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MNEMONIC INSTRUCTIONAL SETS AND THE ACQUISITION AND RETENTION OF CONCRETE AND ABSTRACT WORDS

BY

© FRANKLIN C. GELIN

A THESIS

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled "Mnemonic Instructional Sets and the Acquisition and Retention of Concrete and Abstract Words" submitted by Franklin C. Gelin in partial fulfilment of the requirements for the degree of Doctor of Philosophy.

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ABSTRACT

The main purpose of this research was to investigate the effects of imagery, verbal, and repetition instructional sets on the acquisition and retention of familiar concrete or abstract noun pairs. Each subject was presented with four different paired-associate lists containing either high-imagery concrete or low-imagery abstract noun pairs. The concrete and abstract nouns were selected on the basis of subject-rated imagery values and were matched for equivalent mean and standard deviation meaningfulness values. The same stimulus items were paired with new response items in each list forming an A-B, A-C, A-D, A-E interference paradigm. An attempt was made to equate for habit strength at the end of original learning by using a presentation procedure that allowed for particular word pairs, as they were learned, to be dropped from subsequent study trials but reinstated on a criterion test trial. After four lists had been learned to a specified performance criterion, the subjects were given an unpaced recall test for the response items from all lists. On the basis of a dual-coding hypothesis, it was predicted that fewer acquisition errors and more correct final recall responses would occur: for concrete words than for abstract words; for imagery and verbal set conditions than for repetition set conditions; for the concrete-imagery condition than for the concrete-verbal condition; and for the abstract-verbal condition than for the abstract-imagery condition. All hypotheses, except the last, were confirmed. The results were discussed in reference to verbal and imaginal processing and associative interference theory.

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CHAPTER I

INTRODUCTION

In the last sixty years much time and effort has been spent by experimental psychologists in an attempt to clarify how two elements, A and B, can come to be associated with one another. Historically, the notion that A and B are experienced close together in time has been offered as a basis for an explanation of associational processes. The most difficult problem of the contiguity-over-time hypothesis is its inability to explain how new associations are so easily formed when there has been no obvious history of contiguous association between the new elements. It is the concept of mediation as an intervening process between the initial stimulus and the terminal response that has been postulated as an explanatory concept in accounting for these apparently noncontiguous associations (Deese & Hulse, 1967).

The learning of several A-B pairs can be conceptualized as consisting of three functionally separate processes: the integration of the stimuli; the integration of the responses; and the association of the appropriate stimulus elements with the appropriate response elements. These processes need not occur sequentially but may overlap in time

(Kjeldergaard, 1968). With reference to the associational process, there are two criteria for the inference of mediating responses and response produced stimuli. The first criterion is the observation of, or grounds for inferring, the occurrence of one or more responses subsequent to the initiating stimulus and prior to the terminating response. The second criterion is the demonstration that such temporally intermediate responses and stimuli have actual or potential facilitative or inhibitory effects on one or more measures of the occurrence and strength of the terminating response (Goss, 1961).

The purpose of this paper is to contrast two particular kinds of mediators. One is of long standing tradition in psychological learning theory and the other is just beginning to make an impact on the contemporary verbal learning scene. The former refers to implicit verbal mediators while the latter pertains to nonverbal imagery.

This thesis will be partitioned into five remaining chapters. Chapter II will provide a review of the literature relevant to the research aims of this dissertation and will be the foundation for the rationale and hypotheses discussed in Chapter III. In Chapter IV a detailed description of the experimental design and methodology employed in the study will be presented. Chapter V will include a summary of all statistical analyses performed on the raw data. Finally, Chapter VI will discuss these results in relationship to the hypothesized predictions and theory underlying the research. The potential implications of these findings to education will be briefly discussed.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

Perhaps the most serious problem in the study of mediators is that, for the most part, they are unobservable and thus the basis for their identification must be inferential. This hurdle has not, however, deterred the formulation of very extensive and elaborate hypothetical constructs and intervening variables in the development of psychological theory. Even Watson (1913), although rejecting the utility of nonobservable images as having no functional significance to the understanding of thought and memory, did postulate nonobservable implicit verbal responses as critical to the development of a theory of learning (Watson, 1930). It is interesting to speculate that perhaps it was because of Watson's rejection of mental imagery that the cognitive psychologists such as Köhler (1929) were quick to postulate visual imagery as an explanatory base to account for the ease with which meaningful words can be learned relative to nonsense syllables. It must be remembered that the usefulness of a mediational construct lies in the degree to which the construct facilitates the development of a more coherent and parsimonious theory than could be produced without it (Hilgard & Bower, 1966). There is no escape from the inferential process of mediational identification; we can only correlate observables with observables. As Reese (1970b) has pointed out, if we observe a characteristic electroencephalographic pattern each time a subject reports the use of visual imagery, our correlation is not between imagery and cortical activity but between the subject's report (about visual imagery) and cortical activity.

Meaningfulness and Imagery

Of the many variables that have been investigated to date with regards to paired-associate learning, much attention has been paid to meaningfulness of the stimulus and response elements. Meaningfulness has been measured in several ways: the frequency, latency, or number of associations elicited by a verbal item; the frequency with which the item is experienced; and the familiarity or the pronounciability of the verbal item. The most frequent explanation posited to account for the facilitating effect of meaningfulness upon associative learning has been based in terms of the availability of implicit verbal mediators. The greater the number of associates elicited by the stimulus and the response item, the greater is the probability that a common associate will be found between them (Underwood & Schulz, 1960).

Contemporary research on imagery assumes a different interpretative framework. Reese and Lipsitt (1970) have conceptualized an image as the experience of a sensation in the absense of the original stimulus. Similarly, Bower (1970a) has described an image as presenting "to the experiencing subject some of the same structural information as was presented in one or more earlier perceptions of the object which the imagery is of (p. 502)." Operationally, imagery values for words are obtained by subjective ratings of the relative ease with which some words arouse a sensory experience, such as a mental picture or sound. Another method requires the subjects to rate words on an abstractness-concreteness dimension. The assumption here is that a word's concreteness value is highly correlated with its imagery value. Paivio, Yuille, and Madigan (1968) found the correlation to be .83 with the ratings of imagery and concreteness for 959 nouns. The imperfect correlation was partly attributed to emotional words (e.g. passion, anger) and names of fictitious entities (e.g. ghost, devil) which were rated high in imagery but low in concreteness.

Prior to the recent upsurge of experimentation by Allan Paivio and his colleagues at the University of Western Ontario, very little research utilizing imagery as a theoretical construct was conducted. This paucity of research was probably related to Watson's (1913) rejection of imagery as a useful concept and the dominance of behaviorism in the verbal learning arena. Because the observed stimulus and response were verbal, perhaps it seemed reasonable or more direct and parsimonious to infer that the mediating mechanism was verbal in nature. As Paivio (1969) has pointed out, however, there is no logical reason why one should assume a one-to-one relationship between an associative reaction and the mental process that caused it. After all, if we can respond verbally to both pictures and words, there is no logical reason for not postulating a "mental picture" rather than a "mental word" as mediating a verbal response.

Paivio (1969) has formulated the functional significance of imagery in terms of a "conceptual-peg" hypothesis. Paivio's hypothesis first assumes that imagery can serve as a mediator in associational learning paradigms. The conceptual peg refers to the nominal stimulus which becomes functionally linked to a response item during contiguous presentation by way of some mediational process. When the mediational mechanism is imagery, the degree of facilitation will depend on the image-arousing value of both stimulus and response members. The mediational link consists of a compound image resulting from an amalgam of the images aroused by each of the stimulus and response members during contiguous association. During presentation of only the stimulus item on recall trials, the image aroused by the stimulus becomes especially critical as it serves as the cue that reinstates the compound image from which the correct response can be retrieved. Thus, the prediction follows that stimulus and response items high in imageryevoking potential will be learned faster than corresponding item pairs low in imagery value; furthermore, the positive effects of imagery will be greater on the stimulus side than on the response side. The latter hypothesis is in direct contrast to meaningfulness in which the positive effect is predicted to be greatest on the response side (Goss & Nodine, 1965; Underwood & Schulz, 1960).

In order to test the conceptual-peg hypothesis, Paivio, Yuille, & Madigan (1968) first had groups of university students scale 925 nouns for concreteness, imagery, and meaningfulness. The operational definition of these terms is inherent in the instructions to the subject.

> Any word that refers to objects, materials, or persons should receive a high concreteness rating; any word that refers to an abstract concept that cannot be experienced by the senses, should receive a high abstractness rating . . . (p. 5)
>
> Nouns differ in their capacity to arouse mental images of things or events. Some words arouse a sensory experience, such as a mental picture or sound, very quickly or easily, whereas others may do so only with difficulty (i.e., after a long delay) or not at all. The purpose of this experiment is to rate a list of words as to the ease with which they arouse mental images. Any word which, in your estimation, arouses a mental image (i.e., a mental picture, or sound or other sensory experience) very quickly and easily should be given a high imagery rating; any word that arouses a mental image with difficulty or not at all should be given a low imagery rating . . . (p. 4)

The above two attributes were rated on a seven point low-imagery - high-imagery scale or high-abstractness - high-concreteness scale. Meaningfulness ratings were collected using the production method (Noble, 1952) in which the subjects were given 30 seconds to list as many associates as possible to the key word.

Substantial inter-correlations were found to exist among the three attributes with imagery and concreteness correlating .83, imagery and meaningfulness correlating .72, and concreteness and meaningfulness correlating .56. It was argued (Paivio et al., 1968) that much of the independence of meaningfulness from imagery and concreteness resulted from a number of items that were low on imagery and concreteness but high on meaningfulness. The converse did not hold true; that is, items high on imagery and concreteness were also high on meaningfulness.

A large number of studies using college students as subjects have compared the relative effectiveness of imagery and meaningfulness when the two variables were independently varied over an equivalent range of standard score units based on the normative word sample discussed above (Paivio, 1969, 1970; Paivio, Smythe, & Yuille, 1968; Paivio & Yuille, 1967; Smythe & Paivio, 1968). Since the results of these experiments are consistent with one another, the findings from only one study will be presented. Paivio, Smythe, & Yuille (1968) constructed three basic noun-noun paired-associate lists. From each basic list, four lists were developed varying high and low stimulus and response values of one critical attribute. Four lists varied stimulus and response high- or low-imagery values and controlled for meaningfulness. Another four lists varied stimulus and response meaningfulness values, keeping imagery constant. The remaining four lists covaried both imagery and meaningfulness values. The results of the experiment confirmed the predictions derived from the conceptual-peg hypothesis. Nouns rated high in their value for imagery were learned faster than were low-imagery nouns and the noun-imagery effect was greater on the stimulus side than on the response side. These results persisted even when meaningfulness was controlled across variations of imagery values. The only significant effect of the four lists varying in meaningfulness was a negative effect with recall for low-low pairs higher than for other pair types. Although this finding is not unique (see Smythe & Paivio, 1968), it is still somewhat puzzling. Perhaps superiority of low-low meaningfulness pairs reflects the complex "interference paradox" of associative probability theory (Underwood & Schulz, 1960). The paradox reflects two conflicting predictions: the greater the number of verbal associates the greater is the probability that a connection can be made between the stimulus and response elements; the greater the number of responses (implicit or explicit) available to a particular stimulus, the greater is the potential interference between the stimulus and response elements. Perhaps the specific low-low meaningful pairs in contrast to the other three lists were such that the negative effects from interference were less than the positive effects produced by a specific level of associative probability. In the four covaried lists the only significant main effect resulted from superior performance on the high-high list. In a review of this study and others, Paivio (1969) stated: "The conclusion from these studies is clear. The relations between noun imagery and PA learning not only can not be interpreted in terms of m (meaningfulness), but imagery is the more potent of the two empirical variables (p. 246)."

Evidence for the Imagery-Verbal Processing Distinction

The major thesis implicit in the discussion so far is that there exist at least two basic mediational processes in learning: a nonverbal imagery process in addition to a verbal symbolic one. Since both processes are, to a degree, only inferential in nature, what evidence is there that two processes need to be postulated? It is known that when college students are instructed to use imagery to learn paired-associates, recall will be one and a half to three times better than for control subjects who are given no specific instructions but are allowed to use whatever strategy they so desire (Bower, 1969). One might wish to argue, however, that imagery instructions may simply encourage the subjects to utilize elaborate verbal encoding processes. Negative evidence for such a possibility will be discussed below.

There are several lines of evidence against reducing the effects of imagery to a verbal linguistic coding process. Concrete words such as bouquet, pianist, and boulder seem to have a higher imagery content for most individuals than do such words as effort, satire, and necessity although all six words are relatively equal in meaningfulness value (Paivio et al., 1968). When subjects are requested to press a key upon discovery of an imaginal mediator, the latencies are longer for abstract pairs than for concrete pairs. When asked to discover a verbal mediator, however, latencies do not differ for abstract or concrete word pairs (Colman & Paivio, 1970; Paivio, 1966; Yuille & Paivio, 1967, 1968). Analogous results have been found when subjects are required to respond to single stimulus items rather than to word pairs (Ernest & Paivio, 1971).

Subjective reports have also supported the relationship of imaginal mediators to a stimulus-response concreteness dimension. In the Paivio et al. (1968) study which contrasted lists varying either imagery or meaningfulness or covarying both attributes, subjective reports based on a post-learning questionnaire revealed that the reported use of imagery correlated more highly with stimulus concreteness or learning scores than did the reported use of verbal mediators or repetitional rehearsal strategies. Not only are concrete words easier to learn than abstract words but subjects report using images more frequently when the stimuli are concrete.

The importance of stimulus imagery has been confirmed in several paired-associate experiments where it has been found that forward recall exceeds backward recall for concrete-abstract word pairs but backward recall exceeds forward recall for abstract-concrete word pairs (Bower, 1969;

Lockhart, 1969; Yarmey & O'Neill, 1969).

Since concreteness of the stimulus materials is directly related to memorability, recall should be best for actual objects and worst for names of abstract concepts with pictures of objects and names for concrete objects falling in between. Several investigators have provided support for this hypothesis (Epstein, Rock, & Zuckerman, 1960; Iscoe & Semler, 1964; Jenkins, Neale, & Deno, 1967).

Instructional set has been shown to affect the learning rates of concrete high-imagery nouns. Comparisons have been made between an imagery set, a verbal set, a repetition set, and a control condition in which no specific instructions on how to learn are given (Bower, 1969, 1970c; Bower & Winzenz, 1970; Paivio & Foth, 1970; Paivio & Yuille, 1967; Yarmey & Csapo, 1968; Yuille & Paivio, 1968). An imagery set instructs the subject to form images related to the referents of the given word pair. It is usually suggested that the images be superimposed on each other so that they are interacting in some meaningful although perhaps bizzare fashion. The verbal set either asks the subject to read a sentence which contains the two words to be learned or instructs him to generate his own sentence context. The repetition set is a control condition in which the subject is requested to learn by merely rehearsing each pair in a rote fashion. Presumably this set, if followed, suppresses any functional mediational strategies from developing. There is evidence, however, that university subjects do not uniformly follow instructions under this condition and resort, in some degree, to other strategies (Paivio & Yuille, 1969). Bower and Winzenz (1970) presented three separate lists of 15 high-imagery paired-associates for one study and test trial and compared recall scores under four of the instructional sets described above. Significant differences were found among all conditions; imagery was best, followed by sentence generation, sentence reading, and rote repetition.

