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Short and Long Term Free Recall of Nouns as a Function of Learning Instructions and Noun Concreteness

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SHORT AND LONG TERM FREE RECALL OF NOUNS AS A FUNCTION OF LEARNING INSTRUCTIONS AND NOUN CONCRETENESS

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ABSTRACT

The present study was designed to investigate immediate and delayed recall of abstract and concrete nouns learned using a verbal or imagery set. On the basis of the Dual Coding Hypothesis, it was predicted that concrete nouns would be recalled better than abstract nouns for both immediate and delayed recall. It was further expected that imagery instructions would facilitate recall of concrete nouns more than abstract nouns for both immediate and delayed recall. A secondary interest was to investigate the amount of organization in the recall protocols of subjects for both immediate and delayed recall. According to the Organizational Hypothesis by Begg (1972, 1973), it was predicted that the concrete noun condition would result in more recall organization than the abstract noun condition, and that the concrete noun imagery instruction condition would result in the greatest organization of all conditions. Forty male and female subjects were randomly assigned to one of four experimental conditions; concrete noun-imagery instructions, concrete noun-repetition instructions, abstract noun-imagery instructions, abstract noun-repetition instructions.

Each group of 10 was presented with a list of 30 words to learn. One list consisted of nouns with high imagery-concreteness ratings and the other list was composed of nouns with low imagery-concreteness ratings. The subjects were instructed to learn the words by using imagery or repetition. After the 30 word list had been presented, the task was to write down the words from memory. The subjects were told

to return in one week for the second part of the study which would be "different". When the subjects returned in one week, they were asked to write down all of the words they could remember from the list presented the previous week. After completing this recall trial, the subjects were asked to indicate how they had recalled each word by writing a number beside it. Number 1 was to be used if they "recalled an image or mental picture" first, number 2 was to indicate "recalled the word", and number 3 was to indicate some other recall method, which they were to describe. Recall frequencies were treated with an analysis of variance procedure. Recall organization or clustering was first examined using the Adjusted Ratio of Clustering (ARC) developed by Roenker et al. (1971). This data was then transformed into Arcsin values and cast into an analysis of variance. The proportion of words recalled by each recall strategy was transformed into arcsin values and also cast into an analysis of variance. The results of this study showed that both immediate as well as delayed recall are better for concrete material learned using imagery instructions than for all other combinations of word type and instructions. Repetition as a mode of learning concrete material results in inferior recall performance when compared with the use of imagery. Abstract material was learned equally well with either repetition or imagery instructions. It was also found that retention loss is less for delayed recall in imagery coded concrete material than for any other combination of material and learning instructions. The recall strategy data did not provide any useful information, probably due to subjects' confusion in understanding the instructions.

The recall organization data showed that recall was not correlated

with organization in this study. It was concluded that the results of this study are generally in support of the Dual Coding Hypothesis (Bower, 1969; Paivio, 1969) and fail to support the Organizational Hypothesis (Begg, 1972).

CHAPTER I

INTRODUCTION AND REVIEW OF LITERATURE

Introduction

Mental imagery is the almost universally possessed ability to picture something in one's mind. The ability to form images plays a very important part in our daily lives and even when we sleep we are often engaged in dreaming, an imagery form.

There are many examples of how we are engaged in imagery activity during the day. Commercial advertising is possibly the best example of how imagery is used. In a single day the average person is deluged with advertisements, all attempting to have the viewer imagine himself using a new product and consequently have a much improved life. Television and films are media forms that involve the ability to imagine oneself in various activities or places. Literature is a good example of how an author attempts to involve the reader in imagery through the use of vivid and colorful descriptions. Our daily language reflects the common use of imagery by such statements as "picture this", or "imagine that". If you are ever bored, you probably engage in the most popular form of imagery, which is fantasy or daydreaming. Psychological treatments such as hypnosis and systematic desensitization rely heavily on imagery for their effect.

The above forms of imagery do not seem unusual by any means, and yet the scientific community has spent relatively little time studying

the function of imagery. Only within the last two decades have researchers begun to take an active interest in imagery. For the scientific community, the question of the function of imagery has been related to the study of verbal learning and memory. Everyday experience as well as scientific studies indicate that imagery is strongly involved in certain types of memory, such as memory for concrete material or anything that can be pictured in the mind.

The current investigation identifies a problem in recent studies of imagery. The problem is, what facilitating effects does imagery have for long term memory? There is a long and interesting history of imagery that forms the background for this question. The following sections present this background.

Historical Background of Imagery

"The role of imagery in cognitive function is one of the oldest and most difficult problems investigated by psychologists" (Marks, 1972, p. 83). Ancient references to imagery date back some 2500 years to a mnemonic system that was developed by the Greek poet Simonides, which in turn has been handed down to us by Latin teachers of rhetoric (see Yates, 1966). According to the ancient story, Simonides was called outside while attending a large banquet. During his brief absence, the roof of the hall collapsed, killing everyone inside. The bodies of the victims were impossible to identify and Simonides was asked if he could help. He was able to identify each of the corpses by recalling where each person sat before the tragedy. He was able to do this by visualizing the room and then mentally walking about, "seeing" who had been seated in each chair. The mnemonic that developed as a result of this technique

is called the "method of loci," because it involves recalling things in a series of locations.

This memory device involves taking an imaginary walk along some very familiar route, such as through your home, where at any point along the way the objects surrounding you can be imagined very clearly. The main points of a speech or any other list of items can be pictured as objects which are visualized at various locations along this route. The items to be recalled can be retrieved from memory simply by taking a mental walk along this route. Bower (1969, 1970) has done a series of studies on this method, finding strong support for its effectiveness in facilitating recall.

Another historical reference to imagery involves the ancient "wax tablet" model of memory, where the image was equated with the memory trace. This was the theory espoused by Plato (see Gomulicki, 1953) which stated that perceptions and thoughts are impressed on the mind as on a block of wax, to be remembered and known as long as the image lasts.

Aristotle believed the ability to think was dependent upon the retention of images arising from sensations. He believed that memory was also a function of images and could not occur without them (Ross, 1959).

To the ancients there was little doubt that imagery existed. It was taken for granted as one of man's most basic functions. It was not until the eighteenth and nineteenth centuries along with the beginnings of experimental psychology that imagery was investigated scientifically.

In 1883 Galton pioneered work on the measurement of individual differences in imagery by the use of his famous breakfast-table questionnaire. He asked various individuals to describe their breakfast table scene and to indicate whether the image they had was clear or dim, the

extent to which objects were colored if at all, and the extent of contents in their field of vision. His studies stimulated numerous attempts to relate individual differences in the vividness of images to thought and memory functions. Noted historian E. G. Boring (1950) states that "Galton's greatest contribution to introspective psychology was... his study of imagery and of individual differences in imagery."

At the end of the nineteenth century a great controversy arose between Wundt and his followers who asserted that all thought could be reduced to sensory and consequently imaginal elements, and Kulpe and the Wurzburg school, who discovered what they called "imageless thought." Kulpe's experimental technique involved presenting a trained introspectionist with a mental problem which he was to solve. The subject was to observe his conscious processes while attempting to solve the problem. It was during this type of experiment that subjects reported that the problem was dealt with in non-sensory fashion. Subjects reported experiencing conscious attitudes such as doubt, uneasiness, difficulty, confusion, etc. The controversy could not be resolved, however, as the major experimental technique used in its investigation was subjective introspection. Both schools of thought were open to criticism because of this experimental approach.

Wundt's student, Titchener, carried on the investigation of the elements of consciousness that Wundt had started. He postulated three elements of consciousness, one of which was images. He stated that images are the characteristic features of ideas, and that they vary along the dimensions of quality, intensity, extensity, duration, clearness and vividness. Although Wundt, Titchener and the Structuralists failed in their attempt to identify the elements of consciousness, they recog-

nized the importance of imagery in cognitive functioning and added impetus to what we again today consider to be a significant and worthwhile problem in psychology.

As the Structuralist movement declined, J. B. Watson (1913) was forming his ideas of what psychologists should be studying. He and his followers, who were called Behaviorists, reacted negatively to the Structuralists' methods of introspection, and maintained that psychology should be totally scientific and objective. The Behaviorists rejected all references to mental imagery, memory traces, etc., on the grounds that these concepts were unacceptably subjective and mentalistic, and secondly, that there was no empirical support to indicate that imagery had any functional relation to behavior.

To replace imagery, Watson substituted implicit verbal responses as the mechanism responsible for association, memory and thought. This was the origin of the view that has since dominated American Psychology. It seems paradoxical, however, that Watson should throw out imagery as too subjective and inferential and substitute implicit verbal responses which (at the time) could not be measured any more satisfactorily than imagery. As Paivio (1969) states:

> It may seem more direct and parsimonious to infer a verbal mediator when the response is verbal but this follows only if one assumes a one-to-one relationship between an associative reaction and the mental process that caused it. Such an assumption would be unwarranted for one can respond verbally to pictures as well as to words and so, by analogy, one's verbal response could just as logically be mediated by a 'mental picture' as by 'mental words' (p. 242).

Within the last two decades there has been growing disenchantment with the traditional Behavioristic approaches, and theorists and researchers alike have taken a new look at mediating processes, and imag-

ery in particular. In fact, Osgood (1961) has long argued in favor of nonverbal mediation processes. Staats (1961) has gone a step further and indicated how imagery can be incorporated into a verbal learning model. Paivio (1969) has attempted to give an objective definition of what is meant by imagery by saying:

> Images are regarded as symbolic processes which are linked developmentally to associative experiences involving concrete objects and events. In relation to language, they could be regarded as conditioned sensations for which appropriate words function as conditioned stimuli, or as constructions that are actively generated by the individual (p. 243).

