to conclude that the type of mediation practice pair did not substantially affect subsequent learning.

To summarize these results, the strongest effects obtained were those attributable to variation of stimulus and response C, with the former having a greater effect than the latter. Lower recall for subjects using the R set, as compared to the I and V set groups, occurred for the first two trials but disappeared on the third trial. The expected interactions of I and V set with stimulus C and response were not obtained. The recall of subjects given the R set was less affected by variation of the stimulus and response attributes than the recall of those asked to use images or verbal mediators. It appears then, that the concreteness variable was the most potent in the study.

**Post-experimental Reports**

The first page of the report contained two 7-point scales on which the subject indicated the difficulty of using the instructed mediation technique, and the number of pairs with which he followed his set. The mean ratings for each group for the Easy-Hard scale appear in Table 5, and for the number of pairs scale in Table 6.
TABLE 5
Mean rating and standard deviations for 7-pt. easy-hard scale as a function of stimulus and response C, practice pair and set

<table>
<thead>
<tr>
<th></th>
<th>C Response</th>
<th></th>
<th>A Response</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C</td>
<td></td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>X S.D.</td>
<td>X S.D.</td>
<td>X S.D.</td>
</tr>
<tr>
<td>I</td>
<td>5.4 1.20</td>
<td>5.4 1.02</td>
<td>4.6 0.80</td>
</tr>
<tr>
<td>A-A</td>
<td>4.3 1.62</td>
<td>4.6 1.50</td>
<td>4.0 0.89</td>
</tr>
<tr>
<td>V</td>
<td>5.2 1.83</td>
<td>4.8 1.17</td>
<td>4.5 1.63</td>
</tr>
<tr>
<td>A-A</td>
<td>4.5 1.43</td>
<td>4.3 1.35</td>
<td>4.3 1.10</td>
</tr>
<tr>
<td>R</td>
<td>4.7 1.49</td>
<td>4.9 1.59</td>
<td>4.4 0.80</td>
</tr>
<tr>
<td>A-A</td>
<td>5.2 1.25</td>
<td>5.0 1.00</td>
<td>3.9 1.64</td>
</tr>
</tbody>
</table>
TABLE 6
Mean ratings for 7-pt. no pairs - all pairs
scale as a function of stimulus and
response C, practice pair and set

<table>
<thead>
<tr>
<th></th>
<th>C Response</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X S.D.</td>
<td>X S.D.</td>
<td>X S.D.</td>
<td>X S.D.</td>
<td></td>
</tr>
<tr>
<td>C-C</td>
<td>5.8</td>
<td>0.87</td>
<td>5.4</td>
<td>0.80</td>
<td>5.7</td>
</tr>
<tr>
<td>A-A</td>
<td>5.4</td>
<td>1.74</td>
<td>5.0</td>
<td>1.10</td>
<td>5.7</td>
</tr>
<tr>
<td>C-C</td>
<td>5.9</td>
<td>1.14</td>
<td>5.0</td>
<td>0.89</td>
<td>5.5</td>
</tr>
<tr>
<td>A-A</td>
<td>5.3</td>
<td>1.19</td>
<td>5.2</td>
<td>1.40</td>
<td>5.4</td>
</tr>
<tr>
<td>C-C</td>
<td>5.8</td>
<td>1.33</td>
<td>5.0</td>
<td>1.41</td>
<td>4.5</td>
</tr>
<tr>
<td>A-A</td>
<td>5.3</td>
<td>1.27</td>
<td>4.7</td>
<td>1.10</td>
<td>4.1</td>
</tr>
</tbody>
</table>
The analysis of the Easy-Hard ratings is summarized in Table 7, Appendix D. The significant effects of both stimulus C (F = 51.68, p < .01) and response C (F = 16.88, p < .01) reflect the potency of C, even on mediation reports. Subjects indicated that it was easier to follow their set when the stimulus or response was concrete than when either was abstract. The stimulus C x response C interaction (F = 14.65, p < .01) shows further that employing a particular technique was rated as equally easy for C-C and C-A pairs, more difficult for A-C and most difficult with A-A pairs.

Although the type of practice pair had no effect on learning, subjects reported that their set was easier to follow after practicing with C-C than with A-A pairs (F = 5.02, p < .05). The lack of any effects involving set reveals that subjects reported that repetition was as easy to use as the two types of mediators.