Extended research into the sentence reading condition has revealed that the type of connective provided in the sentence is crucial with verbs depicting action being more facilitative than either conjunctions or prepositions (Rohwer, 1970). Furthermore, if the experimenter provides sentence context and also instructs the subjects to visualize the described scene, recall is better than if no imagery instructional set is provided (Bower, 1969). In a similar light, if pictures of objects rather than words are used as stimuli, learning will be best if the picture associates are displayed interacting together as opposed to simply juxtapositioning the pictures next to each other (Reese, 1970a; Wollen & Lowry, 1971). In summary, learning will be facilitated by any context that permits or encourages a meaningful unitary organization of the stimulus and response items.

Instructional sets have also been crossed factorially with the presentation of both concrete and abstract words. The general prediction is that imagery set should be most effective with concrete words and verbal set most effective with abstract words. Two experiments failed to find this interaction (Paivio & Yuille, 1967; Yuille & Paivio, 1968) but this disconfirmation may have resulted from the use of study intervals that were too short for adequate imagery mediation to occur (Bugelski, 1968; Wood, 1967). Subjective reports have provided some evidence that the subject's strategies in these experiments are often determined more by the characteristics of the words than by instructional sets; this is especially so when the subjects are instructed to use a repetition strategy (Paivio & Yuille, 1969).

Yarmey and Csapo (1968) found that a verbal set (sentence generation) was superior to an imagery set for abstract words but found no differences between sets for concrete words. However, an obvious ceiling effect occurred for the concrete words. Ten paired-associates were presented for five alternate study and test trials. Independent of instructional set, almost the entire list of concrete words had been learned by the second trial (mean recall - 9.8) while learning was not complete for the abstract words even by the end of the fifth trial (mean recall range - 7.0-9.0). The ease with which the concrete word list was learned may have masked any potential interaction with set.

One recent experiment (Paivio & Foth, 1970), however, has confirmed the expected interaction between imagery and verbal instructional sets with concrete and abstract noun pairs. The experiment employed a very powerful instructional set which required subjects to think of a mediating visual image and then draw a representational picture of it or think of a mediating phrase or sentence and then write it down. Subjects were presented one study and test trial with either thirty concrete noun pairs or thirty abstract noun pairs. Each subject was instructed to use imagery mediation for one-half of the pairs and verbal mediation for the other half. Each noun pair was presented for fifteen seconds. The imagery set resulted in significantly higher recall than the verbal set for concrete nouns but the reverse effect occurred for the abstract nouns. It was also noted that subjects often failed to generate an image mediator for the abstract nouns and even when they did, the response latency for discovery of the image mediator was longer than for the discovery of a verbal mediator. When the data were reanalyzed for only those abstract noun pairs in which mediators were generated, the differences between instructional sets disappeared. Thus the superiority of the verbal instructional set over the imagery set can perhaps be attributed to the relative difficulty of generating mediating images for abstract words. A replication of the experiment without requiring the subjects to draw or write the mediators resulted in superior recall of concrete nouns under the imagery set than under the verbal set and no differences or slightly higher recall of abstract nouns under the imagery set than under the verbal set.

In summary, there has been a combination of failures and successes in demonstrating the instructional set interaction with concrete and abstract word pairs. When instructional set differences have been found, the greatest effect has been imagery set superiority with concrete words and to a lesser degree, verbal set superiority with abstract words. One of the probable reasons for inconsistent instructional set effects is that abstract words can, to some degree, suggest concrete referents. The word "pain" may conjure up an image of a flame or a dentist drilling a tooth. Bugelski (1970) reports that subjects instructed to form images for abstract words do as well as uninstructed subjects on recall tests and furthermore, the uninstructed subjects frequently report using concrete referents as an aid to memorization. Under an imagery set higher recall for concrete over abstract words may be attributed to a more difficult task imposed upon the learners of abstract words. The concrete referent to an abstract noun is "further removed" than is the concrete referent to a concrete noun. The word pair, knife-pain, may be learned by conjuring up an image of a knife in someone's arm. Even though this image may be readily retrievable on recall, the subject must remember that the image is to be translated to mean pain. A mistranslation may occur and the subject may respond "injury" or "hurt" or even "arm." Contrast this with the word pair, knife-blood, in which the image formed is a sharp knife covered with blood. During recall, this image seems to make the correct response more readily available requiring less decoding than did the knife-pain word pair. Thus, abstract words may to some degree form both verbal symbolic and nonverbal imagery engrams in memory but the latter is considered to be a less effective memory trace for response retrieval when the materials are abstract rather than concrete.

One further set of evidence supporting an imagery-verbal processing distinction has been presented in which interference tasks are introduced in the learning paradigm. The assumption here is that the central mechanism underlying visual imagery is the same one underlying visual perception. If this is true then distracting tasks that require visual perceptual skills should be more interfering in learning situations where imagery mediation is utilized than tasks that entail different processing modalities such as the tactile or auditory senses. In one experiment (Bower, 1969), four groups of subjects were required to learn a list of thirty paired-associates while at the same time perform a distracting task. The independent variables were imagery versus rote repetition instructional sets and visual versus tactile interference tasks. The distracting task required tracking, with the middle and index fingers, a wavy line that weaved erratically back and forth across a horizontal slot one inch wide. In one condition, the line was printed and the subject had only visual cues to guide him in tracking. In the alternate condition, the line was a raised string and the subject, with his eyes closed, had to use only tactile cues to keep the string between his two fingers. On a subsequent recall test the findings were as predicted. Recall was highest for subjects who had been instructed to use an imagery strategy and for these subjects the visual task interfered more with performance than did the tactile task. No differential effects from the interfering tasks were found for the subjects given the rote learning set. In another related experiment (Atwood, 1971), subjects had to learn either highly abstract associations or relatively concrete and hence highly imaginable ones. The distracting task required the subject to verbally react to the presentation of a digit, either 1 or 2 by saying "two" or "one" respectively. In one condition the digits were presented auditorily by the experimenter and in the other visually. Although this task appears to be almost trivial in terms of the demands on the subject, the results were striking. Both tasks interfered with the easily learned concrete materials and the more difficult abstract ones. Of critical importance, however, is that the visual digit presentation interfered most with the concrete materials and least with the abstract materials but the auditory digit presentation interfered most with the abstract associates and least with the concrete ones. The findings from these two experiments support the notion that interfering tasks in the same perceptual modality as is utilized in imagery mediational processes will prevent adequate imaginal visualization from occurring and hence disrupt any benefit that might have been derived therefrom.

Studies in Long-Term Retention

Most of the studies discussed so far have investigated the effects of concreteness-abstractness or imagery values of nouns on acquisition and recall in the paired-associate task. It should be noted, however, that the tests for retrieval have been immediate recall measures following the presentation of a fixed number of alternate study and test trials. Little attempt has been made to study the retrieval of information over longer periods of time. Studies in long-term retention not only provide important theoretical contributions to learning theory but also have obvious implications to applied psychology in education.

Butter and Palermo (1970) investigated the differential recall of response items in paired-associate lists by varying the imagery values of both the stimulus and response components. Sixteen noun pairs were presented for two alternate learning and recall trials followed by an additional recall test either immediately or forty-eight hours later. The predicted order of recall, high-high, high-low, low-high, low-low, was found for both immediate and long term recall. Fewer correct responses were made after the forty-eight hour period as compared to the immediate recall test but none of the interactions with time was significant. The experiment was replicated using a longer list (thirty-two pairs), two or four alternate study and test trials, and either an immediate or delayed recall test. The order of recall for the thirty-two-pair list was the same as for the sixteen-pair list regardless of time of recall-test or number of learning trials. Surprisingly, the main effect of time failed to reach significance. Perhaps, for these stimulus materials, the retention interval was simply too short. One finding of interest was that both stimulus and response imagery values were positively related to learning. Butter and Palermo (1970) suggest that response concreteness is of little consequence only when the task is relatively easy. But when the task is made more difficult by increasing the number of pairs to be remembered, or by reducing the number of learning trials, or by increasing the time between learning and recall, the imagery aroused by both the stimulus and response items during acquisition is important to the retrieval process at the time of recall.

Schnorr and Atkinson (1969) presented three lists of concrete-concrete noun pairs under either an imagery or repetition set. Each list of sixteen pairs was presented for one study and test trial. Subjects were given a "surprise" recall test for all three lists after a one week interval. More correct responses were recalled under the imagery set than under the repetition set for both initial and delayed recall where delayed recall was the proportion of items correctly recalled in the initial test that were correctly recalled one week later. Using a similar procedure, Yarmey and Baker (1971) found analogous results comparing picture-picture pairs with concrete-concrete noun pairs. There was higher recall for imagery set and picture pairs than for repetition set and noun pairs for both initial and delayed recall.

Experiments in long-term retention can also be investigated using multiple lists and testing for recall after all lists have been presented. Bower (1969) presented five different twenty-pair concrete noun pair lists under either imagery instructions or standard paired-associate instructions. Each list was presented for one study-test-study sequence after which recall was tested on all five lists. There was higher recall for the imagery subjects on both initial and delayed tests. The extra study trial apparently more than compensated for any effects due to cumulative interference over lists as delayed recall was slightly higher than initial recall. In summary, the few experiments exploring long-term retention have yielded results analogous to those found for studies employing shorter retention intervals.

Theories of Imagery Processing

In Chapter I, it was mentioned that the learning of A-B pairs could be conceptualized as consisting of three functionally separate processes: stimulus integration; response integration; and stimulus-response association. Which process is most affected by imagery mediation is of theoretical interest.

Bower (1969) views the beneficial effects accrued from imagery mediation as occurring more at the associative stage than at the stimulus or response encoding stages. He discounts the position that imagery elaboration results in greater distinctiveness of cues leading to less intralist generalization and hence higher recall; he also discounts the position that imagery processing has its main effect by raising the general level of response availability. Evidence against the distinctiveness of cues position was provided in one experiment in which it was found that stimulus recognition was no higher for subjects given an imagery set than for subjects given a rote repetition set. Bower (1969) reasoned that if the response availability hypothesis is correct, one should expect differences between an imagery set and a repetition set on a recall test but not on a recognition test. Bower (1969) tested this notion and found significant differences favouring the imagery set under both test conditions thus providing negative evidence for the response availability hypothesis.

In support of the position that imagery mediation results in "better or stronger" associations than does verbal mediation, Bower (1970c) found that an interactive imagery set (the subjects were instructed to imagine the referents to the words interacting in an integrative scene) resulted in superior recall performance than either a separation imagery set (the subjects were instructed to visualize the referents to the words in a nonintegrative way; that is, they were to place each image in different positions in the visual field) or a rote repetition set.

While the above evidence suggests support for the relational association position, it does not directly discount the distinctiveness notion unless by distinctiveness Bower (1970c) is referring exclusively to the stimulus encoding phase of learning. It is hard to imagine that an interactive imagery set, which can perhaps be described as conferring a type of "perceptual-unity" on the objects to be associated (Asch, 1969), would not result in some degree of distinctiveness of the stimulus-response complex. While imagery may not result in distinctiveness at the stimulus encoding stage, it may do so at the associative stage providing a very unique stimulus-response unit. It is perhaps the unit which, because of its distinctiveness, is highly resistent to general or specific forms of interference.

In regard to the distinctiveness notion, it is interesting to note that subjects under instruction to use imagery to associate concrete noun-noun word pairs will perform at a higher level if the stimuli are low-frequency words with few dictionary meanings rather than high-frequency words with many dictionary meanings (Schnorr & Atkinson, 1970). For example, the words camel, igloo, and volcano can be contrasted with book, dish, or girl. Schnorr and Atkinson (1970) theorize (post hoc) that the probability of successful reconstruction of the correct stimulus given the verbal stimulus will be inversely related to the potential number of images that the verbal stimulus can suggest. This hypothesis, coupled with the assumption that the number of dictionary meanings varies directly with the number of potential images evoked by a word, predicts superior performance with words containing few dictionary meanings than with words containing many dictionary meanings. Furthermore, to the degree that remembering the context in which the stimulus occurred in the imaginal association is important to response retrieval, low-frequency words generally occur in fewer contexts than high-frequency words, and hence there should be a higher probability of recalling the appropriate context when the stimulus is of low-frequency rather than of high-frequency. Evidence in support of this high-low frequency theory has recently been provided (Paivio & Madigan, 1970; Paivio & Smythe, 1971).

In proposing an alternate theory to account for recall differences of concrete and abstract words, Wickens and Engle (1970, p. 271) have stated that "the concept of abstractness implies that the word in question is broad and inclusive in meaning." They have suggested that superior recall of concrete over abstract words can perhaps be accounted for by the higher probability of semantic overlap and hence greater interference amongst abstract words. Wickens and Engle (1970) derived this notion from an experiment using the Peterson and Peterson (1959) paradigm. This paradigm requires the subject to count backwards by threes from a designated number following the presentation of the to-be-remembered stimuli. Recall performance over trials for noun triads was found to decline more for abstract words than for concrete words and this finding in part led to the semantic overlap hypothesis. Paivio and Begg (1971) tested this hypothesis using the same paradigm employed by Wickens and Engle (1970) but controlled for interitem associative overlap between and within the concrete or abstract noun triads. Recall was still higher for concrete than for abstract nouns. Paivio and Begg (1971) concluded that the effects of noun concreteness on recall could be more reasonably attributed to the positive effects of imaginal encoding than to the negative effects of interitem associative interference among abstract items.

In summary, it seems clear, at least at the theoretical level, that different responses are being recalled in the cases of imaginal elaboration and verbal elaboration. In the former case, presentation of the verbal stimulus results in retrieval of a compound amalgamated stimulus-response image in which the subject must visually search for the response and then decode and translate the response image into a verbal response. In the latter case, presentation of the verbal stimulus encourages the subject to reconstruct the mediational verbal chain that provides the direct link to the response. It appears quite possible that the information stored under imaginal elaboration may be both quantitatively and qualitatively different from that stored under verbal mediation.

Visual-Spatial - Verbal-Sequential Processing

Some attempt has been made to functionally differentiate the imagery and verbal memory codes. Paivio (1971a) has postulated that imagery processes are specialized for parallel processing while the verbal system is most adept at sequential processing. Parallel processing in this instance is meant to imply simultaneity of functioning whereas sequential processing implies the interdependence of successive operations. Both codes, however, are operationally parallel; that is, within each system, items of information can be processed independently of one another.