The current resurgence of interest in the investigation of imagery and its relation to learning and memory has been fostered by a more realistic and open minded approach on the part of investigators. The current view is expressed very well by McKellar et al. (1972) as he says that:

> ... while the ability to generate and employ mental imagery varies across people, the potential to do so is probably universal. Given appropriate and optimal conditions of training and performance it is likely that all persons could utilize imagery coded information (p. 98).

Methodological Considerations in Imagery Research

The earliest studies of imagery (e.g., Galton, 1883) investigated individual differences in imagery ability. In many studies, imagery ability was assessed by having subjects report (in a rating scale fashion) how strong or clear a mental image they could produce of various scenes suggested to them by the experimenter.

Recent investigations of imagery take a more functional approach by attempting to answer the question, "What effect does mental imagery have upon recall?" In attempting to answer this question, three general classes of operations have been used. First, stimulus attributes have been manipulated. Pictures, words, and sentences have been used

as stimuli. Words have been used most frequently, with attributes such as word frequency, meaningfulness and imagery-concreteness being varied systematically. Second, instructions to subjects have been varied in an attempt to create different sets, usually imagery, verbal, or rote memorization. Finally, subjects have been selected to investigate individual differences in learning and memory as a function of age, sex and imagery ability differences as measured by objective tests.

The dependent variable in these studies has been amount of immediate or delayed recall of the stimulus items. The experimental tasks most frequently used in studying learning and memory are "free recall" and "paired-associate" designs. In the free recall design, the subject is presented a list of single items, one at a time for learning. At the end of the list he is asked to recall as many words as possible by saying them or writing them down.

The more frequently used design has been the paired-associate (PA) design, of which there are two basic types. The first is called the "anticipation" method where the stimulus item (word, picture, or trigram) is presented for a few seconds then the response item is presented. The Ss learn the task by anticipating what the response word is during the few seconds before it appears after the onset of the stimulus word. The second method, and the one more frequently used of the two, is called the "study-test" method. Both items of a pair are presented together during the "study" trial and then during the test trial only the stimulus word is presented and the S must say or write the correct response word. The pairs of items in the list to be learned are re-randomized for each successive presentation. There may be one or several trials (each trial consisting of one study and one test series).

Within each of the three basic approaches to studying imagery just mentioned, there is one particularly troublesome problem. Imagery, and for that matter, covert verbal responses, are not directly observable phenomena. When a subject is presented with a stimulus to learn, we can only speculate about what happens covertly (be it an image or implicit speech or both). The central processes thought to be involved are memory storage in the form of words, images, or both, and transformations which involve recoding a word into an image or the converse. Subjects who are presented with a visual compound may respond with a covert description of the pictured event and it is this verbal description rather than visual imagery which constitutes memory storage. One could also take the opposite position that subjects spontaneously visualize an image of the interaction after hearing the verbal context, and visual imagery is responsible for improved performance.

Even though it is not possible to determine objectively what the covert processes are, the approach of studying the recall effects of various types of stimuli learned with various learning sets is providing some very interesting as well as useful information on the function of memory. The current thoughts on the function of imagery are at the theoretical level. There are several different theories that attempt to account for the existing data. These will be discussed in a later section.

Imagery as an Individual Difference

The early research in the area of imagery was an attempt to identify individual differences in imagery ability and then relate this ability to the accuracy of recall. This was done in several different ways.

Subjects' imagery abilities were determined by having them picture various scenes or objects suggested by the experimenter. The subject reported on his image by stating that it was "clear, fairly clear, or dim."

Another method that was used involved having subjects look at a picture for a short time and then describe the picture from memory in as much detail as possible. The subject was asked to indicate clarity for each part recalled and was scored for accuracy of recall of the picture and clarity of image.

A third method used involved presenting subjects with different geometric drawing which they were asked to reproduce from memory. These techniques and their variations constituted the early methods of measuring imagery. The theoretical assumption in these types of studies seemed to be based on the wax-tablet concept of memory, which equated memory function with quality or vividness of the image.

In studies by Carey (1915), Davis (1932), Fracker (1908), and Kuhlmann (1907), imagery ability was operationally defined by one or more of the above methods. Kuhlmann (1907) as well as Fracker (1908) reported that imagery ability enhanced memory for visual forms or colors. Kuhlmann (1907) found very low correlations between imagery ability and scholastic performance. Carey (1915) failed to find any relationship between memory and imagery ability. He concluded that "...the clearness of imagery bears no relation to the effectiveness of the mental process which it accompanies." (p. 490). Davis (1932) presented subjects with tests which involved self reports of the type of imagery modality most frequently used. He found positive correlations between tonal memory and auditory imagery, and also between visual imagery and memory for geometrical figures.

McKellar, Marks and Barron (1972) reasoned that Ss who report vivid visual imagery would make more efficient use of the "memory walk" (method of loci) mnemonic technique in a memory task than those who report poor imagery. Independent variables in this study were sex, and imagery ability as determined by high or low scores on the VVIQ (Vividness of Visual Imagery Questionnaire, see Marks, 1972). They found that compared to the control group, the groups receiving the "mental walk" instructions showed significantly greater recall. The most interesting finding, however, was that neither imaging ability, nor sex, were significant effects. The study was replicated to verify the finds and the same results were obtained.

The majority of studies (Carey, 1915; Kuhlmann, 1907; McKellar, Marks & Barron, 1972) have found no relationship between imagery ability and the accuracy of recall. The studies of Davis (1932), and Fracker (1908) found relationships respectively between visual imagery ability and memory for geometrical figures, and visual imagery ability and memory for visual forms or colors. Neither of these studies found relationships between imagery ability and verbal recall, however.

The failure of these studies to obtain any conclusive evidence for the relationship between imagery ability and verbal recall is probably indicative of both the shortcomings in experimental design (Carey, 1915; Fracker, 1908; Kuhlmann, 1907) and the theoretical approach to the concept. A methodological criticism of these studies is that an individual's self reported imagery vividness or ability may not be a valid measure and it is certainly not an objective measure. Carey's (1915) statement that the clarity of imagery bears no relationship to the effectiveness of the underlying memory process that it accompanies may be

applicable to the findings of these studies, at least where imagery ability is so subjectively defined.

Imagery Instructions

Studies investigating the effects of instructions range from those where subjects are simply told to use imagery in learning words, to studies giving specific detailed memory schemes for learning, such as the method of loci or the pegword system.

Kirkpatrick (1894) appears to have been the first to study the effects of imagery instructions in a free-recall experiment. He presented Ss with 10 item word lists of concrete nouns with or without instructions to form a mental picture of the objects named. The results, which were replicated in two studies, indicated that recall was slightly but consistently better under the imagery instructions. In one of the experiments, recall was again tested after three days, and the imagery group recall was almost twice as great as for the no-imagery group.

Peterson and McGee (1974) did a series of experiments designed to investigate the effects of instructional set and imagery ratings, and the number of dictionary meanings upon recognition and recall. Using a paired-associate learning paradigm, they found that interactive imagery instructions produced superior recognition of stimulus words, response words, and pairs compared to rote-repetition instructions. Response recall was also higher following imagery instructions than following repetition instructions. High imagery ratings aided stimulus recognition and response recall, but not response recognition or pair recognition. The effects of imagery ratings and instructional set could not be accounted for by the number of dictionary meanings.

Instructional set and imagery ratings had different effects upon recognition and recall and Peterson and McGee concluded that these two techniques do not initiate the same underlying process. However, despite differential effects upon recognition, the two variables showed a highly similar influence on recall, as significantly more responses were correctly recalled following imagery instructions than following repetition in structions and for pairs with high rather than low imagery ratings.

Bugelski (1974) had both college seniors and eighth graders learn a list of 20 concrete words. He compared the effects of control instructions with imagery instructions and an incidental learning group, whose task was just to rate each of the words on a 7 point scale for their imagery value. Words were presented auditorially at the rate of 6 seconds each. The Ss were then asked to write down the words in serial order. The results showed that imagery instruction groups as well as imagery-incidental learning groups recalled significantly more words than the standard control learning instruction groups. The eighth graders did just as well in learning the words as the college seniors, and nearly 20% of members of each of the imagery groups recalled all of the 20 words.

Imagery instructions in the above studies are simple and straightforward. The studies of mnemonic techniques involve much more elaborate learning instructions, as subjects memorize and practice a list of numbered words or a series of locations to be associated with new words to be learned. Some studies instruct subjects to use imagery with the mnemonic technique, and others have required subjects to use the mnemonics without the use of imagery. These studies have varied the type of words

to be learned as well as varying components of the mnemonic techniques themselves. The first mnemonic technique is the method of loci which has been introduced previously, and the second mnemonic technique is called the "pegword" or "one-bun" method. Where the method of loci uses mental snapshots of locations as memory pegs, the pegword system uses a familiar list of names of simple concrete objects. A typical pegword list is one composed of rhymes of the first 20 or so integers. An example of the most commonly used pegwords for the first five integers is 1-bun, 2-shoe, 3-tree, 4-door, 5-hive. Whether these or other pegwords are used as rhymes, they should be names of concrete objects and the pegword list must be memorized so that it can be easily recited. To memorize any list of items, each item is associated with a pegword and a vivid mental image is formed of the two objects interacting in some way. For example, to memorize a shopping list consisting of milk, eggs, hamburger, etc., the milk can be imagined being poured all over a soggy hamburger bun, then a shoe stepping on a dozen eggs, hamburger packages growing on trees, etc.. To recall the list, it is only necessary to run through the familiar pegword list and recall the image that was formed with each item. Experimental investigations of the two techniques have been made by several researchers.