The summary of the analysis of the "No Pairs - All the Pairs" scale is given in Table 8, Appendix D. Subjects reported following their set more often with pairs of concrete than abstract stimuli (F = 8.66, p < .01) and responses (F = 12.48, p < .01) and more often after practicing with C-C than A-A pairs (F = 3.48, p < .01). The main effect of set (F = 4.72, p < .01) is due to subjects reporting that they followed the I and V sets more often than the Repetition set.

On the second page of the questionnaire, the subject
wrote a description of how he learned each pair. Two judges independently classified each description into one of four categories: imaginal mediator, verbal mediator, repetition and unclassifiable. The correlation between the classification for the two judges was .95. A mean score for each subject for each of the four categories was obtained by averaging the classifications of the two judges. The means of these scores for each group, indicating the mean number of pairs for which subjects reported following their set, appear in Table 7. Since most subjects reported following their instructed set, a dichotomy of followed the set vs. did not follow the set was used for the analysis.

Table 9, Appendix D, gives the summary of the analysis of variance of the reported mediations. The main effects of stimulus C (F = 4.76, p < .05) and response C (F = 3.98, p < .05) indicate that subjects reported using their instructed technique more often when either the stimulus or the response term was concrete. The set effect (F = 43.52, p < .01) reveals that subjects reported following the R set for fewer pairs than either the I or V sets. The latter two did not differ significantly from each other.
TABLE 7
Mean total number of pairs (and standard deviations) for which subjects reported following their set as a function of stimulus and response C, practice pairs, and set

<table>
<thead>
<tr>
<th></th>
<th>C Response</th>
<th>A Response</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X S.D.</td>
<td>X S.D.</td>
</tr>
<tr>
<td>C-C</td>
<td>14.3 1.35</td>
<td>12.9 1.87</td>
</tr>
<tr>
<td>A-A</td>
<td>13.9 2.43</td>
<td>12.6 3.56</td>
</tr>
<tr>
<td>C-C</td>
<td>13.9 2.17</td>
<td>12.2 4.47</td>
</tr>
<tr>
<td>A-A</td>
<td>13.0 2.53</td>
<td>13.2 1.72</td>
</tr>
<tr>
<td>C-C</td>
<td>8.6 5.52</td>
<td>10.1 3.83</td>
</tr>
<tr>
<td>A-A</td>
<td>9.1 4.55</td>
<td>8.3 3.07</td>
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</table>
DISCUSSION

The set by type of pair interaction of the mediation phase and the subjects responses on the post-experimental reports suggest that the instructions were successful in encouraging subjects to employ different learning techniques. The differential effect of type of pairs (C-C versus A-A) on the latency of mediator discovery for the I and V set groups indicates that the subjects in these two groups were employing different types of mediators. On one 7-point scale, subjects responded that they followed their set for more than half the pairs. This was true as well for their written descriptions of their mediators. The use of these different techniques by the subjects in the three set groups resulted in differential performance during learning. This is discussed below, first considering the general effects of set and then the interaction of set with item C.

The main effect of the set variable on learning was the superior recall of the I and V set over the R set group. This main effect, obtained on trials one and two, indicated that instructions to use repetition interfere with PA learning. The interfering effect of repetition may be due to the subject being unable to find mediators.
Indirect support for this is found in the reduced effect of stimulus and response C when subjects were instructed to use repetition. Since variation in C appears to influence the effectiveness of both imaginal and verbal mediation, the smaller effect of C with repetition suggests that these subjects were not using mediators. The reduced C effect was obtained only on the first trial, however, and by the third trial the R set group recalled as many pairs as the I and V set groups. A possible interpretation of this finding is that the subjects in the R set condition attempted to use repetition only on the first trial, but, having little success with the technique, they changed on the next trial to some form of mediation strategy, (cf. Paivio & Yuille, 1967). Some indication of this is found in the post-experimental questionnaire. Subjects in the R groups reported following their set for fewer pairs than subjects in the other two set conditions. The interpretation that subjects switch from repetition to mediation could be tested by giving appropriate instructional sets and interrupting subjects at various stages in learning to question them concerning their learning techniques.

The predicted interaction of pair and set was obtained in the mediation phase of the study, suggesting that imaginal and verbal mediators are equally available for C-C pairs but only verbal mediators are readily aroused by A-A pairs of nouns. This represents a replication of
a similar finding by Yuille and Paivio (in press) and, since the latter study involved armed forces personnel, different lists, and a different procedure, it indicates the generality of the finding. Thus, one aspect of the imagery hypothesis is well supported: noun \( \mathcal{Q} \), especially of the stimulus member affects the discovery of imaginal but not verbal mediators.