These theoretical constructs have been tested experimentally by manipulating the accessibility of the two memory codes in sequential (memory span and serial learning) and nonsequential (free recall and recognition) learning tasks. Paivio and Csapo (1969) reasoned that since words can be read faster than objects can be named, a sufficiently fast presentation rate would allow for verbal processing of words but not for pictorial stimuli. The fast presentation rate should also interfere with the arousal of any referential or associative imagery to words. Since the verbal code is hypothesized to be necessary for sequential processing and because pictures can not be verbally processed at a fast presentation rate, memory for pictures should be poorer than for words in memory span and serial learning tasks if the stimulus materials are presented at a fast rate. For tasks not requiring sequential processing, memory for pictures should be as good as memory for words even at a fast rate as serial order information need not be retained. In this instance, pictures can be encoded as concrete images and later decoded into words for purposes of verbal recall. Recall for abstract or concrete words should not differ at the fast rate for either sequential or non-sequential tasks as only the verbal code can be utilized. At a slow rate of presentation, the probability of dual memory processing will be greatest for pictures followed by concrete words and least likely for abstract words. Thus, memory for pictures should be at least as good as for words in serial learning and memory span tasks and should be better than words in free recall and recognition tasks.

The above predictions were tested experimentally by presenting either pictures, their concrete noun labels, or abstract nouns at either a fast presentation rate (5.3 items per second) or a slow presentation rate (2 items per second) in four different memory tasks: memory span, serial learning, free recall, and recognition. The predictions were basically confirmed. Memory for pictures relative to words was poorest at the fast presentation rate in the sequential tasks and best at the slow rate in the nonsequential tasks. No differences among stimulus types appeared at the fast rate in the nonsequential tasks. At the slow rate, concrete words were better recalled than abstract words in free recall, recognition, and serial learning. In summary, presentation rate affected picture memory the most because of the availability of dual coding only at the slower presentation rate and affected abstract words the least because of the high probability that only the verbal code was involved at either presentation rate.

Paivio and Csapo (1969) also investigated the number of false positives (new items recognized as old) that occurred in the recognition task. Significantly more false positives were made for words than for pictures at both presentation rates. If it can be assumed that the verbal code was not available for pictures at the fast rate, this finding suggests that some aspects of the stimulus information in the imagery code for pictorial stimuli are better retained than in the verbal code for word stimuli.

Summary of Research Implications

In summary, imagery appears to be most effective for coding and decoding concrete bits of information while verbal mediation appears most effective for storing abstract information. While it seems intuitively obvious that imagery does not easily lend itself to the processing of abstract materials, it is not clear why imagery should be more effective than verbalization for processing concrete materials. Perhaps images are less susceptible to interference than are verbal mediators. This may be because of the nature of the stability of the image or because of the kinds of experiences most likely encountered as interfering. Perhaps images are as susceptible to interference from other images as verbal mediators are to each other, but man, being primarily a verbal beast, is more exposed to and spends more time coping with verbal behaviors than he does with nonverbal images. The precise mechanism of interference (e.g. unlearning or response competition) is not really critical at this point. Images are for one reason or another, more stable, less susceptible to decay, or are more resistent to either general or specific forms of interference than are verbal mediators.

Another possibility is that imagery is most effective when accompanied by verbalization. It is very difficult to spend any length of time imaging perceptual objects in space without covertly verbalizing the experience. Paivio (1971a) has suggested that we give implicit verbal labels to all stimuli but will only form images when the stimuli are relatively concrete or can readily suggest a concrete image. Stated in another way, abstract words tend to elicit only one memory trace (verbal engram) while concrete stimuli elicit two memory traces (both a verbal and a pictorial engram). Recall should be substantially facilitated when two memorial representations are available rather than just one (Paivio, 1971a).

Differences in stimulus encoding and decoding also may partially account for the differential effectiveness of the two memory systems. In the Paivio and Foth (1970) study discussed earlier, reaction time data indicated no differential time factor in the formulation of either an image or verbal mediator to a concrete word. Recall latencies revealed, however, that it took longer to recall concrete responses learned by verbal mediators than concrete responses learned by imagery mediation. Paivio (1971b) has suggested that imagery mediation may facilitate recall by providing an efficiently organized spatial compound which either takes up less space in memory or can be decoded more efficiently during recall than can a verbal mediator composed of a sequentially organized linguistic string of elements. It is on the basis of this visual-spatial verbal-sequential functional distinction and the dual-coding hypothesis that the following research was formulated.

CHAPTER III

RATIONALE AND HYPOTHESES

Rationale

The basic assumption underlying the proposed research is that nonverbal imagery and verbal symbolic mechanisms are the two basic components of thinking (Bower, 1969; Paivio, 1969, 1971a). The nonverbal system seems to be more adept at processing concrete information while the verbal system acts as a more efficient processor of abstract information. It is assumed that during acquisition, concrete stimuli will tend to elicit two engrams in memory (verbal symbolic and nonverbal imagery) while abstract stimuli will tend to elicit only one (verbal symbolic). Forgetting is conceptualized as a process whereby the memory traces, for one reason or another, decay or become less accessible or less supportive of recall over time. Concrete stimuli can be recalled more reliably than can abstract stimuli because the former are supported in memory by two engrams, either one of which, when retrieved, is sufficient for criterion performance. Furthermore, because the imagery system is specialized for parallel processing as opposed to sequential processing in the verbal system, concrete-imagery redintegration may take less time and produce fewer errors than abstract-verbal redintegration.

An extension of this theory would suggest that items represented in memory by two engrams should be less susceptible to general interference than would items represented by only one engram. Perhaps the presence of an additional memory code (imagery) offsets specific interference effects that occur when only a verbal code is available. One would thus expect more inter- and intralist interference when learning a corresponding set of abstract associates. Such a prediction would be consistent with the general finding that learning performance with concrete words is superior to that of abstract words.

While there is a great deal of evidence pertaining to different acquisition rates for concrete and abstract materials, little research has focused on the differential forgetting of such materials over time. Furthermore, the few studies which have employed long-term retention intervals (Butter & Palermo, 1970; Schnorr & Atkinson, 1969; Yarmey & Baker, 1971) have simply administered a fixed number of alternate study and test trials. This procedure is somewhat inadequate. An experiment designed to compare retention for two or more values of a variable in acquisition must ensure equal levels of original learning (Underwood, 1964).

In the proposed study an A-B, A-C, A-D, A-E interference paradigm will be employed. Prior to testing for retrieval of concrete and abstract nouns, an attempt will be made to equate the different paired-associate lists for habit strength at the end of original learning. Performance criteria will be equated by using a presentation procedure that allows for particular word pairs, as they are learned, to be dropped from the study trials but reinstated for test trials so as to minimize selective overlearning of some pairs. The major hypothesis is that after four interfering lists of concrete or abstract nouns are learned to a common performance criterion level, more concrete nouns will be readily retrievable than abstract nouns.

It is perhaps interesting to contrast the above hypothesis with research that has manipulated meaningfulness of trigrams. Keppel (1968) has reviewed a large number of studies in which retention tests were administered either twenty-four hours or one week after the completion of learning. In all experiments an attempt was made to equate the level of learning prior to the retention interval. Although the number of trials to criterion was less for high-association trigrams than for low-association trigrams, differential recall over time was not observed to occur; in other words, "meaningfulness does not influence rate of forgetting (Keppel, 1968, p. 201)."

These findings support the theory that differential acquisition rates reflect the greater difficulty of finding an appropriate verbal symbolic mediator for the low-association words or trigrams. However, once a mediator is discovered and the verbal unit learned, the rate of forgetting of the "low-association" mediator will be the same as for the "high-association" mediator.

On the other hand, faster acquisition rates <u>and</u> greater long-term retention of high-imagery words over low-imagery words follows if certain assumptions are made. High-imagery words can be learned by either imagery mediation or verbal mediation or both. Low-imagery words, by definition, do not readily suggest images and there is therefore a high probability that verbal mediators will be utilized during acquisition. Acquisition rates are faster for high-imagery words because of the potential availability of two types of mediators, either of which will suffice for recall, and possibly because of the greater stability of memory traces based on visual imagery. Retention losses will be less for high-imagery words for the same reasons. High-imagery words will be acquired faster and retained longer than low-imagery words only to the degree that visual imagery is differentially utilized in the learning of concrete as opposed to abstract materials.

The type of mediation (imagery or verbal) utilized during learning will depend on at least three such factors: firstly, the subject's ability to formulate one or the other of the two kinds of mediators; secondly, the degree to which the semantic characteristics of the word readily suggest either an image or a verbal associate; and thirdly, the subject's predisposition to formulate particular kinds of mediators. The proposed research will manipulate two sets of independent variables related to the latter two factors. Two levels of imagery values for familiar nouns (high-imagery concrete and low-imagery abstract) will be crossed factorially with three sets of instructions: an imagery set, a verbal (sentence generation) set, and a repetition set. The purpose of employing instructional sets reflects an attempt to bring the learning strategies of the subjects under the control of the experimenter. To the degree that this can be accomplished, it can be predicted from the dual-processing theory that instructional set will interact with imagery values. Thus, several hypotheses can be generally stated. High-imagery concrete words will be learned faster and retained better than low-imagery abstract words. For high-imagery concrete words, acquisition and recall performance scores will be higher under imagery instructions than under verbal instructions; for low-imagery abstract words, acquisition and recall performance scores will be higher under verbal instructions than under imagery instructions. The repetition set should suppress relevant mediational strategies from developing and provide a useful comparison against which the effects of both the imagery and verbal sets can be evaluated.

Experimental Design

The study will employ a mixed design including two independent variables crossed factorially and one repeated measures factor. One between subjects factor will contrast two levels of concreteness-imagery values for nouns (concrete or abstract) and the other between subjects factor will contrast three different instructional sets (imagery, verbal and repetition). The repeated measures factor is represented by four paired-associate lists (A-B, A-C, A-D, A-E).

Dependent Measures

The dependent acquisition measure will be the number of response errors made on each list during test trials. The dependent retention measure will include the number of correct responses recalled for each list with a correct response being defined in two different ways: matched to the correct stimulus and placed in the correct list (ordered recall) or matched to the correct stimulus but not necessarily placed in the correct list (unordered recall).

Hypotheses: Acquisition

1. Irrespective of instructional set, more errors will occur during test trials on the abstract noun lists than on the concrete noun lists.
2. For the concrete nouns, more errors will occur on test trials under the verbal set than under the imagery set.
3. For the abstract nouns, more errors will occur on test trials under the imagery set than under the verbal set.
4. For concrete nouns, more errors will occur on test trials under the repetition set than under the imagery and

verbal sets.

5. For abstract nouns, more errors will occur on test trials under the repetition set than under the imagery and verbal sets.

Hypotheses: Ordered Recall

6. Irrespective of instructional set, more concrete nouns will be correctly recalled than will abstract nouns.

7. More concrete nouns will be correctly recalled under the imagery set than under the verbal set.

8. More abstract nouns will be correctly recalled under the verbal set than under the imagery set.

9. More concrete nouns will be correctly recalled under the imagery and verbal sets than under the repetition set.

10. More abstract nouns will be correctly recalled under the imagery and verbal sets than under the repetition set.

Hypotheses: Unordered Recall

11. Irrespective of instructional set, more concrete nouns will be correctly recalled than will abstract nouns.

12. More concrete nouns will be correctly recalled under the imagery set than under the verbal set.

13. More abstract nouns will be correctly recalled under the verbal set than under the imagery set.

14. More concrete nouns will be correctly recalled under the imagery and verbal sets than under the repetition set.

15. More abstract nouns will be correctly recalled under the imagery and verbal sets than under the repetition set.

CHAPTER IV

METHOD

Subjects

Out of a total of approximately 500 first and second year undergraduate students enrolled in two large lecture sections of Introductory Educational Psychology at the University of Alberta, 120 volunteers agreed to participate in the study. Of these students, only 101 actually participated of which 5 were discarded for not completing all portions of the experiment. Of the remaining 96 subjects, 23 were male and 73 were female. Prior to volunteering, all subjects were informed that they would be paid $2.00 to cover their transportation costs to and from the University.

Paired-Associate Lists

Thirty concrete and thirty abstract nouns were selected from the 925 noun list compiled by Paivio, Yuille, & Madigan (1968) which were rated for imagery, concreteness, and meaningfulness. The two lists were selected on the basis of imagery values and were matched for equivalent mean and standard deviation meaningfulness values. Because the experimental procedure required the subjects to type the responses at a computer terminal, the initial selection of nouns was also based on word length so the high- and low-imagery items were relatively equivalent in typing difficulty. Four lists each containing six pairs of high-imagery nouns were constructed. The same stimulus items were paired with new response items in each list forming an A-B, A-C, A-D, A-E interference paradigm. An identical set of lists was constructed with low-imagery nouns. This interference paradigm was selected on the basis of pilot data which revealed that substantial forgetting would occur under the prescribed conditions of the proposed experiment. All pairing of nouns was random with the exception that any obvious association was avoided and no two words in any pair began with the same letter. Table 1 lists the noun pairs with accompanying norm values.