Gordon Bower (1969) has demonstrated dramatic effects of the pegword system on learning and memory. He reasoned that the technique provides a systematic retrieval scheme, the advantages of which could be reduced by changing some of its essential features. He did this by reducing the number of imaginal hooks or pegs the subject was taught to use in learning a 20-item list. Thus different groups were required to use 10 hooks, with two words per hook; five hooks, with four words per

hook; two hooks, with 10 words per hook; or one hook with all 20 words. Subjects were instructed and trained on the procedure with emphasis on constructing a "grand imaginal scene" involving all the to-be-remembered words in a key image, although the items were presented serially at a 5 second rate.

Bower expected that retrieval would become more disorganized with fewer hooks - the subject would fail to exhaust all words attached to a hook, lose track of what he had recalled, or unlearn words as new ones were added to a hook. The results were completely contrary to his expectations. Recall immediately after presentation of a list of 20 items, or at the end of five lists of 20 words, was equally good regardless of the number of pegs used, averaging 86% for the immediate and 72% for the delayed tests, as compared to 52% and 28%, respectively, for the control subjects given standard free recall instructions.

Groninger (1971) investigated the effects of the method of loci mnemonic technique on short term and long term memory. He compared Ss who learned a 25-word list of high-imagery words using the method of loci to a control group who basically learned the list by grouping the words. All Ss were required to learn the words in a given order. Learning times, along with three types of recall measures involving ordering of words and a recognition memory measure, were taken after 1 and 5 weeks. Results showed that learning was faster and recall better with fewer errors in the imagery condition. The recognition memory measure showed very high scores in both groups, with no significant differences between them. Groninger concluded that the effectiveness of mnemonic imagery device comes about by making items more accessible during recall.

A study by Santa, Ruskin and Yio (1973) investigated a variety of mnemonic techniques and learning strategies and compared these in a free recall paradigm where Ss learned abstract word lists or concrete word lists. They found that recall of concrete words was superior to recall of abstract words in almost all conditions. Instructions to form separate images of the words (separation imagery) and a story construction technique (without specific instructions to form images) resulted in the best recall scores for the concrete word lists. Using Dunn's index of clustering (1969), they found that recall was highly related to the extent of organization. They concluded that imagery was utilized by Ss in the concrete list story construction task and was responsible for facilitating learning and recall.

Paivio (1968) used the one-bun mnemonic in a study which investigated both the effects of imagery instructions and the effects of abstract vs concrete pegwords. The subjects were trained to use the one-bun mnemonic with one group using the standard concrete rhyme, while a second group learned an abstract rhyme: one-fun, two-true, three-free, etc., with the peg words of lower imagery value than the corresponding concrete pegs. The Ss given the imagery set were instructed to use mental images along with the rhyme in order to recall the items. The Ss not given the imagery instructions were told to recall the list by saying to themselves the rhyming words along with the to-be-remembered item. The material to be learned was a list of 10 concrete nouns, which were presented at a 4 second rate, for one study and one test trial. Results of the study were very clear, in that recall was generally better for the list learned under mnemonic instructions than for the control list, and under imagery instructions rather than no imagery instructions.

Mnemonic instruction without imagery had no beneficial effect. The surprise finding was that, contrary to expectations, recall increased dramatically for the subjects given the imagery set regardless of whether the mnemonic rhyme was concrete or abstract! This contrasts sharply with the findings for standard paired-associate learning, where noun imagery-concreteness has consistently had a strong positive effect when varied on the stimulus side of pairs (Paivio & Yuille, 1967, 1969). Paivio interpreted the contrasting effects by pointing out the differences between PA tasks and the pegword system. In the PA task the stimulus word is presented on recall trials and its image-evoking capacity is more important than instructional sets in determining response recall, while in the mnemonic system the pegwords are implicit and even ones that are concrete cannot function as effective cues for the arousal of mediating images. Thus the contribution of concreteness as a variable is accordingly depressed while that of the imagery instructions is relatively enhanced.

There can be little argument that the studies investigating imagery instructions have shown that learning and memory are facilitated by such instructions, particularly with words that can be called concrete.

A number of other results emerged from these studies which can be briefly summarized. Immediate recall was facilitated by use of the pegword system in studies by Bower (1969), Paivio (1968) and Santa, Ruskin and Yio (1973). Delayed recall was also facilitated by the use of mnemonic strategies in studies by Bower (1969), and Groninger (1971). Another result of interest was that recall was related to the extent of organization in the Santa, Ruskin and Yio (1973) study. Possibly the most important finding other than the strong effect shown for imagery

instructions, was the facilitating effect of learning concrete words as opposed to abstract words. The studies by Paivio and Yuille (1967), and Santa, Ruskin and Yio (1973) shared this result.

Variation of Stimulus Attributes

As mentioned previously, the imagery mnemonic systems were based on the assumption that concrete objects and events are more easily remembered than more abstract stimuli, and several studies of mnemonic techniques supported this assumption strongly. But studies other than those using mnemonic devices have also given strong support to the finding that the imagery-concreteness dimension may be the most important word attribute affecting learning and memory. Two types of studies lend support to this; those comparing memory for objects and pictures with words, and those directly varying the imagery-concreteness of words to be learned.

The earliest of the first type of these studies was done by Kirkpatrick (1894). He tested recall for a number of different lists of items, including the names of objects and the actual objects. For both sexes, and at all age levels from third grade to college, average recall was highest for objects. Calkins (1898) essentially replicated Kirkpatrick's findings using pictures of objects rather than the actual objects. Moore (1919) found immediate recall to be better for objects than for pictures and better for pictures than for words. Superior recall for either objects or pictures as compared to their verbal labels has also been obtained by Kaplan, Kaplan, and Sampson (1968), Lieberman and Culpepper (1965), Paivio, Rogers, and Smythe (1968), Sampson (1970), and Scott (1967). The evidence overwhelmingly supports the general con-

clusion that objects or their pictures are easier to recall than their verbal labels. This finding is particularly interesting because in each of the experimental tasks, the required response was verbal, which would seem to favor better recall of the word rather than the picture. Verbal processes alone cannot adequately account for these findings.

The second type of studies varying the imagery-concreteness of words have found the effects of high imagery-concreteness to be consistent and positive. In one of the earlier studies (1929), Stoke found recall to be higher for concrete nouns than for abstract nouns. This finding has been confirmed in recent studies (e.g., Dukes & Bastion, 1966; Olver, 1965; Winnick & Kressel, 1965), in which group ratings have been used to define abstractness concreteness. Tulving, McNulty, and Ozier (1967) found better recall for words rated high than for ones rated low in vividness, where vividness was defined in terms of "the ease with which you can picture something in your mind" when presented the word.

Finally Paivio (1968) used a factor analytic study or word attributes and found that the rated imagery or concreteness of a word is the best single predictor of associative learning involving meaningful material. The imagery-concreteness ratings used by Paivio in the majority of his studies since 1968 were obtained in a study by Paivio, Yuille and Madigan (1968). They asked subjects to rate words for abstractness-concreteness on a 7 point rating scale. A rating of 1 was to indicate that the word referred to an "...abstract concept that cannot be experienced by the senses...". A rating of 7 was to indicate that the word was high on concreteness and could be described as "any word that refers to objects, materials or persons." Imagery ratings were obtained using

the same 7 point rating scale except that 1 indicated the word "...arouses a mental image with difficulty or not at all...". A 7 indicated that the word "... arouses a mental image (i.e., a mental picture or sound or other sensory experience) very quickly and easily...". Word meaningfulness was also obtained in this study using Noble's (1952) production method. This was defined as the mean number of written associations to a word in 30 seconds. This list of 925 nouns with each of their three indices of abstract-concreteness (C), imagery (I), and meaningfulness (M) has been the basis of nearly all the studies since 1968 investigating any of these word attributes.

Explanations of Imagery Effects

The Dual Coding Hypothesis

What kind of an explanation can be offered for the striking and consistent effects of imagery-concreteness on learning and memory? Paivio (1969) as well as Bower (1969) have both postulated what is called the "dual coding hypothesis", which is that visual imagery and verbal symbolic processes represent alternate coding systems in cognition. The verbal memory system is theoretically most suited to processing and storing abstract or conceptual material that has little if any concrete reference. On the other hand, the visual imagery system is most suited to processing and storing concrete material that can be pictured imaginally. The studies of the effects of imagery instructions and their differential effects on learning concrete and abstract nouns as well as the studies showing superior recall for concrete material suggested a need to conceptualize a dual memory system. Proponents of this theory (Bower, 1969; Paivio, 1969) suggest that concrete mater-

ial and especially concrete material learned with imagery instructions, can be coded in both the visual imagery system and the verbal system, while abstract material can only be coded in the verbal system. This dual coding of concrete material should result in better recall because of the nature of the partially separable but overlapping (in the case of concrete material) memory systems. The following research lends strong support for the belief that the two coding systems do exist and can be functionally distinguished.

Atwood (1971) attempted to demonstrate the existence of a visual component in mnemonic processes by applying the method of selective interference (Brooks, 1967, 1968) to the use of imagery in verbal learning. Brooks' studies had shown that reading a message is antagonistic to the simultaneous representation of spatial relationship, whereas listening to a message is not. Atwood reasoned that if a true visual process is involved in learning, then the use of imagery in verbal learning should be disrupted by concurrent perception of a visual signal, while perception of an auditory signal should interfere far less. If the processes significant to remembering are nonvisual in nature (i.e., purely verbal or conceptual), there should be no difference in the interfering effects of perceived visual and auditory signals.