Although lending support to the imagery hypothesis, the latencies of mediator discovery might be interpreted as too long to be useful in PA learning. The mean latencies varied from 6.92 to 10.11 seconds, while the inter-pair interval during the learning phase was 5 seconds. However, requiring subjects to report their mediators probably results in key-press latencies that are considerably longer than the arousal latencies for the symbolic mediation processes themselves. For example, the subject may not have pressed the switch immediately upon discovering a link but first "checked" to see if an adequate description of the mediator could be given. Socially unacceptable links might also have been rejected for more acceptable ones (Yuille, 1965). The effect of requiring verbal descriptions on the key-press latency of reported imagery to individual nouns has been investigated by Simpson and Paivio (in preparation). They found that latencies were significantly longer when a verbal description was required than when it was not, suggesting that the latencies of mediator discovery in the present
study were probably briefer than indicated by the overt response.

The prediction that the I and V set subjects would be differentially affected by variation in noun C was not supported. The lack of an imagery-verb difference might be due to the subjects in the I and V set conditions using the same mediation technique. It is possible that subjects employed verbal mediation exclusively. The results of the mediation phase indicate that the discovery of verbal mediators is unaffected by variation in noun concreteness. Accordingly the learning of pairs with verbal mediators should not have been affected by C. The results of the learning phase, with recall by subjects in all conditions influenced by C, suggests that some process other than verbal mediation was operative. In other words, although all the subjects may have used verbal mediators, the use of this device alone cannot account for the learning results. Perhaps, some correlate of C was operative in the study. However, those variables known to be related to PA learning (i.e., m and frequency) were controlled. It is noted that the abstract words are generally longer than the concrete nouns which might have affected the subjects recognition of the stimulus and response members. Winnick and Kressel (1965) found that tachistoscopic recognition thresholds were not different for concrete and abstract words. It seems unlikely then that the C effect can be explained solely in terms of verbal mediation.
Subjects may have been using both types of mediators, verbal and non-verbal to link the pairs, with the two differentially affected by C. Schulz and Lovelace (1964) suggested that the discovery and the utilization of mediators are two different aspects of the mediation process: discovery is a necessary but not a sufficient condition for effective mediated association. The mediation latency phase in the present study and the Yuille and Paivio (in press) study assessed the effects of noun C on the discovery of imaginal and verbal mediators. The PA learning results of the present study suggest that both imaginal and verbal mediation are effective (i.e., the mediators can be discovered and utilized) with concrete stimulus pairs and thus recall was higher for C-C and C-A pairs. With abstract stimulus pairs, however, imaginal mediators are apparently difficult to discover while the more easily discovered verbal mediators may be difficult to utilize. In other words, although discovery of verbal links is unaffected by C, the utilization of these links is affected. The inability of subjects to use verbal mediators could be due to a number of possible factors. For example, perhaps verbal mediators are subject to interference. Recall of a specific verbal link might be affected by interference from other mediators the subject employed in learning a list of pairs. Such an interpretation resembles the interference paradox suggested by Underwood and Schulz (1960). Although no research has been conducted to directly test this idea, a series
of studies summarized by Rohwer (1966) is related. Rohwer, Lynch, Levin and Suzuki (in press) found that linking pairs of nouns by a sentence facilitated recall. The sentential facilitation was found to be greater when a verb joined the two nouns. If the link involved a conjunction or preposition, the facilitation was less. Rohwer, Shuell and Levin (in preparation) found that the sentence effect was not caused by differences in availability of responses to different types of mediators, which suggests that the effectiveness of verbal mediators may not be related to interference.

The studies reported by Rohwer (1966) as well as subsequent investigations (e.g., Rohwer, Lynch, Suzuki and Levin, unpublished paper) involved subjects learning either concrete pairs or pairs of pictured objects. Rohwer's systematic investigation, with only concrete material, has led him to postulate that imaginal processes may underly the verbal effect. Also, Bower (1967) has recently suggested the importance of imagery in mediating associative learning. Thus, overt verbal mediation may involve covert pictorial representation. This interpretation is well suited to the results of the present study. If verbal mediation requires concomitant imaginal representation to be effective, then subjects employing verbal mediators with pairs containing abstract stimuli would not be expected to have higher recall than subjects employing images. The ineffectiveness of the two types of mediators
with abstract material is for two different reasons: imaginary mediators are difficult to discover while verbal mediators although easily discovered, are ineffective because imaginal representation must accompany them.