Presentation Procedure

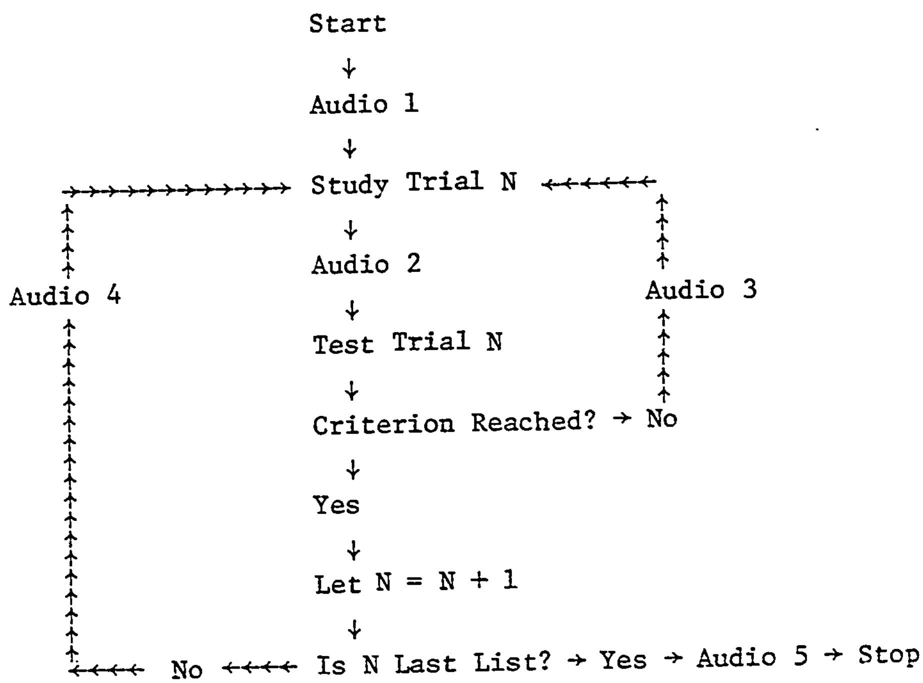
Word pairs were presented to individual subjects on an IBM 1510 CRT instructional display screen and the learning program was executed under control of an IBM 1500 operating system. Standard paired-associate directions were received by the subject through headphones in coordination with the presentation of the stimulus materials. Figure 1 presents a flow diagram of the learning program and the audio messages. All responses were recorded by having the subject type in the appropriate word at the computer terminal. These responses appeared on the monitor as they were typed and could be corrected for errors by the subject. When the subject was satisfied with his response, he would

TABLE 1

CONCRETE AND ABSTRACT NOUN PAIRS WITH
IMAGERY AND MEANINGFULNESS VALUES

Stimulus	Responses			
	list 1	list 2	list 3	list 4
hound	scarlet	lip	tomb	mother
barrel	dress	hotel	chin	village
elbow	nail	maiden	officer	tripod
rock	flood	person	stain	body
lad	corner	square	mule	harp
beast	letter	juggler	engine	string
pledge	mercy	advice	crisis	spirit
law	satire	deed	mind	ego
moral	hour	welfare	gender	custom
cost	perjury	mood	evidence	answer
attitude	economy	irony	duty	malady
greed	length	effort	violation	position

	Imagery Values		Meaningfulness Values	
	Mean	SD	Mean	SD
Concrete stimuli	6.29	.22	5.85	.37
Abstract stimuli	3.40	.36	6.01	.39
Concrete responses	6.34	.20	5.71	.21
Abstract responses	3.27	.27	5.70	.31



Audio 1 This is the first part of the learning experiment. The list of word pairs which you are to learn will appear on the screen in front of you, one pair at a time (12 seconds)

Audio 2 Now you must type the response words. You can begin when the rectangle appears on the screen. (7 seconds)

Audio 3 Watch the screen in front of you. The word pairs will be presented again. (7 seconds)

Audio 4 For the next part of the experiment, you must learn another list of word pairs. The pairs will appear on the screen in front of you, one pair at a time. (15 seconds)

Audio 5 That completes the experiment. Thank you very much for participating. If you have any questions or if you were not able to follow all of the instructions, please talk to the supervisor. Goodbye for now. (15 seconds)

FIGURE 1. Flow diagram for noun-pair presentation procedure and audio messages.

"enter it" by pushing an appropriate key. Alternate study and test trials were employed. Each word pair was presented for eight seconds on study trials and each stimulus item for a maximum of fifteen seconds on test trials. The test trial for a stimulus item would terminate at the time the subject "entered it" or at the end of fifteen seconds whichever came first. A pause of one second occurred between the offset of one word pair (or stimulus item) and the onset of another. The length of the inter-trial intervals within or between lists is indicated in Figure 1. The serial order of presentation of the words on any particular study or test trial was randomized.

Errors included wrong responses or omissions. Each entered response was read by the learning program in two letter sequential units. If more than one unit was incorrect, the response was scored as an error. For example, the word "crisis" would be accepted as correct if spelled "crises," "krisis," or "crisiss" but not accepted if spelled "creses" or "crisses." Thus, one letter substitutions, which pilot data revealed to be the most common type of error, were acceptable.

The final learning criterion was five out of six correct responses. During learning, however, any specific response that was correctly recalled on a test trial was dropped from the subsequent study and test trials. This procedure, consisting of presenting progressively fewer pairs, continued until each response in the six-item list had been responded to correctly. At this point the entire six-item list was presented again for one study and criterion test trial. If the criterion (five out of six responses correct) was not reached, the program repeated itself by presenting another series of study and test trials with those pairs not correctly recalled on the criterion test trial. When criterion was reached the next list was presented. After the subject reached criterion on the last list, the program terminated. Immediately following program termination, a paper and pencil recall test was administered in which the subject was given the stimulus items and had to recall the response items for each list. This was essentially an unpaced free recall test. Appendix C contains a copy of this test.

In addition to the experimental lists, two practice lists were formed: one contained two concrete word pairs (lion-car, cannon-garbage) and the other contained two abstract word pairs (crime-skill, triumph-pain). These word pairs were also used as examples in the written instructions given to the subjects. The practice trial was presented prior to the experimental lists to ensure that the subject understood the task and the general instructions on how to operate the key-board terminal. Word pairs were not dropped during learning and a criterion of one perfect trial was required before the onset of the first experimental list.

Instructional Sets

Each subject received two sets of written instructions. One set included a general introductory description of the paired-associate task as well as information pertaining to the use of the IBM computer terminal. Subjects were instructed on how and when to type their responses, how to correct typing errors, and how to enter their responses. Each subject also received instructions pertaining to the use of either an imagery, verbal (sentence generation), or repetitional strategy. These written instructions included appropriate examples of how to learn paired-associates. The word pairs in the examples corresponded to the type of words (concrete or abstract) presented in the task. Appendix A contains the general introductory instructions and Appendix B contains the six different instructional sets.

During any one testing session, either concrete or abstract words were presented to groups of eight to twelve subjects with each subject working independently at a computer terminal. Prior to initial testing, the six different instructional sets were divided into four groupings: concrete-male, concrete-female, abstract-male, and abstract-female. The instructional sets were randomly ordered within each grouping using a table of random numbers. Distribution of the instructional sets from these prearranged groupings thus insured subject randomization and also kept the male to female ratio approximately equal in each experimental group.

CHAPTER V

RESULTS

Acquisition

The number of response errors that occurred on test trials was analyzed in a 2 x 2 x 4 analysis of variance with repeated measures on the last factor. The first factor represented concreteness of the noun pairs (concrete or abstract); the second factor represented mnemonic instructional sets (imagery or verbal); and the last repeated measures factor represented the four lists. The two repetition instructional groups were excluded from the analyses because of heterogeneity of variance and are discussed below. Table 2 presents the summary table for this analysis and Figure 2 presents the mean differences between all of the experimental conditions. In this analysis, the sums of squares for the first two factors (concreteness and mnemonic sets) were partitioned into three orthogonal planned contrasts. All contrasts were one-tailed. More errors were made with the abstract noun pairs than with the concrete noun pairs (hypothesis 1, $F = 73.31$, $df = 1, 60$, $p < .001$) and more concrete noun errors occurred under the verbal mnemonic set than under the imagery set (hypothesis 2, $F = 4.59$, $df = 1, 60$,

TABLE 2

MEANS AND ANALYSIS OF VARIANCE
FOR ACQUISITION ERRORS

(a) Mean number of acquisition errors

Treatment	List			
	1	2	3	4
Concrete-imagery	0.44	1.06	1.81	0.88
Concrete-verbal	1.00	2.75	2.25	1.81
Concrete-repetition	3.69	3.69	6.44	4.44
Abstract-imagery	4.25	3.88	4.63	2.31
Abstract-verbal	4.31	5.31	4.75	3.06
Abstract-repetition	8.25	8.25	7.75	8.13

(b) Summary of Analysis of Variance

Source	df	MS	F
Between Subjects	63		
C-A	1	420.25	73.31***[a]
CI-CV	1	26.29	4.59*
AV-AI	1	11.27	1.97
Subjects W. Groups	60	5.73	
Within Subjects	192		
List (A)	3	26.01	7.55***
A x Concreteness (B)	3	13.39	3.88*
A x Instructional Set (C)	3	5.76	1.67
A x B x C	3	0.07	0.02
A x Subjects W. Groups	180	3.45	

[a] * $p < .05$
** $p < .01$
*** $p < .001$

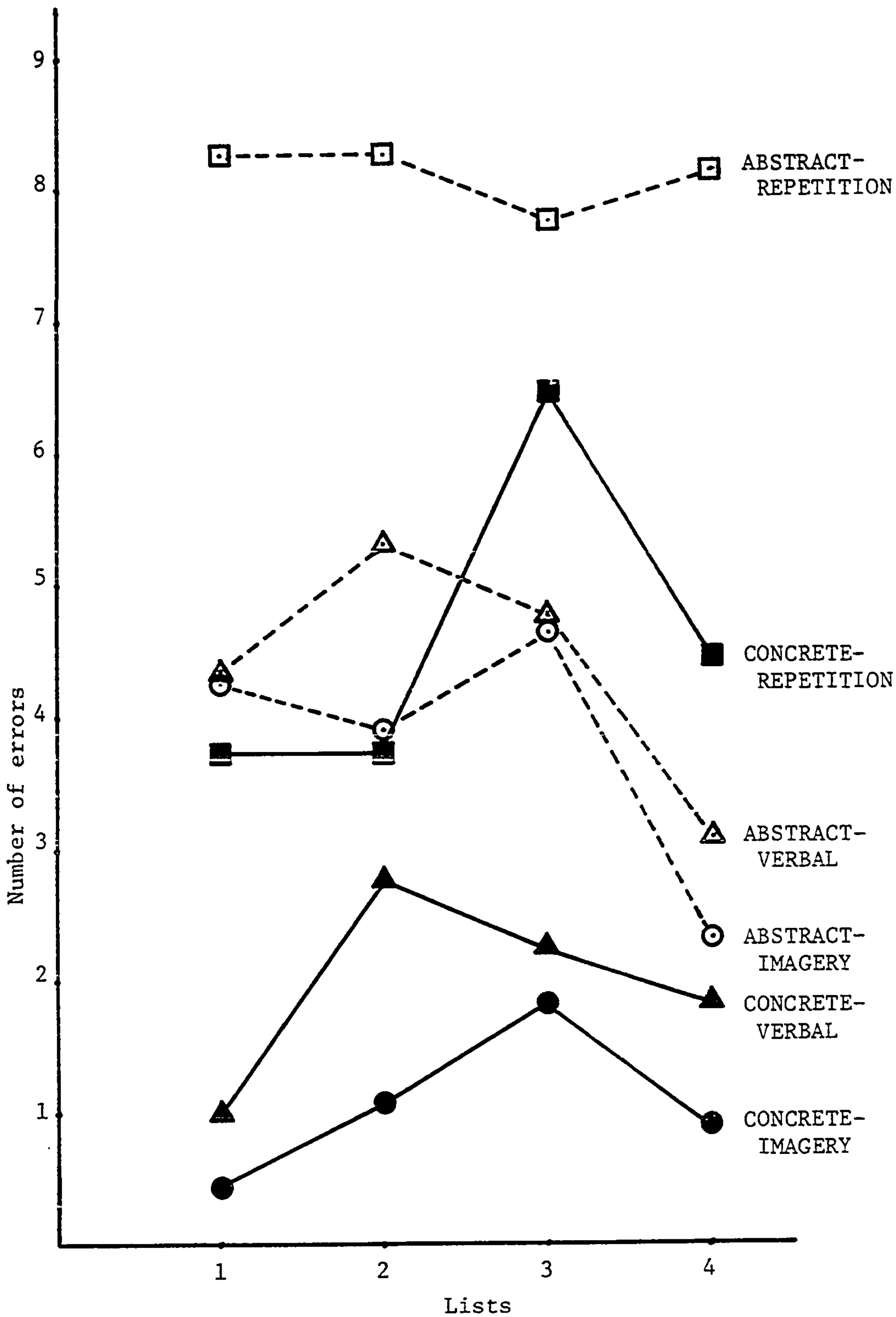


FIGURE 2. Mean Number of Acquisition Errors on each List

$p < .05$). No differences were found between the corresponding mnemonic sets for abstract words (hypothesis 3, $F = 1.97$, $df = 1, 60$, $p > .05$). The analysis also revealed a significant list effect ($F = 7.55$, $df = 3, 180$, $p < .001$) and a list by concreteness interaction ($F = 3.88$, $df = 3, 60$, $p < .05$). An examination of Figure 3 shows that the total number of errors increased from list 1 to list 3 and then decreased on list 4. Scheffé tests revealed that the list effect was primarily the result of fewer errors on list 4 than on either lists 2 ($p < .01$) or 3 ($p < .01$). Scheffé tests also revealed that the list by concreteness interaction (see Figure 3) was a function of significant differences between concrete and abstract nouns on lists 1 ($p < .001$), 2 ($p < .001$) and 3 ($p < .001$), but not on list 4 ($p > .05$).

The main effect of list and list by concreteness interaction were also tested using the Greenhouse and Geisser approximation (Winer, 1962). This very conservative test does not require the assumption of equal covariances in the pooled variance-covariance matrix. In the Greenhouse and Geisser test, the F ratios are calculated in the traditional fashion but the degrees of freedom used in finding the critical values are adjusted. Using this technique, the list effect was still significant ($p < .01$) but the list by concreteness interaction was not ($p > .05$).