The dependent variable in Atwood's study was the proportion of words recalled on the test trial of a modified one trial study-test PA task. The independent variables were imaginal phrases versus abstract phrases; and visual interference versus auditory interference versus no interference. The Ss in the imaginal phrases condition were presented 35 tape-recorded phrases that were started and concluded with concrete nouns, with 4 seconds between phrases. They were instructed to

"visualize" the interaction suggested by the phrase. On the test trial (immediate recall) they were presented the first word of the phrase and their task was to recall the last word.

In the abstract phrase condition, the task was identical except that the two words within the phrase were abstract nouns selected from the Paivio, Yuille, and Madigan list (1968). Subjects in this abstract phrase group were instructed to contemplate the meaning of each phrase as a whole. In the two interference conditions, the numbers 1 or 2 were presented either visually or auditorially, one second after the presentation of each phrase. Whatever number was presented, the S was to respond verbally by saying the opposite number.

Consistent with the dual coding theory and Atwood's expectations, it was found that visual interference reduced recall of the imagery phrases much more than did auditory interference, while no interference produced the best recall. In the abstract phrases condition, auditory interference reduced the recall much more than did visual interference, while the no interference condition again resulted in the best recall. Atwood concluded that the results of this study and those by Paivio (1969) and Bower (1969, 1970) suggest the existence of two partially separable cognitive processing systems: a visual (V) system and a verbal-auditory (VA) system. He postulates that the V system controls visual perception and visual imagination, while the VA system controls auditory perception, auditory imagination, internal verbal representation, and speech.

Further support of the dual coding hypothesis comes from what could be considered a cross-culture validation of the theory. Sasson and Fraisse (1972), from the University of Paris, investigated the ef-

fects of interpolated tasks on the free recall of concrete and abstract sentences. Their predictions were based on a dual coding hypothesis that maintains that abstract material is stored primarily verbally, while concrete or visual material is stored primarily imaginally. They found that both interpolated pictures and concrete sentences produced about the same amount of significant retroactive interference on the immediate recall of unrelated concrete sentences. The results of the delayed recall were similar. For the abstract sentences, neither immediate or delayed (2 days) recall were interfered with by interpolated pictures on concrete sentences, but interpolated abstract sentences produced significant retroactive interference. Sasson and Fraisse concluded that the findings can best be accounted for by the hypothesis that concrete sentences are stored primarily as visual images and the contents of abstract sentences are stored primarily verbally.

Elliott (1973) investigated the theory that mental imagery and auditory information are functionally related to representational mechanisms in distinct imaginal visual and auditory memory systems. Subjects learned high or low imagery word triads under imagery or repetition instructions and performed interpolated tasks designed to interfere with imagery or verbal memory systems between the stimuli presentation and short term recall test. Word triads were each presented for six seconds after which the Ss were required to perform one of the interpolated tasks for 32 seconds before recalling the word triad orally. Subjects were given one word from each triad as a cue for long term recall which was tested 1 3/4 hours after the initial stimulus presentations. Elliott found that recall performance was superior for the imaginal instructional set as opposed to the rote repetition condition, and

for words of high imagery value in contrast to low imagery words. The visual language task and the auditory nonverbal task provided differential and maximal interference under imaginal and rote repetition conditions respectively. Only high imagery words under the imagery instructions were recalled to any appreciable extent on the long term recall test, the proportion being approximately 49%, as compared to approximately 2% for low imagery words or high imagery words under a repetition learning set.

Elliott concluded that although there is some support for a theory of discrete imagery and auditory memory systems, the dichotomy is an oversimplification, and the facilitative effect of mental imagery depends on the simultaneous storage of a verbal and visual representation.

Alternative Explanations of Imagery Effects

The experimental investigations of imagery-concreteness have been subject to various explanations involving other word attributes such as word frequency, familiarity, and meaningfulness. Deese (1960) investigated recall of words as a function of high and low frequency, and found that recall was greatest with high frequency lists. A number of other studies have shown that high frequency words are easier to recall than low frequency words (Bousfield & Cohen, 1955; Hall, 1954; Murdock, 1960). The effects of frequency as well as familiarity, however, are inconsistent across experiments, as other studies have shown. Peters (1936) found no effect of frequency on recall. Paivio (1968) used factor analysis to study various dimensions of meaning, and found essentially no correlation between free recall and either frequency, or ratings of familiarity and "usualness". Frincke (1968) similarly obtained no corre-

lation between frequency and free recall, and found a negative correlation of -.33 between rated familiarity and recall. Peterson and McGee (1974) found that the number of dictionary meanings did not account for differences between recall of concrete and abstract nouns.

Paivio and Smythe (1971) studied word imagery, (I), frequency, (F), and meaningfulness, (M), in short term memory. They independently varied word I, F, and M in different lists and investigated the effect of each on immediate recall. I, F, and M were varied by using the ratings from the Paivio, Yuille and Madigan (1968) study previously discussed.

They found that overall correct recall was much better for high-I words (66%) than for low-I words (39%). Conversely, low-F words were recalled significantly better than high-F words (65% vs. 43%). The effect of M was not significant.

Paivio and Yuille (1967), and Smythe and Paivio (1968) have demonstrated conclusively that I is more effective than M when the two variables are independently varied over an equivalent range in terms of standard score units based on the normative sample (Paivio, Yuille, and Madigan, 1968). The effects of M have varied from slightly positive, to zero, to slightly negative in the different experiments. The conclusions from these studies are consistent and clear. The relations between noun imagery and learning not only cannot be interpreted in terms of M, but imagery is the more potent of the two variables.

To investigate the possibility that some other unidentified correlate of I might be responsible for its effects, Paivio (1968) did a factor-analytic study. The stimuli were 96 nouns, for which mean scores were obtained on ease of learning and various semantic and associative

characteristics. The learning variables were recall scores for the nouns when they served as stimulus terms in PA learning as well as scores from a free-recall experiment. The other noun attributes, 27 in all, included several measures of concreteness and imagery, and other potentially effective variables such as M. familiarity, distinctiveness, associative reaction time, semantic differential meaning dimensions, and so on. The results showed that only nine of the noun attributes correlated significantly with one or more of the learning scores and, of these, rated I was the best predictor of learning, closely followed by other indices of imagery and concreteness. Frincke (1968) also found that the imagery-concreteness factor is the best predictor of free recall. Paivio (1969) concludes "... the evidence indicates that this dimension is the most potent one yet identified among familiar words."

Aiken (1971) studied linguistic and imagery sets in immediate recall of paired-associates. The stimuli were 32 pairs of concrete nouns selected from the Paivio, Yuille, and Madigan (1968) list. These nouns were imbedded in sentences and were underlined and capitalized. The task involved learning the PA's by forming a "vivid and active mental image of the scene described in each sentence, (imagery instructions), or by simply memorizing the sentences. A one trial study-test design was used where the study time for each sentence was 10 seconds. He found that recall was significantly better for objects in the imagery groups than those in the memorization group. He concluded that mental imagery as an aid in recall cannot be reduced or equated to the recall of linguistic chains.

The most recently researched explanation of the facilitating effects of imagery on learning and memory is the "organizational hypothe-

sis" proposed by Begg (1972). The basic assumption of this theory is that images aroused by discrete verbal stimuli can be combined into complex images. As such, a single image could represent the meaning of a concrete sentence, a list of single words (Bower, 1970), or a triad of concrete nouns. The theory assumes that complex images are functionally unitary, integrated memory structures, or sets, whose elements tend to be remembered or forgotten together as wholes. Therefore, integrated images reduce memory load relative to non-integrated storage of the same stimuli. Begg presented lists of meaningful adjective-noun phrases to Ss who were asked for partial recall of nouns or adjectives, whole recall of everything, or cued recall of the nouns or adjectives. These tasks were compared with the free recall of nouns or adjectives. In concrete pairs, cued recall exceeded the other three conditions, which did not differ from each other. In abstract pairs, free recall exceeded the other tasks which did not differ among themselves. Begg concluded that the results supported his hypothesis that concrete pairs are remembered as unitized images.

Begg and Robertson (1973) investigated long-term retention of high and low-imagery nouns in incremental free recall, paired-associates learning, and cued and noncued recall of noun pairs. They controlled acquisition such that differences in long term recall could not be attributed to differential initial learning. They found that recall of concrete words exceeded recall of abstract words at 48 hours and also at 72 hours. They also found that concreteness was positively related to organization. They pointed out that this was very much in support of the "imagery-organization hypothesis". Begg (1973) found that in a one trial, paired associate learning task, using high imagery nouns,

that for immediate free recall there was no reliable difference between the number of pairs recalled for Ss instructed to form separate images and Ss instructed to form integrated images. For immediate cued recall, however, when one of each pair of words was given in the recall test, recall was significantly better for individuals receiving integration rather than separation imagery instructions. Begg concludes that his integration imagery theory accounts for the results.

Morris and Stevens (1974) have also investigated the relationship between imagery and organization. They used lists of high I words and presented them on a memory drum at a 4 second rate. They tested recall between groups receiving linking imagery instructions (Ss were asked to form one image linking each three consecutive words), single or separate imagery instructions, and instructions to read the word aloud as it appeared and just learn it. Three 24 word lists were presented and Ss were tested for free recall after each of the three lists. They found that recall was significantly better for the linking imagery groups than for the single imagery and the control groups, which were not reliably different. In a second experiment, they compared single imagery with a control group which was told just to learn the words. They found that for each of three study-test trials, there was no difference between the two groups. They concluded that the only tenable explanation of the function of imagery is that it facilitates memory because it helps organize the material and that imagery alone (as in their separate image conditions) does not facilitate learning or recall.