To summarize, the interpretation which seems best suited to the data is that 1) both verbal and imaginal mediators can be discovered to mediate noun pairs, the former more rapidly than the latter with abstract noun pairs and 2) that only imaginal links are readily utilized as effective mediators of response retrieval. The one result which may be viewed as discrepant with this interpretation is the equal recall of concrete stimulus pairs by subjects given the I and V sets. If imagery is more effective a superiority of the I set group might be expected. The suggestion of such a difference in Figure 3 cannot be taken as evidence of a real difference. Future investigations will reveal the efficacy of this interpretation.

A study has recently been completed by Yarmey and Csapo (1967) in which were obtained results differing in some respects from those present here. They instructed two groups of subjects each to use imaginal mediators, verbal mediators, or both imaginal and verbal mediators, while two groups received no mediation instructions. One group under each instruction condition learned a 10 pair C-C list, the other group a 10 pair A-A list. Thus eight groups of subjects were used in a 4 by 2 factorial design.
Their subjects had no practice pairs with which to practice the instructed technique and a 10 second recall interval was used. Consistent with the findings of the present study, subjects given the imagery and verbal set recalled C-C pairs equally well. However, with the A-A list the verbal set subjects recalled significantly more pairs than subjects given the imagery set. Because the latter finding is discrepant with the results of the present investigation, that part of the Yarmey and Csapo design was replicated using their lists, instructions, and procedure. This involved presenting a list of 10 A-A pairs to two groups of subjects for 4 learning and recall trials. One group was read the imagery instructions, the other group the verbal instructions. The PA material was presented auditorially via a tape recorder. The results showed no significant difference in recall on any trial between the two groups, supporting the results of the present study. The procedure employed by Yarmey and Csapo involved using intact groups, with only one group of subjects in each condition. Thus, it is possible that the imagery-verbal set difference they obtained results from group experimental error (cf. Lindquist, 1952). While the issue needs to be explored further, the evidence suggests that verbal mediation is not more effective than imaginal mediation when learning 10-pair or 16-pair lists of abstract stimuli with either 8 or 10 second recall intervals.

It should be emphasized, finally, that the most potent
variable in this study was noun C. The variation of C on both the stimulus and the response side of pairs accounted for the largest proportion of the variance in recall scores. As predicted, and consistent with previous findings, variation in stimulus C had a larger effect than variation in response C. A comparison of recall for A-C and A-A pairs reveals, however, that the response variable does have a large effect on recall when the stimulus is abstract. This may reflect the fact that both members of a pair contribute to the discovery of a mediators during study trials (hence the superiority of C-C over C-A pairs). With A-C pairs, the response may prime S to find an associative image to the stimulus term so that imagery can be used to mediate the pair. Such priming is much less likely to occur with A-A pairs and so recall of these pairs is very poor.

The effect of noun C on learning was large enough to over-shadow the instruction effects. Although the mediation instructions did have some differential effect, the set effects were still small in comparison with item C. Since subjects were university students and have had a number of years of experience dealing with concrete and abstract material, we might expect that they have acquired certain habits for handling this material. The instructional sets could not be expected to completely alter these habitual associative reactions to concrete and abstract nouns. Perhaps the differential effect of sets would be stronger if children were used as subjects, in as much as children
should experience less interference of habitual reactions to instructional sets.

This attack on the problem of distinguishing different mediation processes has resulted in the tentative conclusion that imagery is the most effective type of mediation when learning pairs of nouns. The problems of the subject's previous learning history as well as experimental parameters such as list length and presentation intervals, must be examined to assess the efficacy of this conclusion.
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APPENDIX A

Mean values for imagery ratings (I), meaningfulness (M), frequency of occurrence (F), and concreteness ratings (C) for 64 concrete and 64 abstract nouns.
## APPENDIX A

### CONCRETE NOUNS

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APPENDIX B

The six original 16 pair

PA Lists
APPENDIX B

List CCl

Microscope - Alcohol
Nail - Goblet
Avenue - Physician
Harp - Abdomen
Automobile - Monk
Mother - Elbow
Professor - Skin
Factory - Square
Tweezers - Keg
Vest - Honeycomb
Slipper - Iron
Forehead - Hurdle
String - Maiden
Dress - Building
Boulder - Machine
Circle - Bungalow
LIST C02

Engine - Bar
Corner - Jelly
Officer - Cord
Pianist - Wigwam
Hound - Body
Macaroni - Damsel
Girl - Newspaper
Student - Acrobat
Tablespoon - Accordian
Chief - Tomb
Hotel - Lip
Lad - Chin
Lark - Gentleman
Tripod - Letter
Seat - Hairpin
Doll - Village
LIST CAI