As was stated above, the two experimental groups given repetition instructions were not included in the

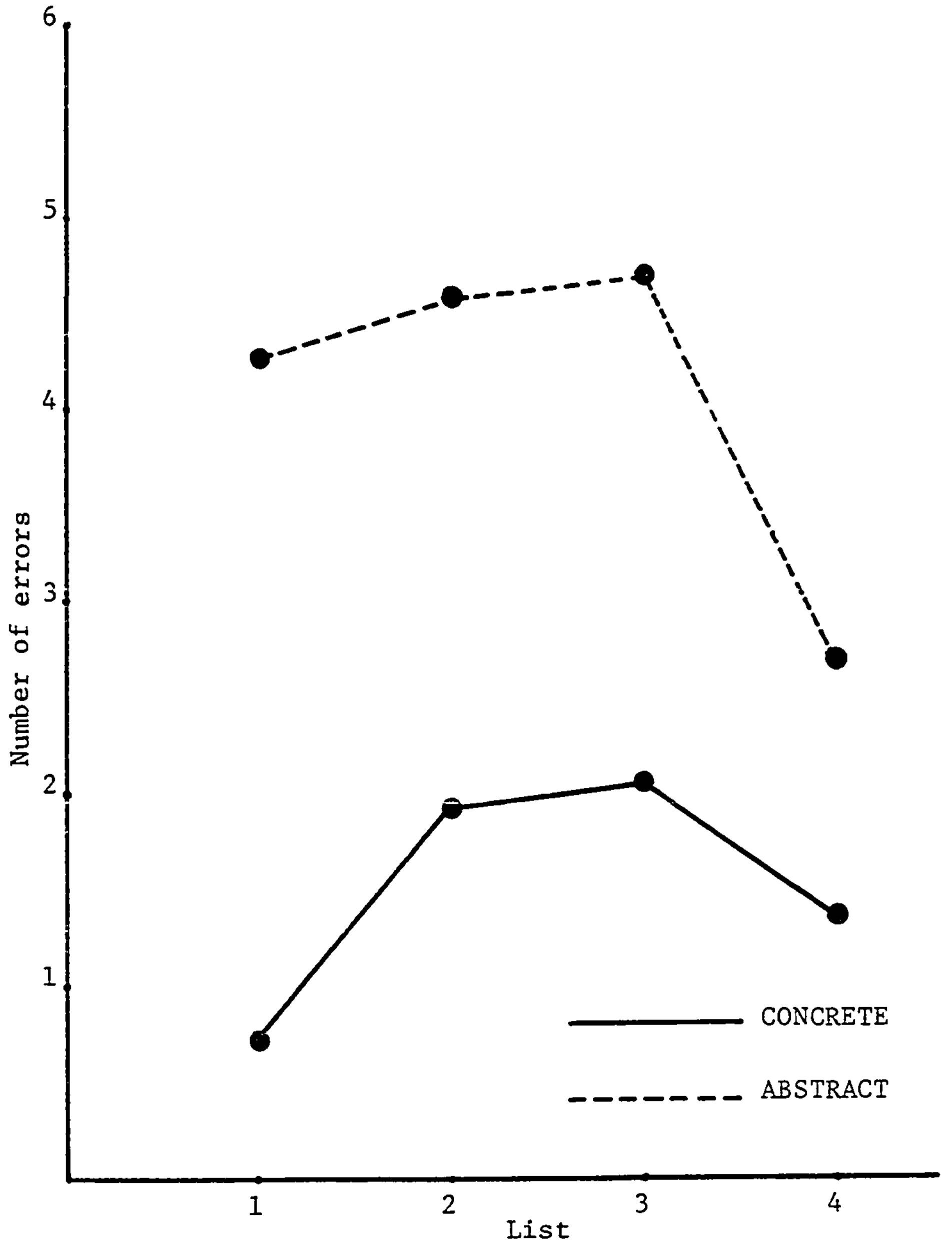


FIGURE 3. Acquisition Errors: List
by Concreteness Interaction

overall analysis. This decision was based on an examination of the error score variances of these two groups relative to the remaining experimental groups. Table 2 contains the means and Table 3 contains the variances of acquisition errors for each of the experimental conditions and Figure 2 graphically illustrates the mean scores for the same groups. It can be seen that variance ratios as large as 100 to 1 occurred (see list 4). Cochran's test for homogeneity of variance revealed highly significant differences between the variances ($C = .173$, $df = 24, 15$ $p < .01$). Figure 2 clearly indicates that differences between instructional sets were greatest between the repetition group and either the imagery or verbal mnemonic conditions for both the concrete (hypothesis 4) and abstract (hypothesis 5) noun pairs.

Ordered Recall

This measure represented the number of correct responses matched to the appropriate stimulus item and placed in the correct list. Differences among groups were analyzed in a 2 x 3 x 4 analysis of variance with repeated measures on the last factor (lists). The sums of squares for the first two factors (concreteness and instructional sets) were partitioned into the five planned orthogonal contrasts discussed earlier in Chapter III. Table 4 presents the summary table for this analysis and Figure 4 portrays the relationships between the six experimental groups.

All but one of the five contrasts were significant as

TABLE 3

VARIANCES FOR ACQUISITION ERRORS

Treatment	List			
	1	2	3	4
Concrete-imagery	0.53	1.13	2.43	0.52
Concrete-verbal	1.07	6.87	3.40	3.36
Concrete-repetition	7.96	9.70	32.00	49.73
Abstract-imagery	8.07	3.05	8.25	2.50
Abstract-verbal	6.10	7.96	6.07	3.00
Abstract-repetition	37.80	24.20	31.27	53.72

TABLE 4

MEANS AND ANALYSIS OF VARIANCE
FOR ORDERED RECALL

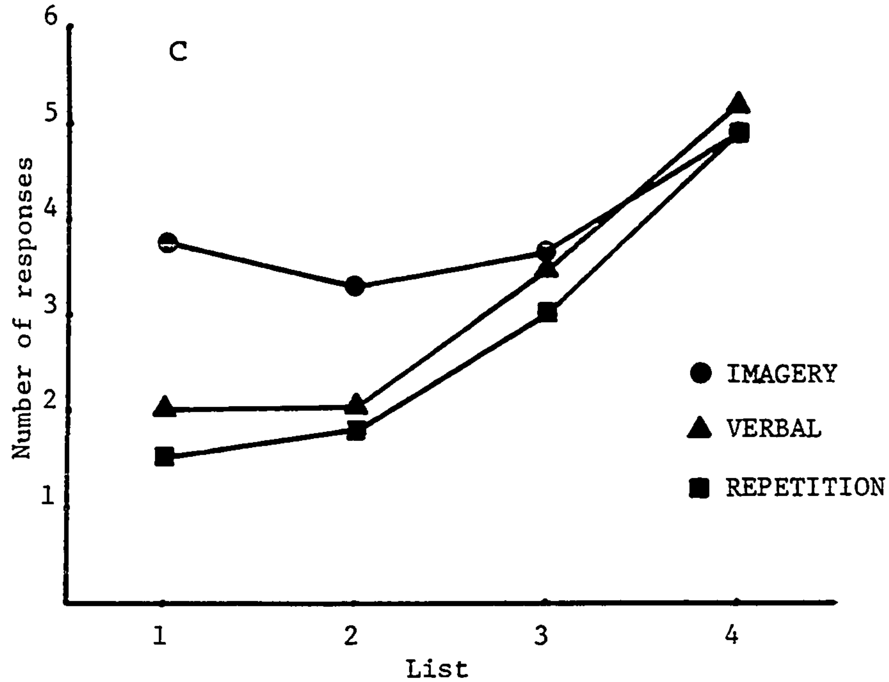
(a) Mean number of correct responses

Treatment	List			
	1	2	3	4
Concrete-imagery	3.75	3.31	3.63	4.88
Concrete-verbal	2.00	2.06	3.50	5.19
Concrete-repetition	1.56	1.81	3.00	4.88
Abstract-imagery	1.31	1.50	3.06	5.31
Abstract-verbal	1.81	2.00	3.44	5.56
Abstract-repetition	0.38	1.06	2.38	5.56

(b) Summary of Analysis of Variance

Source	df	MS	F
Between Subjects	95		
C-A	1	25.52	8.06[a]**
CI-CV	1	15.86	5.01*
AI-AV	1	5.27	1.66
CI & CV - CR	1	22.53	7.11**
AI & AV - AR	1	18.34	5.79**
Subjects W. Groups	90	3.17	
Within Subjects	288		
List (A)	3	240.35	144.60***
A x Concreteness (B)	3	13.93	8.38***
A x Instructional Set (C)	6	4.20	2.53*
A x B x C	6	2.49	1.50
A x Subjects W. Groups	270	1.66	

a   * $p < .05$
** $p < .01$
*** $p < .001$



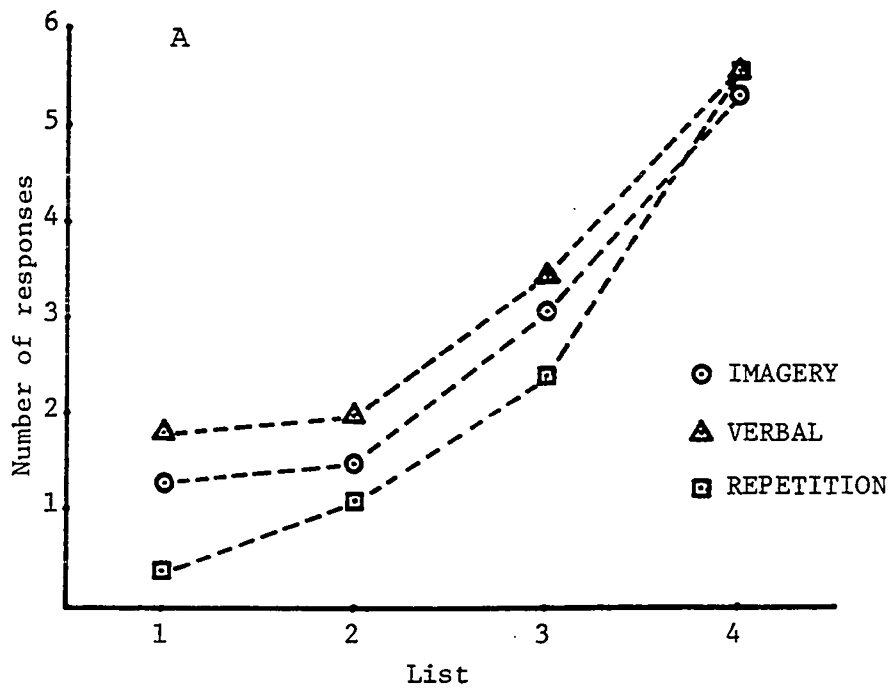


FIGURE 4. Ordered Recall: Mean Number of Concrete (C) and Abstract (A) Correct Responses Recalled on each List.

hypothesized. More concrete nouns than abstract nouns were recalled (hypothesis 6, $F = 8.06$, $df = 1, 90$, $p < .01$). More correct responses occurred in the concrete-imagery condition than in the concrete-verbal condition (hypothesis 7, $F = 5.01$, $df = 1, 90$, $p < .05$) and in the imagery and verbal mnemonic conditions taken together than in the repetition instructional condition for both concrete nouns (hypothesis 9, $F = 7.11$, $df = 1, 90$, $p < .01$) and abstract nouns (hypothesis 10, $F = 5.79$, $df = 1, 90$, $p < .01$). No differences occurred between the abstract-verbal and abstract-imagery conditions (hypothesis 8, $F = 1.66$, $df = 1, 90$, $p > .05$).

The main effect of lists was significant ($F = 144.6$, $df = 3, 270$, $p < .001$) as was the list by concreteness interaction ($F = 8.38$, $df = 3, 270$, $p < .001$) and the list by instructional set interaction ($F = 2.53$, $df = 6, 270$, $p < .05$).

The more conservative Greenhouse and Geisser method (Winer, 1962) of evaluating the within-subject effects also revealed the list effect ($p < .001$) and list by concreteness interaction ($p < .01$) but failed to reveal the list by instructional set interaction ($p > .05$).

Scheffé tests revealed the list effect to be the result of an increasing number of correct responses occurring from list 1 to list 4. Significantly more correct responses occurred on list 4 than on list 3 ($p < .001$) and on list 3 than on lists 1 ($p < .001$) or 2 ($p < .001$). No differences occurred between lists 1 and 2 ($p > .05$). The list by concreteness interaction is illustrated in Figure 5 and indicates the effect was due to a diminishing recall superiority of concrete over abstract nouns from list 1 through to list 4. In fact, at list 4 more abstract nouns were correctly recalled than were concrete nouns. Scheffé tests revealed a significant difference between concreteness and abstractness at list 1 ($p < .01$) but not ($p > .05$) at lists 2, 3, or 4 and also revealed an interaction of concreteness-abstractness with lists 1 and 4 ($p < .01$).

Figure 6 reveals the instructional set by list interaction. Differences between the three instructional sets were greatest at list 1 and progressively diminished over lists. Scheffé tests revealed significant differences between imagery and repetition groups at list 1 ($p < .05$) but not ($p > .05$) at lists 2, 3, or 4.

Unordered Recall

The recall responses were rescored such that a correct response was any response correctly paired with the appropriate stimulus irrespective of list order. The results were analyzed using the same five planned orthogonal contrasts as were used to analyze the ordered recall data. Table 5 contains the summary table for this analysis and Figure 7 portrays the means for each experimental group. More concrete nouns were correctly recalled than abstract nouns (hypothesis 11, $F = 21.02$, $df = 1, 90$, $p < .001$). More correct responses were recalled under the imagery and