These studies on organization in imagery all involve different types of tasks and yet according to their authors, all results tend to support the organizational hypothesis. A critical look at the data,

however, shows that organization is correlated with recall, and a cause-effect explanation goes beyond the data. Also, some of Begg's own data is inconsistent with the hypothesis. In Begg's (1973) study, where organization was controlled as an independent variable, there was no difference between the number of concrete-noun pairs recalled in groups receiving separation imagery instructions and groups told to form integrated images. These results actually fail to support the organizational hypothesis and contradict findings in the Morris and Stevens (1974) study. It is also of interest that Morris and Stevens did not find a significant difference between recall in groups told to use imagery (separation) and a control group with no specific learning instructions. Concrete words were used in this study and it is quite possible that subjects in the latter groups who were left to their own learning approach used imagery also, which would be the most efficient way to learn these words.

Both the organizational hypothesis and the dual coding hypothesis attempt to explain why imagery facilitates learning and memory. The majority of data support the dual coding hypothesis, particularly the selective interference studies by Atwood (1971), Sasson and Fraisse (1972), and Elliott (1973). The studies of mnemonic techniques support the organizational hypothesis as do studies by Begg (1972), Begg and Robertson (1973), and Morris and Stevens (1974). The two theories do not contradict each other, but the organizational hypothesis does not handle all the data as well as the dual coding hypothesis. Morris and Stevens (1974) go so far as to say that the only tenable explanation of the function of imagery is that it facilitates memory because it helps organize the material, and that imagery alone does not facilitate learning

or recall. This last assertion is not consistent with several of the previously cited studies. Kirkpatrick (1894), using concrete words, found that subjects instructed specifically to use imagery had consistently better recall than those subjects not instructed to use imagery. This was true for both immediate and delayed recall. Paivio (1968) found that the "one-bun" mnemonic technique used without specific instructions to use imagery had no facilitating effect on learning. Aikin (1971) found that subjects instructed to use imagery in learning a list of sentences recalled pairs of concrete nouns imbedded in the sentences significantly better than subjects not instructed to use imagery.

It could be argued, however, that in each instance where imagery instructions were given, the subjects spontaneously used organization and that it was this organization that facilitated memory by reducing the number of units. It would be expected from the organizational hypothesis that subjects specifically instructed to organize the material using compound images should have better recall than those subjects instructed to use separate imagery. This was supported in the Morris and Stevens (1974) study where subjects were to form one image linking each three consecutive words. In the study by Begg (1973), however, no reliable difference in free recall was found between subjects instructed to form integrated images of noun pairs and those instructed to form separate images. In these studies, the instruction to form organized images was an independent variable. If the facilitating effect of imagery is dependent upon organization as its major component (rather than dual coding or imagery superiority), then we should expect to find organization in the free recall of nouns where subjects have not been

specifically instructed to form compound images. In the Begg and Robertson (1973) study, concreteness was positively related to organization without subjects being specifically instructed to form organized images. The Santa, Ruskin and Yio (1973) study previously cited also found that recall was highly related to the extent of organization.

In sum, there is support for both the dual coding hypothesis and the organizational hypothesis. To date, however, it does not appear that the proponents of the organizational hypothesis have shown that organization or clustering of images is the sole contributing factor in imagery that facilitates recall.

Imagery-Concreteness and Retention Interval

Before discussing the studies in this area, it may be useful to review the distinction between short-term memory (STM) and long-term memory (LTM) since practical and theoretical distinctions are made between the two types of memory. According to the memory literature, and specifically Craik and Lockhart (1972), the distinctions between STM and LTM are well documented. Whereas STM has a limited capacity, LTM has no known limit; verbal items are usually coded phonemically in STM but largely in terms of their semantic features in LTM (Baddeley, 1968); forgetting from STM is complete within 30 seconds or less provided there is no rehearsal, although researchers generally call any immediate test of learning STM, while forgetting from LTM is either very slow or the material is not forgotten at all (Shiffrin & Atkinson, 1967). Further evidence for the STM/LTM dichotomy comes from clinical studies (Milner, 1970; Warrington, 1971).

There are other schools of thought among memory theorists however.

Craik and Lockhart (1972) feel that a STM/LTM dichotomy is an oversimplification and they have proposed an alternative to the memory stores or STM/LTM model. They have conceptualized memory in terms of "levels of processing". They suggest that trace persistence is a function of the depth of analysis, with deeper levels of analysis associated with more elaborate, longer lasting, and stronger traces. They state that greater "depth" implies a greater degree of semantic or cognitive analysis. After a stimulus has been recognized, it may undergo further processing by enrichment or elaboration, such as triggering associations, images or stories on the basis of the subject's past experience with the word.

To present a balanced picture of the current thought on memory theory, it should be mentioned that Wickelgren (1973) has criticized much of the research that purportedly supports the STM/LTM distinction. He feels that the majority of evidence can be explained by a single trace theory of memory. There has been some controversy among theorists over the nature of memory traces that continues at present. In the present paper, to avoid any theoretical connotations, the more neutral terms "immediate recall" and "delayed recall" will be employed.

An unpublished study by Paivio and Csapo (see Paivio 1971, p. 201) investigated both immediate and delayed recall as a function of levels of stimulus concreteness and intentional vs. incidental learning instructions. The stimuli were pictures of objects, their concrete noun labels, and abstract nouns. Subjects were presented a homogeneous list containing 72 items in one of the three classes. Each item was exposed by projector for duration of .063 seconds, which had been found previously to permit completely accurate recognition (Paivio and Csapo,

1969). The balance of a 5 second interitem interval was used by the subject to write down the name of the picture or the word that had been flashed. Half of each experimental group was tested for immediate recall, and the other half were tested for recall after one week. The results of interest (intentional groups only) showed greatest recall for the pictures, then concrete nouns, then abstract nouns for both immediate and delayed recall. For immediate recall, the numbers of items recalled of the 72 were 34, 25, and 15 respectively for the picture, concrete noun and abstract noun groups. After one week, recall frequencies were 19, 11, and 6 for these same groups. The investigators conclude that there is a completely reliable orderly progression in free recall performance as a function of concreteness, and that the finding is consistent with the view that nonverbal imagery is of major importance even when recall must be verbally expressed.

Schnorr and Atkinson (1969) investigated repetition versus imagery instructions in the immediate and delayed recall of paired-associates. They presented 18 subjects (college students) with three lists of 32 pairs of nouns. The nouns were "easily imaginal" according to the authors, and some of the words were from the Paivio, Yuille, and Madigan (1968) norms, these words having concreteness and imagery values greater than 6.0. The study was a within--Ss design such that each S learned half of each list by rote repetition and the other half by imagery. For each word to be learned by the imagery method the Ss task was to create a mental image in which the two words were interacting and to describe the image to the experimenters. For pairs that were to be learned by repetition, the S was to repeat the pair slowly four times, and to refrain from using either verbal or imaginal mediation. Eight seconds

were given for the study of each pair. A recall test immediately followed the study of each list, wherein the stimulus word was presented and the S had 8 seconds to respond. Ss were retested for recall one week following the initial session. It was found that the imagery condition resulted in far superior recall when compared to the repetition condition (85% versus 35%) in the initial test and was also significantly greater in the one week retest (38% and 26% respectively).

The studies reviewed in earlier sections have provided some support for the facilitating effects of both high concrete material and imagery instructions or set on both immediate and delayed recall. To review briefly, Kirkpatrick (1894) found that imagery instructions with high concrete nouns facilitated both immediate and delayed recall. The effect was slight however, and no comparison was made with abstract nouns. Aiken (1971) found that an imagery set facilitated recall of concrete noun pairs imbedded in sentences for immediate recall, but did not test delayed recall or include an abstract sentence condition. The Paivio and Csapo study (see Paivio, 1971, p. 201) found that concrete stimuli, both pictures and their concrete noun labels, were recalled better than abstract nouns in tests of both immediate and delayed recall, even without the use of any learning set. The learning task, however, involved actually writing down the stimulus words during the learning trial, which is a different task than the other recall studies involve and may not be directly comparable. Schnorr and Atkinson (1969) used only concrete nouns in a PA task and found that an imagery set facilitated both immediate and delayed recall in comparison to repetition set. Peterson and McGee (1974) found that both interactive imagery instructions and imagery ratings resulted in better immediate recall in a paired-asso-

ciate study.

In contrast to the above studies, research by Rogers (1967), Shamp (1968), and Shamp and Palermo (see Palermo, 1970) have failed to find long term memory effects of concrete nouns and in some cases abstract nouns have been recalled better than concrete! Rogers (1967, unpublished master's thesis, cited in Paivio, 1971) failed to replicate Kirkpatrick's (1894) findings with concrete nouns. What is equally anomalous is that he found recall for abstract nouns was facilitated by imagery instructions.

Butter (1970) presented subjects with a PA task in which high or low imagery words were paired with a one digit number. Subjects were given one learning trial where each of the 8 word-number pairs to be learned was presented once at a 4 second rate (words were stimulus terms and numbers were response terms). The instructions to subjects were only to name the pairs as they were presented. Subjects were divided into two groups; one group was tested for recall at 2 minutes, while the other was tested after 2 days. Butter found that numbers paired with concrete nouns were recalled much better than numbers paired with abstract nouns in the immediate recall test. However, in the delayed recall test, a complete reversal occurred. Numbers paired with abstract words were now recalled much better than in the immediate recall test and much better than numbers paired with concrete words!

Yuille (1971) attempted to replicate Butter's (1970) study. He used the same materials and procedure as Butter except he did not monitor subjects GSR's as Butter had. He failed to find the reversal effect that Butter found and instead, found that numbers paired with concrete nouns were recalled better than numbers paired with abstract nouns in

both immediate and delayed recall tests. He explained the failure to replicate Butter's findings by pointing out an error in her data analysis and also by suggesting that subjects became aware of the nature of the study and rehearsal became a factor.