Microscope - Promotion

Nail - Malady

Avenue - Interest

Harp - Truth

Automobile - Immunity

Mother - Event

Professor - Evidence

Factory - Situation

Tweezers - Necessity

Vest - Enterprise

Slipper - Virtue

Forehead - Legislation

String - Heredity

Dress - Capacity

Boulder - Ownership

Circle - Occasion
LIST CA2

Engine - Cost
Corner - Magnitude
Officer - Fault
Pianist - Tribute
Hound - Memory
Macaroni - Spirit
Girl - Idea
Student - Theory
Tablespoon - Advice
Chief - Trouble
Hotel - Satire
Lad - Citation
Lark - Attitude
Tripod - Belief
Seat - Democracy
Doll - Economy
LIST AAl

Malady - Promotion
Welfare - Explanation
Interest - Origin
Truth - Investigation
Immunity - Expression
Event - Deduction
Evidence - Ability
Situation - Violation
Necessity - Hypothesis
Enterprise - Deceit
Virtue - Miracle
Legislation - Duty
Heredity - Episode
Capacity - Answer
Ownership - Intellect
Occasion - Perception
LIST AA2

Cost - Perjury
Magnitude - Thought
Fault - Method
Tribute - Effort
Memory - Adversity
Spirit - Opinion
Idea - Honour
Theory - Mind
Advice - Mercy
Trouble - Quality
Satire - Amount
Citation - Simile
Attitude - Chance
Belief - Amendment
Democracy - Custom
Economy - Decree
APPENDIX C

The imagery, verbal and repetition set instructions
APPENDIX C

INSTRUCTIONS FOR IMAGERY SET

Please listen carefully. This is an experiment on learning pairs of words. You will learn a number of pairs of words so that when you are shown the first word of a given pair you can tell me the second word that goes with it. This learning of pairs will not be done until later, however, and I will describe the method in detail then.

What I want you to do now is this. I want you to practice a technique that will help you to learn the pairs. The technique involves using mental images as links. That is, using a mental picture of the objects or events suggested by two words to link them together. When using this technique you link the two words by thinking of some mental picture which the words remind you of, and which includes things or events suggested by both the words, that are to be associated. Then, if the first word is presented alone it brings to mind the mental picture which will remind you of the second word of the pair. For example, on seeing the pair "garden - money" you might "picture" or imagine a garden with money growing on it. Later, when the word "garden" is presented alone it brings to mind the mental picture and you remember the second word "money". Try
linking "garden - money" this way.

In a moment, you will be presented a number of pairs of words, one pair at a time. I don't want you to learn these pairs, but I want you to link each pair of words, as quickly as you can, by a mental image. In other words, I want you to practice using this linking technique. Use only mental images to link each pair. So for each pair of words find an image (that is a mental picture) linking the second word of the pair with the first word. For example, if you were given a pair MAN DOOR you might use the image of a man at a door or a man going through a revolving door to connect the pair.

Now each pair of words will appear on the screen in front of you. The moment you get a picture that links the objects or events suggested by the two words press the switch in front of you. Immediately after you press the switch, briefly describe the image you used. There are three practice pairs at the beginning to familiarize you with the procedure. Are there any questions?

Now you are to learn a list of pairs of words. These words are new ones and not related to the words you just used for practice. Use the technique you just practiced with all the pairs of words you are to learn. As soon as you see a pair of words, quickly form a mental picture which links the objects or events suggested by the words. Do this in the way you just practiced. How well you do will depend on how effectively you use mental picture.
After you have seen each pair in the list the first word of each pair will be presented alone and in a different order than the paired list. You say out loud the second words that you remember. So, you will first see the pairs of words. Then the first word of each pair alone and you try to say the word that was paired with it. There will be four of these trials in all.

Are there any questions?
INSTRUCTIONS FOR VERBAL SET

Please listen carefully. This is an experiment on learning pairs of words. You will learn a number of pairs of words so that when you are shown the first word of a given pair you can tell me the second word that goes with it. This learning of pairs will not be done until later, however, and I will describe the method in detail then. What I want you to do now is this. I want you to practice a technique that will help you to learn the pairs. The technique involves using words as links. That is, using a word or sentence to connect the two words together. When using this technique, you link the two words by forming a phrase or sentence using both the words that are to be associated. Then, if the first word is presented alone it brings to mind the word or sentence which will remind you of the second word of the pair. For example, on seeing the pair "garden - money" you might think of the sentence "garden vegetables earn money". Later, when the word "garden" is presented alone, it brings to mind the sentence and you remember the second word "money". Try linking "garden" and "money" in this way.