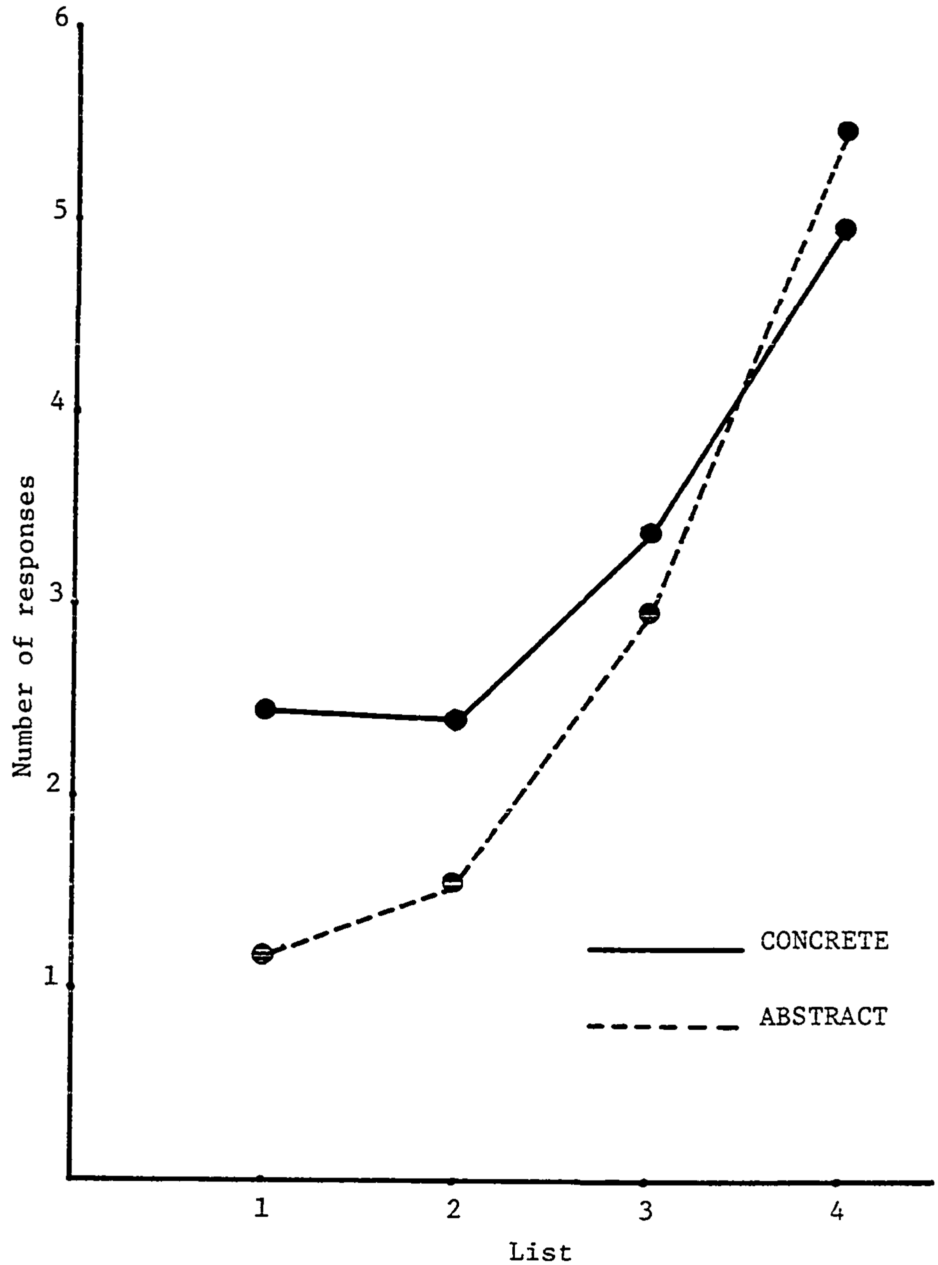


FIGURE 5. Ordered Recall: List by Concreteness Interaction

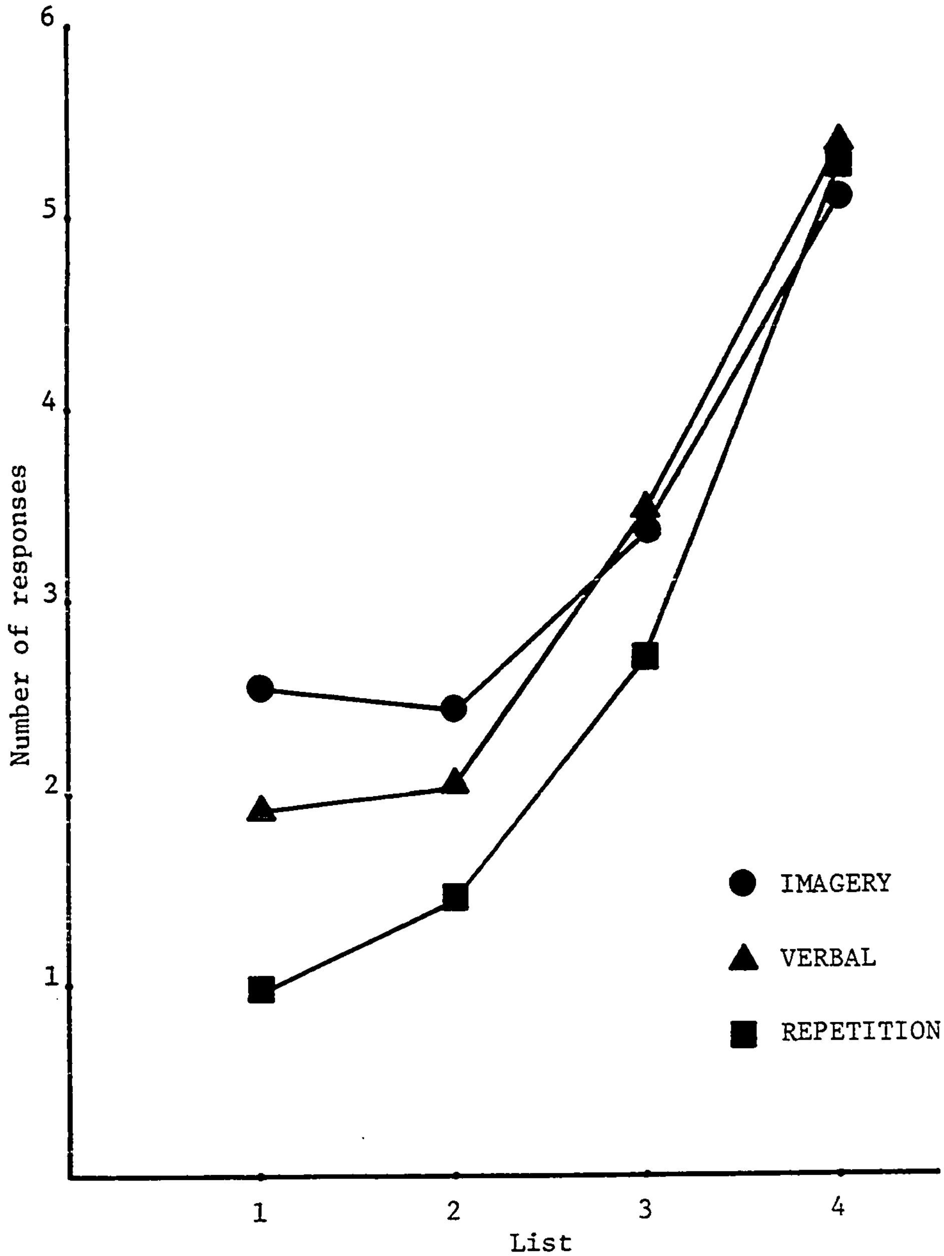


FIGURE 6. Ordered Recall: List by Instructional Set Interaction

TABLE 5

MEANS AND ANALYSIS OF VARIANCE
FOR UNORDERED RECALL

(a) Mean number of correct responses

Treatment	List 1	List 2	List 3	List 4
Concrete-imagery	4.63	4.50	4.44	5.38
Concrete-verbal	3.19	3.63	5.06	5.50
Concrete-repetition	2.44	2.81	4.06	5.38
Abstract-imagery	2.06	2.88	4.00	5.56
Abstract-verbal	2.69	3.31	4.38	5.75
Abstract-repetition	0.87	1.81	2.94	5.63

(b) Summary of Analysis of Variance

Source	df	MS	F
Between Subjects	95		
C-A	1	55.51	21.02[a]***
CI-CV	1	4.87	1.84
AI-AV	1	5.27	2.00
CI & CV - CR	1	32.07	15.15***
AI & AV - AR	1	44.04	16.68***
Subjects W. Groups	90	2.64	
Within Subjects	288		
List (a)	3	155.00	95.33***
A x Concreteness (B)	3	13.10	8.06***
A x Instructional Set (C)	6	5.57	3.43*
A x B x C	6	2.54	1.56
A x Subjects W. Groups	270	1.63	

a * $p < .05$
** $p < .01$
*** $p < .001$

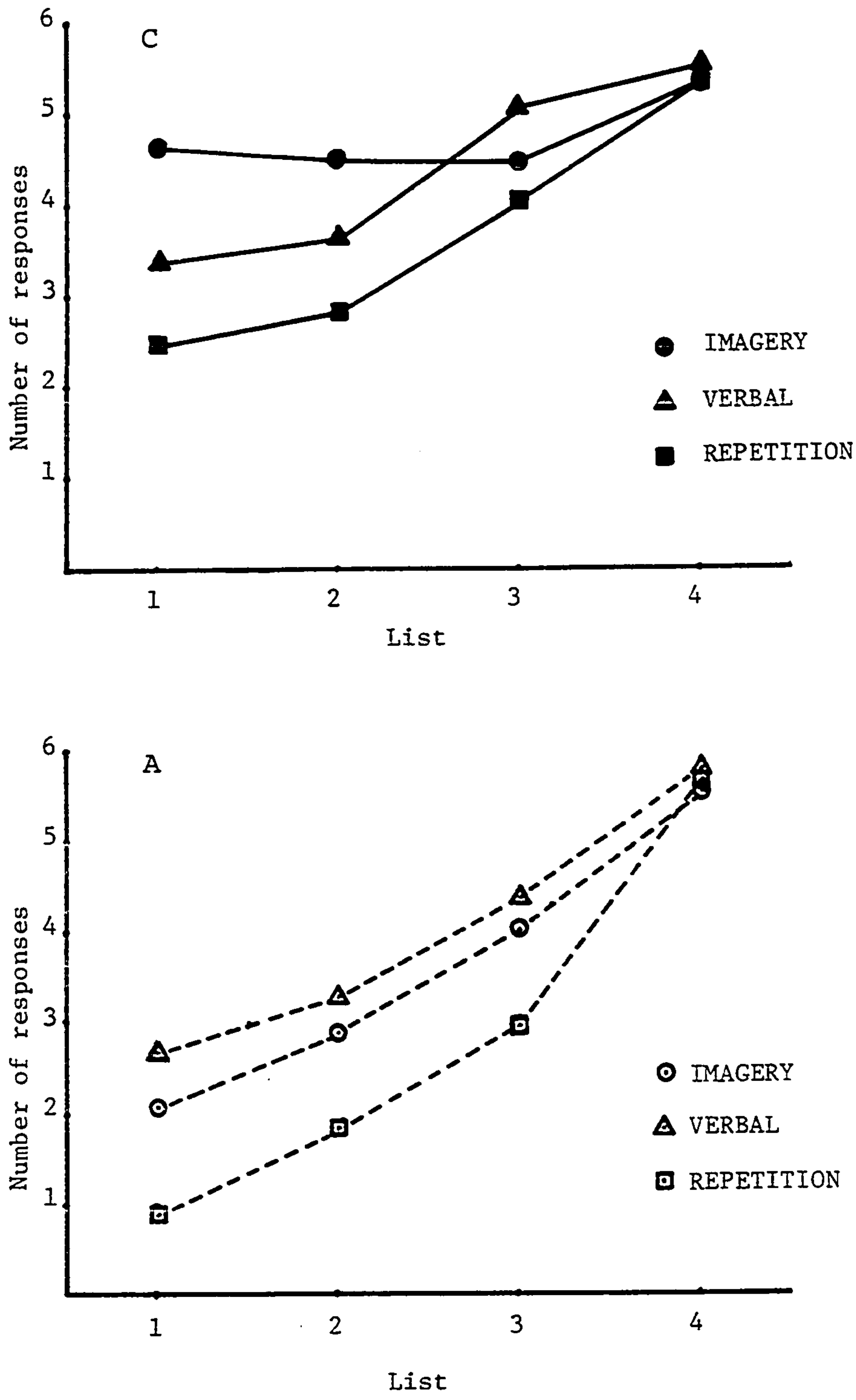


FIGURE 7. Unordered Recall: Mean Number of Concrete (C) and Abstract (A) Correct Responses Recalled on each List.

verbal mnemonic sets taken together than under the repetition instructions for both concrete nouns (hypothesis 14, $F = 15.15$, $df = 1, 90$, $p < .001$) and abstract nouns (hypothesis 15, $F = 16.68$, $df = 1, 90$, $p < .001$). No differences were found between concrete-imagery and concrete-verbal (hypothesis 12, $F = 1.84$, $df = 1, 90$, $p > .05$) or between abstract-imagery and abstract-verbal conditions (hypothesis 13, $F = 2.00$, $df = 1, 90$, $p > .05$).

The partitioning of the within-subjects variance resulted in findings analogous to ordered recall. The main effect of list was significant ($F = 95.33$, $df = 3, 270$, $p < .001$) as was the list by concreteness interaction ($F = 8.06$, $df = 3, 270$, $p < .001$) and the list by instructional set interaction ($F = 3.53$, $df = 6,270$, $p < .05$).

The Greenhouse and Geisser technique revealed a significant list effect ($p < .001$) and list by concreteness interaction ($p < .01$) but failed to reveal the list by instructional set interaction ($p > .05$).

Scheffé tests on the within-subject effects revealed precisely the same pattern of results as was found for ordered recall. The list effect was due to the increasing number of correct responses recalled from list 1 to list 4. The two interactions with list were due to significant between group differences occurring at list 1 but progressively diminishing over lists.

Classification of Acquisition Errors

It was thought that a post hoc analysis of the kinds of errors made during acquisition might yield information of interest to the theoretical constructs being investigated in this thesis. The total number of acquisition errors on all four lists were classified into one of seven categories: omissions, intralist errors, interlist correct errors, interlist incorrect errors, stimulus errors, new errors, and spelling errors. Failure to respond during the criterion time period was counted as an omission error. Intralist errors were responses that occurred within the same list that was being tested but were matched to the wrong stimulus. Interlist errors were response intrusions from previous lists. If the interlist error response had been previously matched in an earlier list with the stimulus item in question, it was scored as an interlist correct error, otherwise it was scored as an interlist incorrect error. Stimulus errors occurred when one of the six stimulus items was chosen as a response. New errors were any unique words that had not been presented at any time on study trials. Misspelled words not scored correct by the computer program were classified as spelling errors. Considering all response errors, 66.7% were omissions, 18.2% were intralist errors, 6.1% were stimulus errors, 2.3% were interlist correct errors, 2.2% were interlist incorrect errors, 3.0% were new errors, and 1.5% were spelling errors. Since most of the errors were either omissions or intralist errors, statistical analyses were conducted only on these two classifications of incorrect responses. Post-hoc chi-square tests were made comparing the proportion of omissions and intralist errors between the various experimental treatment groups. Only comparisons significant at or below the .05 level are presented.

Omissions. A higher proportion of omission errors occurred: for concrete nouns (72.4%) than for abstract nouns (64.2%); for concrete-imagery (88.1%) than for either concrete-verbal (66.7%) or concrete-repetition (71.2%) and for abstract-verbal (77.8%) than for either abstract-imagery (69.7%) or abstract-repetition (54.7%). The latter two groups also differed significantly.

Intralist errors. A higher proportion of intralist errors occurred: for abstract words (19.6%) than for concrete words (15.2%); for either concrete-repetition (19.5%) or concrete-verbal (12.2%) than for concrete-imagery (1.5%); and for abstract-repetition (26.0%) than for either abstract-imagery (14.9%) or abstract-verbal (11.1%).

CHAPTER VI

DISCUSSION

In Chapter III, fifteen major hypotheses were explicitly stated--five each pertaining to acquisition, ordered recall, and unordered recall. This chapter will discuss the relationship of the empirical findings to the hypotheses and the implications of the results to the theoretical framework underlying this study.

Results

Four of the five acquisition hypotheses were confirmed. Substantially more errors occurred for abstract words than for concrete words. The effects of instructional set were also strong. For the concrete words, differences existed between all three sets but were greatest between the imagery set and the repetition set. An examination of Figure 2 reveals that differences between concrete-imagery and concrete-verbal sets were greatest at list two presumably reflecting initial proactive interference effects. It is interesting to note that while there was no overall significant difference between the abstract-imagery and abstract-verbal conditions, there was a divergence of these two groups at list two: the abstract-verbal group increased in number of errors while the abstract-imagery group decreased in number of errors. For purposes of general interest, a two-tailed t test on this difference was significant ($t = 2.09$, $df = 30$, $p < .05$). It is difficult to ascertain whether such a difference was a chance effect (the convergence on list three suggests that it might be). Nevertheless, it at least appears that an imagery set does not disrupt or interfere more than does a verbal set with the learning of abstract words.