Shamp (1968) investigated the effects of imagery on immediate and long term retention. A part of her experimental procedure involved the presentation of eight paired-associate items for a single trial, following which subjects were tested for recall of the responses, given the stimuli, 2 minutes, 20 minutes, or 2 days later. The results replicated the findings of Paivio and others (e.g., Paivio, 1963, 1965) for immediate memory, that is, the numbers paired with high imagery-concreteness stimuli were recalled three times as often as numbers associated with low imagery stimuli. After twenty minutes, recall was equal for the responses to the two types of stimuli. Retesting two days later showed that recall of the responses paired with the low imagery concreteness stimuli was twice as great as recall of responses to the high imagery-concreteness stimuli. The recall of responses to the high imagery words decreased with time, as would be expected, but there was a significant increase in recall over time for the responses associated with the low-imagery stimuli!

In another unpublished study, Shamp and Palermo (see Palermo, 1970) further investigated the effects of imagery on long-term retention. They replicated the Paivio (1965) study where concrete and abstract words were used on both the stimulus and response sides of pairs in a PA task. The words were arranged into four types of pairs; concrete-concrete, concrete-abstract, abstract-concrete, and abstract-abstract. The lists and procedures were exactly those used by Paivio, except for

the added test of recall 2 days later. The results on immediate recall were similar to those obtained by Paivio, but on the recall test 2 days later, the significant effects of stimulus abstractness were reduced by 50%. They did not obtain the reversal of recall effects which Shamp obtained in her study, but the results were clear in showing that the effects of imagery are greatly reduced with time. Palermo (1970) suggested on the basis of these results that the effects of imagery may be limited to immediate recall.

Statement of the Problem

Studies have shown that both the "method of loci" and the "peg-word" mnemonic (Bower, 1969; Groninger, 1971) facilitate immediate as well as delayed recall. The principle components of these two mnemonic techniques are 1) explicit emphasis on forming mental images, and 2) the use of concrete words with which stimuli to be remembered are paired. These two variables, i.e., specific instructions to form images, and the use of nouns varying along the abstract-concrete dimension, have been investigated singly, and together. Paired-associate, as well as free recall learning studies and variations thereof, have been the major approaches to investigating these two variables.

As a result of these studies, researchers and theorists alike are forsaking purely verbal explanations of memory and proposing new theories of memory to account for the effects of imagery. In particular, the dual coding hypothesis (Bower, 1969; Paivio, 1969) has been proposed to account for the effects of imagery. It postulates that there are two coding systems that account for memory; the verbal, which is superior in abstract and sequential processing tasks, and the visual or imagery

system which is superior in coping with the concrete aspects of a situation. According to this theory, concrete material is more easily recalled than abstract because it is likely to be stored in both the verbal and the visual systems. Imagery instructions facilitate recall for concrete material because they call to attention the imagery aspects of the material and insure that this memory system is used.

Another recently proposed explanation of the facilitating effects of imagery instructions and concrete material on memory is the "organizational hypothesis" by Begg (1972, 1973). This hypothesis states that imagery facilitates memory because it helps organize the material to be stored into complex images. These complex images or chunks reduce the memory load, thus facilitating recall. Morris and Stevens (1974) go so far as to say that imagery alone does not facilitate learning or recall.

A review of the literature has shown that learning set (imagery instructions) facilitates memory (Kirkpatrick, 1894; Bower, 1969; Wortman & Sparling, 1974; Santa, Ruskin & Yio, 1973). There is also consistency in the finding that concrete material is more earily learned and remembered than abstract (Stoke, 1929; Dukes & Bastion, 1966; Olver, 1965; Paivio, 1968). The "method of loci" mnemonic as well as the "peg-word" mnemonic has shown that imagery instructions strongly facilitate both the immediate as well as delayed recall of concrete material as compared to abstract material. However, when more traditional experimental approaches are used, such as PA or free recall tasks, the facilitating effects of imagery fall into question, particularly for delayed recall. Studies by Rogers (1967), Shamp (1968), Shamp and Palermo (see Palermo, 1970), Butter (1970), Postman (1972), and Yuille (1971) have found that the effects of imagery are greatly reduced with time. Paler-

mo (1970) suggested that the effects of imagery may be limited to immediate recall. Shamp (1968) found that for immediate recall, numbers paired with high imagery nouns were recalled three times as often as numbers paired with low imagery stimuli. After two days, however, recall of responses paired with low imagery nouns was twice as great as recall of responses to high imagery nouns.

The present research is an attempt to clarify the function of imagery on delayed recall. The variables are those that have been established as most significant for the study of imagery, namely imagery instructions and noun concreteness. To study the effects of these variables for both immediate and delayed recall, which is of primary interest, a free recall paradigm was used. Subjects were asked to recall the words they were presented immediately after seeing the list of words and again after one week.

It was expected on the basis of the dual coding hypothesis as well as previous research, that concrete material would be recalled better than abstract for both immediate and delayed recall. It was further expected that imagery instructions would facilitate learning and recall of concrete material for both immediate and delayed recall.

Abstract material, according to the dual coding hypothesis, is stored in the verbal system. Since it is difficult or impossible to form images of abstract words, imagery instructions should not have any facilitating effect.

According to the organizational hypothesis, it is expected that recall of concrete material should be more organized than abstract material. This theory would predict that concrete material learned using imagery instructions should show the greatest organization since it is

this organization which theoretically reduces the memory load and facilitates recall.

CHAPTER II

METHOD

Subjects

Subjects for this study were 40 undergraduate, introductory psychology students from Pacific Lutheran University, Tacoma, Washington. Subjects were randomly assigned to four experimental conditions as sex of subject has not been found to be related to imagery ability (McKellar, Marks & Barron, 1972).

Stimuli

The stimuli for the study were 60 words taken from the Paivio, Yuille and Madigan (1968) norms which were previously discussed. Two lists of 30 words were constructed such that one list was composed of high imagery words and one list was composed of low imagery words. The list length of 30 words was chosen to avoid a ceiling effect that has occurred in previous research (Bugelski, 1974) where shorter lists have been used. The imagery ratings of the norm group (Paivio, Yuille & Madigan, 1968) have a maximum possible range of 1-7. A rating of 1 indicates that it is difficult or impossible to form an image of the word. A rating of 7 indicates that the word arouses a mental image quickly and easily. Meaningfulness values for the norm words were obtained according to Noble's (1952) production method. This was defined as the mean number of written associations to a word in 30 seconds. The frequency values for the norm group were obtained from Thorndike and Lorge (1944).

The means for imagery ratings, meaningfulness, frequency, and word length for the two 30 word lists are presented in Table 1.

Table 1

IMAGERY, MEANINGFULNESS, FREQUENCY AND WORD LENGTH MEANS FOR HIGH AND LOW IMAGERY NOUNS

Means	High Imagery List	Low Imagery List
Imagery 1*	6.30	3.08
Meaningfulness 2*	5.77	5.65
Frequency 3*	32.70	32.00
Length 4*	6.60	6.60

*1 The imagery range is 1-7; 1 indicates a word is very difficult to imagine and 7 indicates the word easily arouses a mental image.

*2 Meaningfulness values indicate the number of written associations to a word in 30 seconds.

*3 Frequency values are expressed as occurrences per million words.

*4 Length indicates word length in number of letters.

The order of presentation of words in each list was then completely randomized and the same order was used for all groups. The lists of words appear in Appendix A.

Procedure

The experimental task required subjects to learn a list of 30 words. The stimulus words were projected on a screen using a Kodak Carousel projector. One learning trial was given where the 30 words were presented serially for 8 seconds each. (Bugelski, et al. 1968, found that 8 seconds was an optimal time to form an image). Subjects were asked to write down all the words they could recall without regard

to order immediately following presentation of the last word. They wrote the words on sheets of paper that were handed out before the presentation of the words. Subjects were tested in groups of 10.

There were four experimental groups, with each given a different word-list learning-set combination. Group one was given a list of 30 abstract nouns to learn using imagery. Group two learned the same list of abstract nouns using repetition. The third and fourth groups each learned an identical 30 word list of concrete nouns, but group three received imagery instructions while group four received repetition instructions.

The instructions for the imagery groups were:

> You will be given 30 words to learn, presented one at a time for 8 seconds each. You are to learn these words by forming a mental image or picture of what the word stands for. Try to form as clear an image as you can. At the end of the list of words, you will be tested to see how many of them you can remember, so please do your best to learn them.

After the presentation of the last word, the instructions were:

> Write down as many words as you can remember in any order; if you are not sure, guess.

The instructions for the verbal set group were:

> You will be given 30 words to learn, presented one at a time for 8 seconds each. You are to learn these words by repeating them to yourself as many times as you can while they are shown on the screen. At the end of the list of words, you will be tested to see how many of them you can remember, so please do your best to learn them.

After presentation of the last word, the instructions were:

> Write down as many words as you can remember in any order; if you are not sure, guess.

All groups were given 10 minutes to write down words. The instructions were read to all groups by a student who had no knowledge of the study, in order to avoid the experimenter's communicating any differential

expectancies to the groups. After this initial test, the subjects were asked not to discuss the study among themselves. They were asked to return the following week to complete the second part of the experiment. They were told that the second part the following week would be "different".

The second part of the study involved a retention test one week following the initial learning trial. Subjects were tested in groups of 10. They were provided paper and asked to write down all the words they could remember in any order from the experiment one week earlier. They were given 10 minutes for this task. Upon its completion, they were asked to indicate their method of recall for each of the words by writing a number beside each word recalled. Number 1 was to be used if they "recalled an image or mental picture" first, number 2 was to indicate "recalled the word", and number 3 was to indicate some other method, which they were to describe.