In a moment, you will be presented a number of pairs
of words, one pair at a time. I don't want you to learn these pairs, but I want you to link each pair of words, as quickly as you can, by another word or phrase. In other words, I want you to practice using this linking technique. Use only words or phrases to link each pair. So for each pair of words find a word or phrase linking the second word of the pair with the first word. For example, if you were given the pair MAN DOOR you might use the word made (man made door) or the phrase is knocking at (man is knocking at door) to connect the pair.

Now each pair of words will appear on the screen in front of you. The moment you get a word or phrase that links the two words, press the switch in front of you. Immediately after you press the switch, briefly describe the word or phrase you used. There are three pairs at the beginning to familiarize you with the procedure. Are there any questions?

Now you are to learn a list of pairs of words. These words are new ones and not related to the words you just used for practice. Use the technique you just practiced with all the pairs of words you are to learn. As soon as you see a pair of words, quickly form a sentence which links the words. Do this in the way you just practiced. How well you do will depend on how effectively you use the word links.

After you have seen each pair in the list, the first word of each pair, will be presented alone and in a different order than in the paired list. You say out loud the second
words that you remember. So, you will first see the pairs of words. Then the first word of each pair alone and you try to say the word that was paired with it. There will be four of these trials in all.

Are there any questions?
INSTRUCTIONS FOR REPETITION SET

Please listen carefully. This is an experiment on learning pairs of words. You will learn a number of pairs of words so that when you are shown the first word of a given pair you can tell me the second word that goes with it. This learning of pairs will not be done until later, however, and I will describe the method in detail then.

What I want you to do now is this. I want you to practice a technique that will help you to learn the pairs. The technique involves using repetition. That is, repeating the two words over a number of times to link them together. When using this technique you repeat each pair of words that are to be associated. Then if the first word is presented alone, the repetition will have made remembering the second one easier. For example, on seeing the pair "garden - money" you would repeat this five or six times. Later, when hearing the word "garden" the second word "money" would be easily remembered. Try repeating "garden - money" a few times.

In a moment, you will be presented a number of pairs of words, one pair at a time. I don't want you to learn these pairs but I want you to repeat each pair a number of times - out loud in rapid succession. In other words, I
want you to practice using this linking technique. Use only repetition to link each pair. So for each pair of words repeat the first word followed by the second word.

Now each pair of words will appear on the screen in front of you. For each pair repeat the pair, out loud, a number of times while it is on the screen. There are three practice pairs to familiarize you with the procedure. Are there any questions?

Now you are to learn a list of pairs of words. These words are new and not related to the words you just used for practice. Use the technique you just practiced with all the pairs of words you are to learn. As soon as you see a pair of words, quickly repeat it a number of times. Do this in the way you just practiced. How well you do will depend on how effectively you use repetition.

After you have seen each pair in the list, only the first word of each pair will be presented alone in a different order than in the paired list. You say out loud the second words that you remember. So, you will first see the pairs of words. Then the first word of each pair alone and you try to say the word that was paired with it. There will be four of these trials in all. Are there any questions?
APPENDIX D
Analysis of Variance
Tables
TABLE 1

Summary of Analysis of Variance for Latency

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***p<.01    \quad F_{max} = 2.7 (p>.05)
TABLE 2
Summary of Analysis of Variance
of Recall Scores \( N = 240 \)

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* p < .05  ** p < .01


**TABLE 3**

Summary of Analysis of Variance
of Recall Scores for Trial 1

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***p < .01

F_{max} = 19.0 (p > .01)
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** p<.01  \( \text{F}_{\text{max}} = 21.8 \ (p > .01) \)
TABLE 5
Summary of Analysis of Variance
of Recall Scores for Trial 3

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** p < .01
Fmax = ∞ (due to cells with 0 variance)
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** p < .01

Fmax = ∞ (due to cells with 0 variance)
TABLE 7
Summary of Analysis of Variance for
7 - pt. easy-hard scale rating

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* p < .05  Fmax = 5.25, p > .05
** p < .01
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*p < .05
**p < .01

Fmax = 4.98 (p > .05)
TABLE 9

Summary of Analysis of Variance for mean total number of pairs for which Ss reported following set

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*p < .05

**p < .01

$F_{max} = 17.0\ (p < .01)$