The above finding is in agreement with the Paivio and Foth (1970) experiment. Imagery mediation was inferior to verbal mediation for abstract words only when the subjects were required to physically draw the image or write down the verbal mediator. When such overt production was not required, there was a tendency towards slightly higher recall under the imagery set. Together, these findings suggest an explanation relating to the relative availability (or unavailability) of discovering appropriate mediators for abstract word pairs. It seems reasonable to assume that for any particular subject, the difficulty of finding appropriate imaginal mediators for abstract words may vary from word pair to word pair. Similarly, there will be substantial individual differences between subjects in attempting to perform such a task. When all subjects are required to actually draw an image, it more or less forces adherence to an imagery strategy. When subjects fail to discover an imaginal mediator under such conditions, they are not likely to retain the word pair for later recall as no mediator of any kind is available. Thus, the relative inferiority of the imagery set to the verbal set in this case reflects the differential availability of imaginal and verbal mediators for abstract words. On the other hand, when subjects are simply given a mediational set and are under fewer constraints to adhere to it, they will likely use the given set whenever possible but will revert to other strategies when the task becomes too difficult to justify the continued use of an inappropriate strategy. The assumption of course is that imagery mediation can sometimes be effective, at least for short-term purposes, when the materials to be learned are abstract. However, forcing subjects to use only an imagery strategy for abstract words may prove detrimental for some subjects or for all subjects with some word pairs.

One question that always arises in experiments manipulating instructional set is whether or not the subjects uniformly follow the directions. Paivio and Yuille (1969) have reported evidence that subjects do not always comply with the instructional set and revert to more appropriate strategies--especially under repetition instructions. Figure 2 reveals the number of errors made by the repetition groups. Considering that subjects had to learn four different lists, each to a criterion of five out of six correct, it is remarkable how stable the differences were between the repetition set and either the imagery or verbal set. For concrete words, the repetition set resulted in more than four times as many errors as did occur under the imagery set and more than twice as many errors as did occur under the verbal set. For the abstract words, the repetition set resulted in about twice as many errors as did the imagery and verbal sets taken together. In fact, on an average more errors were made by the concrete-repetition group than by the abstract-imagery or abstract-verbal groups. In this instance, the effect of set superceded the concreteness-abstractness dimension. There appears to be little doubt that the repetition set substantially suppressed relevant mediational strategies from developing.

Although many subjects appeared to have no qualms about using a repetition set throughout the course of the entire experiment, an examination of the variances for the acquisition errors made for each list provides some evidence that a few subjects may have changed strategies. For each list, the variability of the repetition groups was substantially greater than for either the imagery or verbal groups. Perhaps this result simply reflects substantial individual differences in the ability of subjects to retain information which has been input by rote covert rehearsal. Another possible explanation would suggest that some subjects in the repetition group shifted to a more efficient learning strategy even in the very early stages of the experiment. Table 3 reveals that variability increased dramatically over lists for the concrete-repetition group but remained relatively high and stable for the abstract-repetition groups. As learning progressed throughout the experiment, individual differences among subjects increased under the repetition instructions for the concrete words. Such results would be consistent with a hypothesized shift in strategy by some subjects. The contrasting stability of variance for the abstract-repetition group perhaps suggests that it is the semantic characteristics of the nouns that play a major determining factor governing the probability of a strategy shift. While the probability of a direct shift to a verbal strategy may be equal for both concrete and abstract words, the probability of a direct shift to an imagery strategy would be much higher for the concrete words. Since a shift to an imagery strategy is likely to result in a simultaneous use of a verbal strategy, the probability becomes greater that a shift to either an imagery or verbal strategy or both will occur for the concrete words. Such interpretations are, of course, highly speculative. It is likely that changes of strategies interacted in some complex fashion with the effects from a differential build-up of interference over lists. Nevertheless, it is clear that the instructional set variable did have consequential effects on acquisition errors as was predicted.

It is not of critical concern that there was a significant list effect and list by concreteness interaction. These effects resulted from a substantial decline in the number of errors on list four, the effect being significantly greater for the abstract than for the concrete words.

As the lists were not counterbalanced in the design, it is impossible to attribute the effects to any specific cause. It may have been list specific; that is, words in list four per se were easier to learn for one reason or another than words in the other lists. This explanation seems unlikely in that the effect occurred for both the abstract and concrete words. Also, the effect did not occur for the abstract-repetition group which actually showed a slight increase in number of errors from list three to list four. The effect more likely relates to some interaction between interlist interference and practise effects.

The results from the recall test were very similar to those found in acquisition even though each list had been learned to a common criterion. As would be expected, the differences between the groups were greatest at list one and declined through to list four. For the ordered recall measure, substantially more concrete words were recalled than abstract words. The repetition set resulted in poorer recall than either the imagery or verbal sets for both concrete and abstract words. Recall of concrete words was higher under the imagery set than under the verbal set--especially for lists one and two. Recall of abstract words tended to be somewhat higher under the verbal set than under the imagery set but the effect was not statistically significant. This latter finding is of interest because it is the reverse of the trend in acquisition. Perhaps the imagery-verbal set differences in acquisition and recall for abstract words are trivial or perhaps imagery mediation with abstract words can only be effective over very short periods of time. This would not be surprising considering the complexity of operations required when decoding imagery representations into abstract words.

The results of unordered recall were analogous to ordered recall with one exception. The concrete-imagery - concrete-verbal difference over lists failed to reach significance although the results were in the predicted direction. A two-tailed t test between these two groups on list one did indicate a significant effect ($t = 2.46$, $df = 30$, $p < .05$). In general then, it can be concluded that the results from both recall measures parallel those found in acquisition.

Time Factor

One possible uncontrolled factor affecting the recall measure was time. Since it took some experimental groups longer than others to learn the four lists, the time span between the beginning of list learning and the start of the final free recall test would vary directly with the number of errors made in acquisition. Thus, one might hypothesize that the observed differences in recall simply reflect longer intervals of time between initial learning and final recall for some groups and hence imply simple trace decay over time to account for the results. Such an explanation is highly unlikely. For one, the time differential between the easiest and most difficult learning conditions during acquisition was only about fifteen minutes. More importantly, pilot testing of one A-B list of eight abstract noun pairs revealed no significant retention loss when a "surprise" recall test was administered anywhere from twenty minutes to one hour later. The same result was observed with two eight-pair lists using an A-B, C-D paradigm. Substantial retention losses were observed to occur only under variations of the A-B, A-C paradigm. It was on the basis of this pilot testing that the A-B, A-C, A-D, A-E methodology was chosen. Thus it is unlikely that the time factor contributed in any significant way to the results.

The time factor could be eliminated by presenting list one using the performance criterion method and then presenting the interfering lists for a fixed number of trials. Time would be controlled but one could argue that amount of interpolated learning varied between the experimental conditions (e.g. the interpolated lists would be either concrete or abstract word pairs). It is obvious that in these experiments one can not simultaneously control for both time and amount of interpolated learning unless, of course, the same interpolated task is employed across all conditions.

Response Errors

One factor contributing to the differential effects in acquisition can be inferred from the analysis of response errors that occurred on test trials. Most of the errors were either omission or intralist errors. These two types of errors also tended to covary with one another; that is, where there was an increase in intralist errors, there was a corresponding drop in omission errors. Fewer intralist errors occurred for concrete than for abstract words. Under the imagery, verbal, and repetition sets, the percentages of intralist errors that occurred for the concrete words were 1.5%, 12.2%, and 19.5% respectively and for the abstract words, 14.9%, 11.1%, and 26.0% respectively. This pattern of results suggests that any mnemonic system that encourages contextual organization of the stimulus and response items will reduce intralist interference. Moreover, where imagery mediation can be effectively employed (i.e. concrete words), intralist interference will be even further reduced. It was suggested in Chapter III that imagery mediation may have its effect by unitizing the noun pair into a very distinct spatially integrated compound thus minimizing confusions with other noun pairs in the list. For the concrete words, the intralist error data would support such a hypothesis.

Imagery and Associative Interference Theory

Of obvious relevance to this paper are theoretical notions that can be hypothesized to account for observed effects in an A-B, A-C learning paradigm. Martin (1971) has reviewed the current status of associative interference theory in reference to this paradigm and has proposed that the most viable explanation relates to multiple encoding of the nominal stimulus. Two (or more) distinct behaviours can be linked to the same nominal stimulus but not to the same functional stimulus. Any particular nominal stimulus can be functionally encoded in several distinct ways; multiple stimulus encodings enable the same nominal stimulus to be linked to multiple responses. Retrieval of any particular response upon presentation of a stimulus will depend upon which encoding is dominant. Learning of A-B is seen as strengthening the probability that a specific distinct encoding will appear while the learning of A-C strengthens the probability that a different encoding will appear. The dominance of C over B in retroaction or of B over C in proaction is related directly to the shape of the probability distribution of different functional encodings. The crucial postulate of this theory specifies that the multiple stimulus encodings become differentially salient when more than one response comes to be associated to the same nominal stimulus. Obviously the ease of such differentiation will relate to such variables as the multiplicity of physical features in the stimulus situation and all of the possible internally controlled idiosyncratic meaning encodings generated by the subject.

In the context of this thesis instructions to generate verbal associates or imagery responses to stimulus-response pairs can be interpreted as affecting the number and kind of encodings that the subject can readily use. Rote repetition instructions increase the likelihood that the subject will use poorly defined features of the nominal stimulus for functional encoding or will attempt to match multiple responses to the same functional stimulus. Stated another way, a rote rehearsal strategy probably suppresses relevant mediational encoding from occurring. Verbal mediating instructions should encourage distinct functional encoding by generating a syntactical and/or semantic context for the stimulus and response terms. Imagery instructions should be particularly effective as the subject can simply image a variety of visual encodings or can even clearly differentiate parts of one image. For example if the stimulus was "hand," the subject could visualize a large hand or a small hand, a monkey's hand or a human hand, or he could differentiate parts of the hand into five component fingers placing separate response images on each finger. Of critical importance to recall is that the multiple functional encodings be readily retrievable and decodable upon presentation of the nominal stimulus. Which or how many responses are retrieved will depend upon the probability distribution of associative strengths for the entire set of potential encodings. It seems reasonable that one functional code may be stored in more than one modality. The stimulus "boat" could be encoded semantically as "ship" or "ocean liner" as well as by corresponding visual representations. Words are probably rarely directly encoded as images but are first given a semantic interpretation and then imaged; the kind of imagery aroused will be directly controlled by the semantic interpretation (Bower, 1969). The hypothesized facilitating effect of such overlapping codes is simply the dual-coding hypothesis stated earlier.

Similarly, the importance of reliable stimulus encoding is Paivio's conceptual-peg hypothesis. In addition to creating a unique relational context in which the stimulus and response terms can be organized, dual coding can be interpreted as increasing distinctiveness of the various functional stimulus encodings. In as much as the imagery code acts as a spatially parallel system, decoding will be even more facilitated.

In summary, although the verbal and imagery memory systems are considered to be able to function orthogonal to each other, neither system will ordinarily act independently of one another. Whereas verbal stimuli may arouse either associative verbal responses or nonverbal referent images, object stimuli may arouse either verbal labels or related associative imagery. The meaning of concrete words is derived through association with both concrete objects and events as well as through contextual association with other words. Abstract words, on the other hand, derive their meaning primarily through intraverbal experiences and only to a very limited extent via imaginal processing. Thus concrete words are more likely to evoke associative information from two memorial systems rather than only one as would be the case for abstract words (Paivio, 1971a).

Summary

The main purpose of this study was to examine whether the effects of imagery as defined operationally within the context of the experimental variables (concreteness-abstractness and instructional set) would have a positive facilitative effect not only on rate of acquisition but also on retention; that is, after a series of potentially interfering lists were learned to a common performance criterion, would the conditions in which the stimulus-response pairs were learned with the fewest number of errors also be the same conditions in which more responses would be correctly retrieved when a final recall test on all lists was administered. The one set of hypotheses not confirmed predicted superiority of a verbal set over an imagery set in the acquisition and retention of abstract word pairs. Within the theoretical framework of this experiment, however, there was no reason to expect differences in final recall if no differences appeared in initial learning. With the exception of this finding, the remaining experimental hypotheses were fully supported by the obtained data.

Educational Implications

The development of mnemonic systems should be of considerable interest to educators involved in designing new and innovative instructional technologies. Experimental evidence to date would suggest that mnemonic devices would be especially useful in situations where a large number of unrelated or arbitrary facts must be learned. Mnemonics should aid in both the acquisition and retention of such facts by organizing them into some meaningful context. Despite claims to the contrary by some educators students are required to spend a large bulk of their time simply memorizing vast quantities of information. The face validity of this position becomes apparent upon examination of the tests used to assess student achievement in almost any academic discipline. Even the area tests of the Graduate Record Examination place heavy emphasis on pure retention of factual content. If in a high school biology class a student is asked to spontaneously contrast and compare the nervous system of a clam and an earthworm, he must first be able to recall several appropriate descriptive labels along with corresponding component information for each organism before the exercise of contrasting and comparing can even begin. Sometimes problem solving such as in mathematics involves retaining a number of independent bits of information. These include those given or stated in the problem and the student generated facts and conceptual links which to him seem relevant to finding a solution. Unless all of the information is made readily available by some form of memory support, such as in a diagram or notational system, the information must be held in short-term memory for further processing. Mnemonic instructions could teach students to formulate their own memory support systems whether they be externally produced drawings or internal imagery representations. For example, Sieber, Kameya, and Paulson (1970) found that providing memory supports as an aid to solving some mathematical puzzle games not only facilitated learning but more importantly reduced the large differences that appeared between high and low anxious students when the memory support devices were not provided. In general then, it is hoped that mnemonic techniques would be useful by serving as retrieval aids for bits of information that seem to lack any obvious associative links. Such a proposal is not de-emphasizing in any way the importance of teaching various analytical skills or of encouraging students to formulate creative relationships among concepts. In fact, the production and utilization of mnemonic skills would encourage the development of such abilities. Discovering relevant mnemonic systems often involves incorporating new and unrelated facts into an older established network of organized information. It is important that students be taught the general principles underlying mnemonic systems so that they can experiment and create their own idiosyncratic methods for organizing information. Also where possible, curriculum and textbook materials should liberally employ mnemonic techniques within the course content. This suggestion naturally assumes that the instructor knows precisely what the student is to remember. As Bower (1970b) points out, mnemonic devices are bound to work if for no other reason than that current methods for teaching rote materials in the school are often haphazard and stress simple repetition and drill.

Naturally, the long-term effects of using mnemonics in the applied situation needs to be researched. One question of interest would be whether or not information learned more efficiently by a mnemonic scheme would be retained as well as, better than, or poorer than if the same information had been learned, for example, by rote. The evidence from this thesis strongly suggests the affirmative; appropriate mnemonics facilitate both rate of acquisition and retrieval efficiency.

Finally, substantial research is needed relating the utilization of various mnemonic systems to differences in aptitudes. This thesis has provided evidence justifying the postulation of at least two major information processing systems and the interconnections between them. The differential ability of students to utilize either system as well as the ability to discover and effectively employ associative connections between the two systems is not well understood. Research into these problems will hopefully facilitate an understanding of the principles underlying differential learning strategies and abilities of fast and slow learners so that compensatory instructional systems can be developed.