CHAPTER III

RESULTS

Recall Performance

The raw data were in the form of number of words recalled correctly for both the immediate and delayed recall tests. The scores for all subjects were cast into a 2 (high vs. low imagery noun) x 2 (imagery vs. repetition instructions) x 2 (immediate vs. delayed recall) analysis of variance with repeated measures on the recall variable. The means for each treatment group are presented in Table 2.

Table 2

MEAN IMMEDIATE AND DELAYED RECALL SCORES FOR GROUPS LEARNING ABSTRACT OR CONCRETE NOUNS UNDER IMAGERY OR REPETITION LEARNING SETS

	Immediate Recall	1 Week Delayed Recall	Combined Mean
Imagery Instructions	13.3	9.2	11.25
Abstract Nouns			
Repetition Instructions	14.1	9.1	11.60
Imagery Instructions	21.7	18.8	20.25
Concrete Nouns			
Repetition Instructions	15.3	9.5	10.90

A summary of the analysis of variance is presented in Table 3.

Table 3

SUMMARY OF ANALYSIS OF VARIANCE OF SUBJECTS' RECALL OF CONCRETE AND ABSTRACT WORDS

Source	df	ms	F
Between Subjects			
Noun Type	1	480.20	18.68**
Instructions	1	281.25	10.94**
Noun type x Instructions	1	336.20	13.51**
Between Error	36	25.70	
Within Subjects			
Retention Interval	1	396.05	112.51**
Noun Type x Retention Interval	1	.20	.05
Instructions x Retention Interval	1	18.05	5.13*
Noun Type x Instructions x Retention Interval	1	5.00	1.42
Within Error	36	3.52	

* $p < .05$
** $p < .01$

As Table 3 shows, the main effects of Noun Type, Instructions, and Retention Interval were all significant. The Noun Type x Instructions and the Instructions x Retention Interval interactions were also significant. The Noun Type x Instructions interaction indicates that further analysis is necessary as the main effects can not be directly interpreted. A Newman-Keuls analysis of the Noun Type x Instructions interaction is presented in Table 4.

Table 4

NEWMAN-KEULS ANALYSIS OF THE NOUN TYPE X INSTRUCTIONS INTERACTION

Conditions	Means	10.90	11.25	11.60	20.25
Concrete Nouns-Repetition Instructions	10.90	--	.35	.70	9.35*
Abstract Nouns-Imagery Instructions	11.25		--	.35	9.00*
Abstract Nouns-Repetition Instructions	11.60			--	8.65*
Concrete Nouns-Imagery Instructions	20.25				--

* $p < .01$ df = 36 ms error = 25.70

Table 4 shows that the concrete noun-imagery instructions recall performance was significantly different from the three other conditions which were not significantly different from each other. To show these results more clearly, Figure 1 illustrates the Noun Type x Instructions interaction.

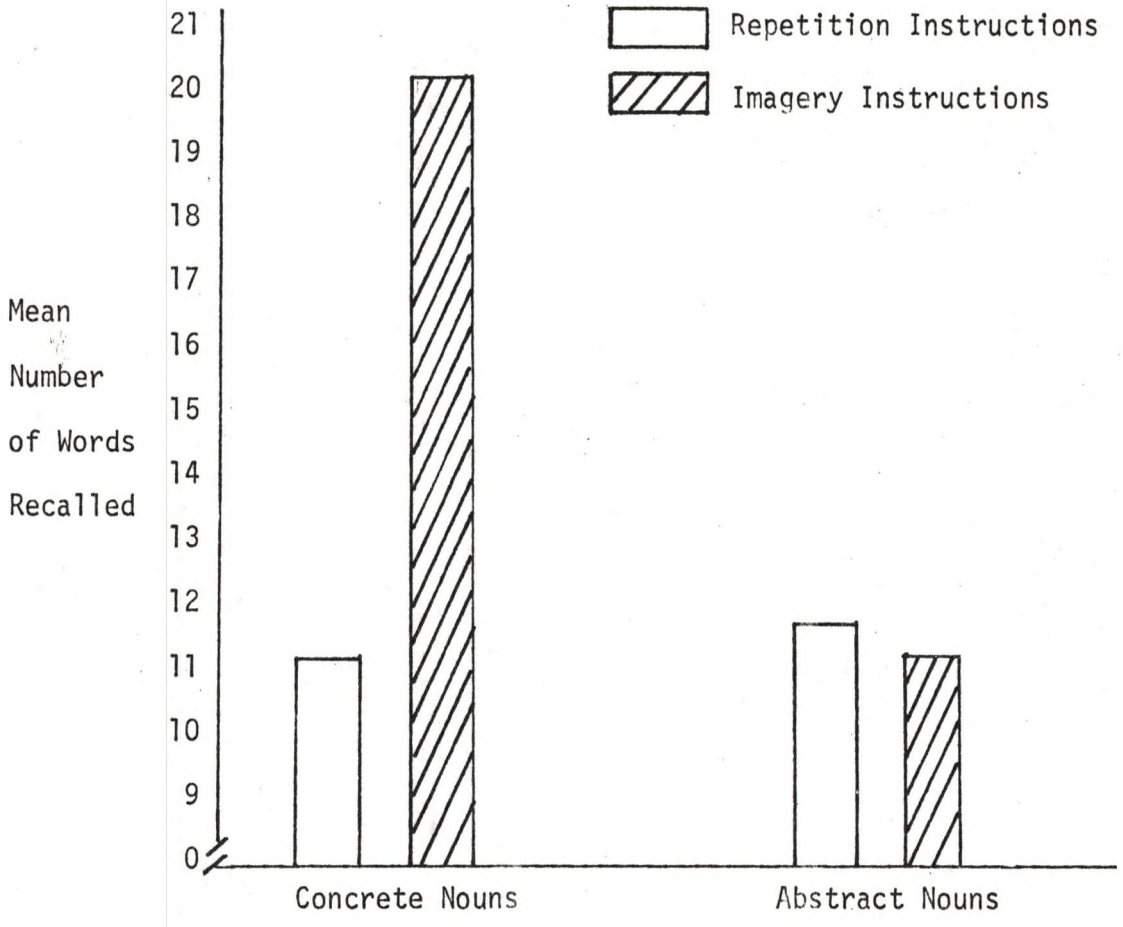

Figure 1. Interaction between noun type and learning instructions.

Most notable about Figure 1 is that almost twice as many concrete words were recalled under the imagery instructions as under the repetition instructions, or any other combination of noun type and learning instructions. Clearly, it appears that something is different about learning concrete words using imagery.

The Instructions x Retention Interval interaction was also signi-

ficant and was further analyzed using a Newman-Keuls test which is presented in Table 5.

Table 5

NEWMAN-KEULS ANALYSIS OF THE INSTRUCTIONS x RETENTION INTERVAL INTERACTION

Conditions	Means	9.3	14.0	14.7	17.5
Repetition Instructions - Delayed Recall	9.3	---	4.7*	5.4*	8.2*
Imagery Instructions - Delayed Recall	14.0		---	.7	3.5*
Repetition Instructions - Immediate Recall	14.7				2.8*
Imagery Instructions - Immediate Recall	17.5				---

* $p < .01$ df = 36 ms error = 3.52

These results can be shown most clearly by referring to Figure 2, which illustrates the Instructions x Retention Interval interaction.

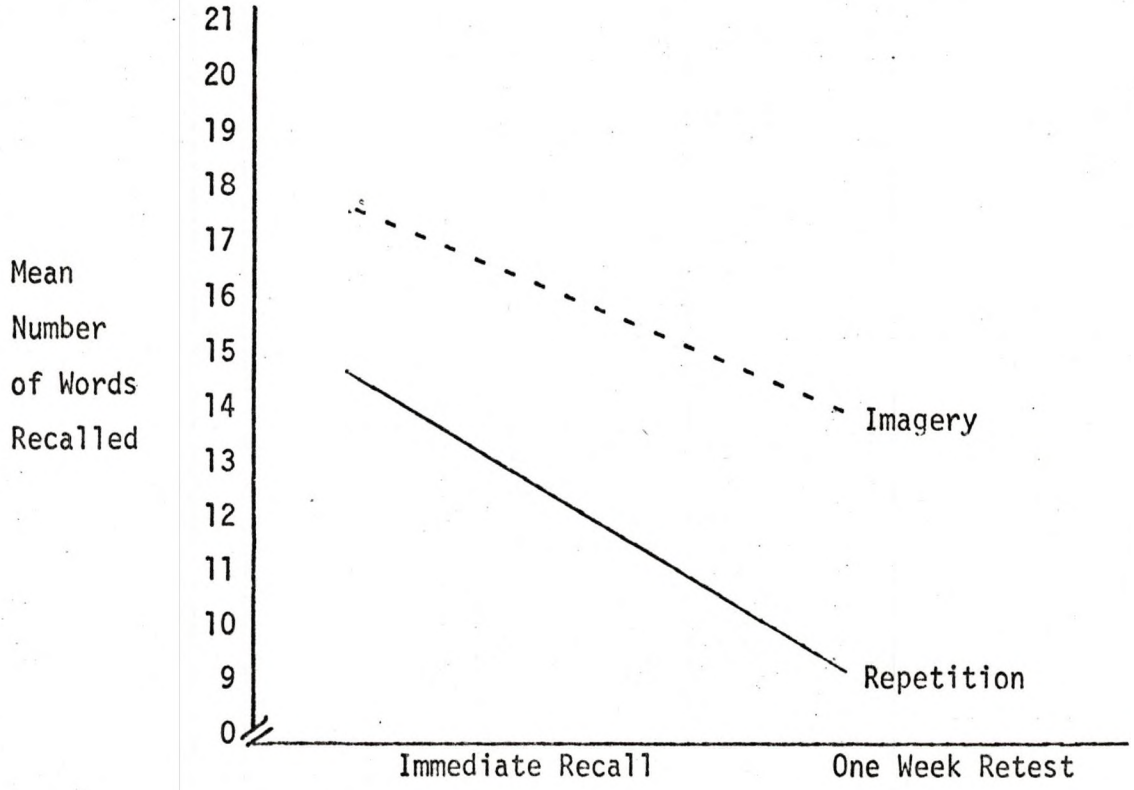

Figure 2. Interaction between learning instructions and retention interval.