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A P P E N D I X   A

General Task Instructions

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Please read this set of instructions carefully before proceeding.

This is a learning experiment in which you will memorize lists of word pairs (e.g. CANNON-GARBAGE: TRIUMPH-PAIN). On study trials it will be your task to memorize each of the word pairs. On test trials you will be presented with only the stimulus word (e.g. CANNON - ?) and you will be required to recall the correct response word (e.g. GARBAGE). If you can remember the correct word, you will type that response on the key board in front of you.

The word that you type will appear on the screen above the keyboard. The word must be spelled correctly. If you make a mistake while typing the word, press the key marked ERASE in the upper right hand corner of the keyboard. This key will erase one letter at a time. Make sure you can find the ERASE key.

After you have completed typing a word, you must press the ENTER key which is located on the right hand side of the keyboard. If you can not remember the correct response, you may push the ENTER key and the next stimulus will appear on the screen. Make sure you can find the ENTER key.

Remember, in order to get a correct response you must:

1) Type the response word
2) Check that the word is spelled correctly
3) Press the ENTER key

On all parts of the experiment, there is a time limit. If you exceed the time limit, the computer will stop accepting your answer and the word which you were typing will be judged wrong. It is therefore important that you work quickly and accurately.

You will probably be asked to repeat some parts of the experiment several times. It is important that you do your best on every trial, even if you have answered correctly on an earlier trial. If you have trouble at first remembering the words, try not to let it discourage you or prevent you from doing the best that you can. We have found that most students find this type of learning a little more difficult than they first thought it would be.

It is very important that you follow the instructions to the best of your ability. Should you fail to follow any instruction, be sure to tell the supervisor since the interpretation of the results may be affected.

A P P E N D I X B

Instructional Sets

Images

There are several ways in which word pairs can be learned. We want you to use one specific method. It is very important that you attempt to use the method described below.

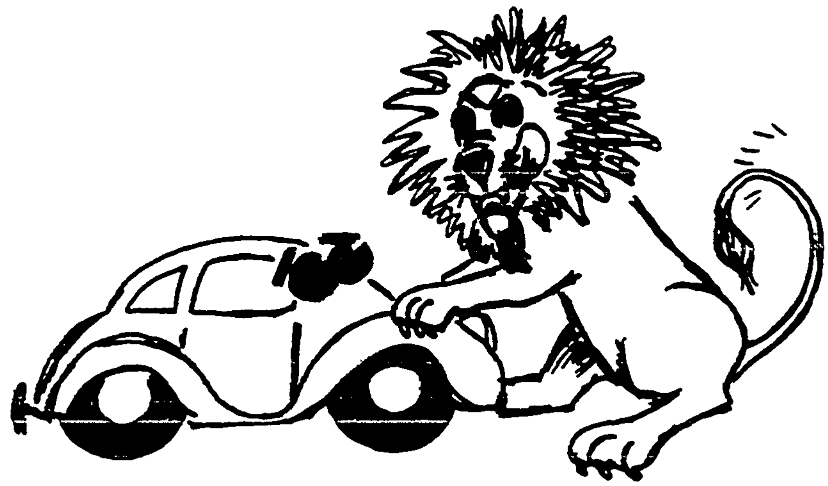
One way in which you can learn to associate a stimulus word with a response word is to form a visual image using the two words; that is, you imagine a mental picture representing the two words. For example, if the word pair is CANNON-GARBAGE, you might imagine a CANNON shooting all sorts of GARBAGE into the air or you might even imagine a rusty old CANNON sitting on top of a GARBAGE dump. It is important that you form a very clear and distinct image uniting the two words together in some fashion. The image may or may not be bizzare. It is strictly up to you to generate the image you think is best. Look at the examples on the next page.

On test trials, when you are presented with the stimulus word CANNON, you should try to remember the appropriate image and hence recall the response GARBAGE.

Remember, it is important that you only use this method throughout the entire experiment. Do not use any other method.

Do you understand the instructions? If not, reread them or ask the supervisor for assistance. If you are ready to start the experiment, do the following:

1) Put on the headset so that it is comfortable to your ears.
2) Carefully type the following four digit number _________ .
3) When you have typed it correctly, press the ENTER key.



LION - CAR

CANNON - GARBAGE

Images

There are several ways in which word pairs can be learned. We want you to use one specific method. It is very important that you attempt to use the method described below.

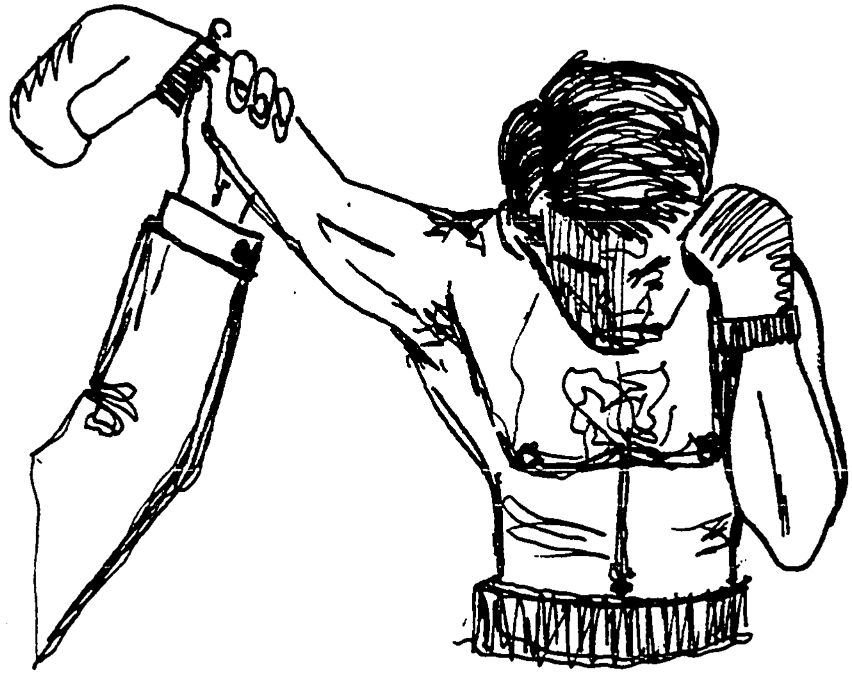
One way in which you can learn to associate a stimulus word with a response word is to form a visual image using the two words; that is, you imagine a mental picture representing the two words. For example, if the word pair is TRIUMPH-PAIN, you might imagine a champion boxer who has won the big fight (TRIUMPH) but who has a bandage around his head (PAIN) or you might even imagine a dentist pulling out a bad tooth (TRIUMPH) from a patient whose facial expression shows great PAIN. It is important that you form a very clear and distinct image uniting the two words together in some fashion. The image may or may not be bizzare. It is strictly up to you to generate the image you think is best. Look at the examples on the next page.

On test trials, when you are presented with the stimulus word TRIUMPH, you should try to remember the appropriate image and hence recall the response PAIN.

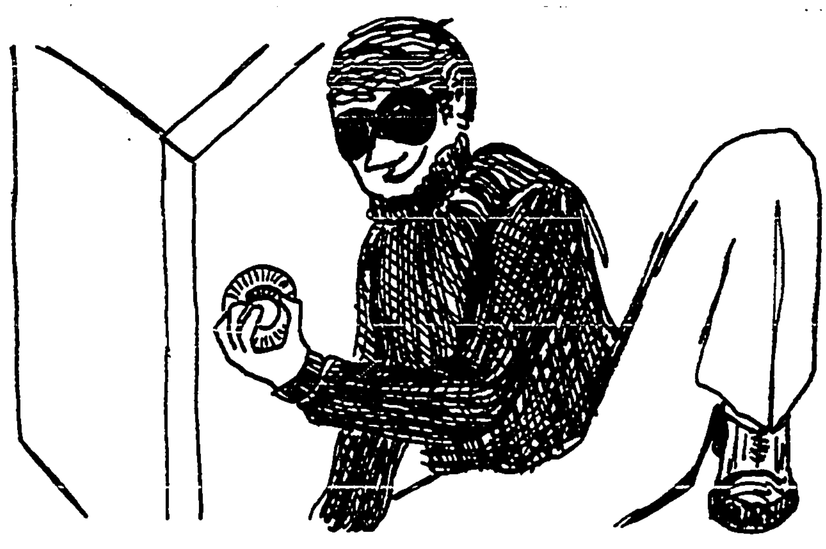
Remember, it is important that you only use this method throughout the entire experiment. Do not use any other method.

Do you understand the instructions? If not, reread them or ask the supervisor for assistance. If you are ready to start the experiment, do the following:

1) Put on the headset so that it is comfortable to your ears.
2) Carefully type the following four digit number ________ .
3) When you have typed it correctly, press the ENTER key.



TRIUMPH - PAIN



CRIME - SKILL

Sentences

There are several ways in which word pairs can be learned. We want you to use one specific method. It is very important that you attempt to use the method described below.

One way in which you can learn to associate a stimulus word with a response word is to form a sentence or phrase connecting the two words. For example, if you were to learn the word pair CANNON-GARBAGE, you might say to yourself:

The CANNON shot all sorts of GARBAGE into the air.

or

The rusty old CANNON was sitting on top of the GARBAGE dump. It is very important to form an interesting sentence that you can easily remember. The sentence may or may not be bizzare. It is strictly up to you to generate the sentence you think is best.

On test trials, when you are presented with the word CANNON, you should try to remember the appropriate sentence and hence recall the response GARBAGE.

Remember, it is important that you only use this method throughout the entire experiment. Do <u>not</u> use any other method.

Do you understand the instructions? If not, reread them or ask the supervisor for assistance. If you are ready to start the experiment, do the following:

1) Put on the headset so that it is comfortable to your ears.
2) Carefully type the following four digit number ________ .
3) When you have typed it correctly, press the <u>ENTER</u> key.

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There are several ways in which word pairs can be learned. We want you to use one specific method. It is very important that you attempt to use the method described below.

One way in which you can learn to associate a stimulus word with a response word is to form a sentence or phrase connecting the two words. For example, if you were to learn the word pair TRIUMPH-PAIN you might say to yourself:

The boxer's TRIUMPH also brought him great PAIN.

or

A dentist's TRIUMPH is a patient's PAIN.

It is very important to form an interesting sentence that you can easily remember. The sentence may or may not be bizzare. It is strictly up to you to generate the sentence you think is best.

On test trials, when you are presented with the word TRIUMPH, you should try to remember the appropriate sentence and hence recall the response PAIN.

Remember, it is important that you only use this method throughout the entire experiment. Do <u>not</u> use any other method.

Do you understand the instructions? If not, reread them or ask the supervisor for assistance. If you are ready to start the experiment, do the following:

1) Put on the headset so that it is comfortable to your ears.
2) Carefully type the following four digit number ________ .
3) When you have typed it correctly, press the <u>ENTER</u> key.

Repetition

There are several ways in which word pairs can be learned. We want you to use one specific method. It is very important that you attempt to use the method described below.

One way in which you can learn to associate a stimulus word with a response word is to say the two words together over and over again in a rote fashion. For example, in order to learn the word pair CANNON-GARBAGE you simply repeat the two words silently to yourself

CANNON-GARBAGE

CANNON-GARBAGE

CANNON-GARBAGE

as many times as possible. On test trials, when you are presented with the word CANNON, you should try to remember the correct response GARBAGE.

This task is a difficult one. There may be a temptation to want to learn the word pairs in some other fashion. However, it is very important to the success of the experiment that you attempt to use this repetition strategy throughout the entire experiment. Do <u>not</u> use any other method.

Do you understand the instructions? If not, reread them or ask the supervisor for assistance. If you are ready to start the experiment, do the following:

1) Put on the headset so that it is comfortable to your ears.
2) Carefully type the following four digit number ________ .
3) When you have typed it correctly, press the <u>ENTER</u> key.

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There are several ways in which word pairs can be learned. We want you to use one specific method. It is very important that you attempt to use the method described below.

One way in which you can learn to associate a stimulus word with a response word is to say the two words together over and over again in a rote fashion. For example, in order to learn the word pair TRIUMPH-PAIN you simple repeat the two words silently to yourself.

TRIUMPH-PAIN

TRIUMPH-PAIN

TRIUMPH-PAIN

as many times as possible. On test trials, when you are presented with the word TRIUMPH, you should try to remember the correct response PAIN.

This task is a difficult one. There may be a temptation to want to learn the word pairs in some other fashion. However, it is very important to the success of the experiment that you attempt to use this repetition strategy throughout the entire experiment. Do not use any other method.

Do you understand the instructions? If not, reread them or ask the supervisor for assistance. If you are ready to start the experiment, do the following:

1) Put on the headset so that it is comfortable to your ears.
2) Carefully type the following four digit number _________ .
3) When you have typed it correctly, press the ENTER key.

A P P E N D I X   C

Recall Tests

______________________________ (Print Your Name)

______________ (Print the four digit number used to start the program)

The main purpose of the following task is to see how many response words you can remember. Try to place the correct response words in the matrix below. If you can remember a response but can not remember which stimulus it was paired with or which list it belonged in, try to guess. I would prefer you to guess than not respond at all. Note that list 1 (CANNON-GARBAGE, LION-CAR) was the practice trial and need not concern us here.

LIST

	2	3	4	5
HOUND	________	________	________	________
BARREL	________	________	________	________
ELBOW	________	________	________	________
ROCK	________	________	________	________
LAD	________	________	________	________
BEAST	________	________	________	________

Are there any remaining responses that you can remember but simply can not place in the list? YES or NO   If YES, list them:

You were given specific instructions (a strategy) on how to learn the word pairs. Did you use any other strategy(ies)? YES or NO

What percentage of the time did you employ some <u>other</u> strategy?
______%

Describe in your own words these other strategies. Use the back of this page if necessary.

_______________________ (Print Your Name)

_______________ (Print the four digit number used to start the program)

The main purpose of the following task is to see how many response words you can remember. Try to place the correct response words in the matrix below. If you can remember a response but can not remember which stimulus it was paired with or which list it belonged in, try to guess. I would prefer you to guess than not respond at all. Note that list 1 (TRIUMPH-PAIN, CRIME-SKILL) was the practice trial and need not concern us here.

	LIST			
	2	3	4	5
PLEDGE	________	________	________	________
LAW	________	________	________	________
MORAL	________	________	________	________
GREED	________	________	________	________
COST	________	________	________	________
ATTITUDE	________	________	________	________

Are there any remaining responses that you can remember but simply can not place in the list? YES or NO If YES, list them:

You were given specific instructions (a strategy) on how to learn the word-pairs. Did you use any other strategy(ies)? YES or NO

What percentage of the time did you employ some other strategy?
_____%

Describe in your own words these other strategies. Use the back of this page if necessary.