Table 5 and Figure 2 show that imagery instructions produce significantly greater immediate as well as delayed recall as compared to the repetition instruction groups, and that retention loss is less for groups receiving imagery instructions than repetition instructions.

Contingent Recall of Words

Although not tied to any theoretical predictions, it was of interest to see if the words recalled during the 1 week delayed retest were all recalled on the immediate recall test. A proportion was calculated for each subject expressing the ratio of words recalled on the 1 week retest that were present on the immediate recall protocol, to the total number of words recalled on the delayed recall test. The mean proportion for each treatment group appears in Table 6.

Table 6

MEAN PROPORTION OF WORDS RECALLED ON THE DELAYED RECALL TEST THAT WERE PRESENT ON THE INITIAL TEST

Condition	Mean Proportion
Concrete Nouns - Imagery Instructions	.91
Concrete Nouns - Repetition Instructions	.92
Abstract Nouns - Imagery Instructions	.82
Abstract Nouns - Repetition Instructions	.85

Since the mean proportions for the Abstract Noun groups appeared to be lower than the Concrete Noun groups, the data were transformed into arcsin values and cast into an analysis of variance. The design was a 2 (high vs. low imagery noun) x 2 (imagery vs. repetition instructions) analysis of variance which is summarized in Table 7.

Table 7

SUMMARY OF ANALYSIS OF VARIANCE OF PROPORTION OF DELAYED RECALL WORDS THAT WERE PRESENT ON THE INITIAL RECALL TEST

Source	df	ms	F
Noun Type	1	.53	1.83
Instructions	1	.08	.28
Noun Type x Instructions	1	.00	.00
Within Error	36	.29	

Table 7 shows that there are no significant differences among treatment groups in the proportion of delayed recall words that were recalled on the initial trial.

It was predicted that concrete material would generally be recalled better than abstract for both immediate and delayed recall. This prediction was only partially supported, however, as the recall scores for groups learning concrete words with repetition instructions were not significantly different from those of groups learning abstract words with either imagery or repetition instructions. Concrete material learned with instructions to use imagery was recalled significantly better in both immediate and delayed recall tests than any other combination of word type and instructions. The retention loss of groups receiving imagery instructions was also less than for groups receiving repetition instructions. The recall contingency analysis indicated that there were no significant differences among treatment groups in the proportion of delayed recall words that were present on the intitial recall protocols.

Abstract nouns were recalled equally well by groups receiving imagery or repetition instructions. There were no significant differences between these groups in their immediate or their delayed recall performance.

Recall Organization

The "organizational hypothesis" by Begg (1972, 1973) was tested in the present study. The hypothesis states that imagery facilitates memory because it helps organize the material to be learned into complex images. These complex images, or chunks, reduce the memory load as compared to recalling each word learned independently. If imagery facilitates recall because of this process, then we would expect the recall of subjects instructed to use imagery (but not told specifically to form single or compound images) to show some clustering.

It was expected that if successive words are grouped together to form these compound images, then these words should appear successively on a recall protocol as the theory maintains that they are recalled as a unit because of the complex image. If such clustering occurred in a free recall test, with no restrictions on recall or cueing of words, this would lend support to the organizational hypothesis.

This is exactly how the hypothesis was tested in the present study. It was assumed that clustering would be tested in its simplest form if co-occurring bidirectional pairs of words were used as the conceptual unit of clustering. The clusters were successive pairs of words (29 in each list) occurring together in the original presentation order. In the recall protocols, the two words comprising any one cluster could appear in either order, anywhere in the protocol, as long as they appeared together. If they both occurred in the protocol, but not together, they did not constitute a cluster.

The Adjusted Ratio of Clustering (ARC), developed by Roenker, Thompson and Brown (1971) was used to assess the amount of clustering. The ARC is a measure of the extent to which specified classes of items

occur together in recall. The value of the ARC is 1 for maximum possible clustering and 0 for chance clustering. It is also independent of list length or the number of items recalled and is therefore a more reliable statistic than other previously developed measures of clustering. ARC scores were determined for all recall protocols in both immediate and delayed trials. Mean ARC scores for each condition are presented in Table 8.

Table 8

MEAN ARC SCORES FOR IMMEDIATE AND DELAYED RECALL OF CONCRETE AND ABSTRACT NOUNS LEARNED UNDER REPETITION OR IMAGERY INSTRUCTIONS

	Immediate Recall	1 Week Delayed Recall
Imagery Instructions	.258	.282
Abstract Nouns		
Repetition Instructions	.444	.201
Imagery Instructions	.154	.170
Concrete Nouns		
Repetition Instructions	.211	.172

In order to analyze the ARC data which were in the form of proportions, the ARC values were transformed into arcsin values. As Winer (1962) points out, this transformation is appropriate for observations expressed as proportions. The arcsin transformations were then cast into a 2 (high vs. low imagery noun) x 2 (imagery vs. repetition instructions) x 2 (immediate vs. delayed recall) analysis of variance with repeated measures on the recall variable. A summary of the analysis of

variance is presented in Table 9.

Table 9

SUMMARY OF ANALYSIS OF VARIANCE OF ARC SCORES

Source	df	ms	F
Between Subjects			
Noun Type	1	1.40	.90
Instructions	1	.04	.03
Noun Type x Instructions	1	.05	.03
Between Error	36	1.55	
Within Subjects			
Retention Interval	1	2.79	3.77
Noun Type x Retention Interval	1	.58	.78
Instructions x Retention Interval	1	2.07	2.80
Noun Type x Instructions x Retention Interval	1	.38	.51
Within Error	36	.74	

As Table 9 shows, there were no significant differences among ARC scores for any of the treatment conditions. Thus, the organizational hypothesis failed to receive support from this analysis. This was so even though a strong effect was found for concrete nouns learned using imagery.

Recall Strategies

After subjects had completed the 10 minute recall test after one week, they indicated by a number code the way they had recalled each word. Number 1 was to be used if they "recalled an image or mental picture" first, number 2 was to indicate "recalled the word" first, and number 3 indicated some other method which they were to describe. The proportion of words recalled by each strategy for each experimental condition is presented in Table 10.

Table 10

RECALL STRATEGIES

Experimental Condition	Recall Strategy: Recalled an Image	Recall Strategy: Recalled the Word	Other
Abstract Noun - Repetition	47%	45%	8%
Abstract Noun - Imagery	39%	52%	9%
Concrete Noun - Repetition	34%	45%	6%*
Concrete Noun - Imagery	53%	41%	6%

* 15% did not respond

Theoretically, subjects told to use imagery should have reported recalling more images unless they had learned abstract nouns which are difficult to imagine. The concrete noun-imagery instruction group should have reported a significantly greater number of words recalled using imagery than other groups, especially since their recall scores were almost double those of the other three conditions. In order to test this the proportion of words each subject recalled using imagery was concerted to an arcsin value and cast into a 2 (high vs. low imagery noun) x 2 (imagery vs. repetition instructions) analysis of variance. A summary of this analysis is presented in Table 11.

Table 11

SUMMARY OF ANALYSIS OF VARIANCE OF SUBJECTS' REPORTED USE OF IMAGERY AS A RECALL STRATEGY

Source	df	ms	F
Noun Type	1	.46	.74
Instructions	1	.07	.11
Noun Type x Instructions	1	.23	.37
Within Error	36	.62	

Table 11 indicates that there were no differences in the reported use of imagery among groups that even approached a level of significance. These results do not provide much helpful information in understanding how subjects actually recalled the words. It seems most likely that subjects were unsure or confused about how to respond to this task as the protocols do not reflect other than chance fluctuations.

CHAPTER IV

DISCUSSION

The results of this study confirm the initial prediction that concrete material should be recalled better than abstract material for immediate recall. The significant Noun Type main effect shows that this is true on the average, but the significant Noun Type x Instructions interaction indicates that a closer look is necessary. From Figure 1 it can be seen that only in the imagery instruction group were concrete nouns recalled better than abstract nouns. A Newman-Keuls analysis of this Noun Type x Instructions interaction presented in Table 4 shows that the concrete noun-imagery instruction group's recall performance was significantly better than the other three groups' performances. The three other groups' recall scores were not significantly different from each other.

The finding that concrete material learned using imagery instructions is recalled better than all other combinations of noun type and learning instructions is consistent with studies by Aiken (1971), Schnorr and Atkinson (1969), Peterson and McGee (1974), Bugelski (1974), and Paivio (1968), which have all found facilitating effects of imagery imstructions with concrete nouns. The instructions to use imagery seem to play a significant role above and beyond the effect of learning concrete nouns compared to abstract.

Previous studies (Dukes & Bastion, 1966; Olver, 1965; Paivio, 1968;

Paivio & Smythe, 1971; Stoke, 1929; Winnick & Kressel, 1965) have shown that when subjects are not given specific instructions about how to learn the material, concrete material is recalled better than abstract. In the present study, concrete nouns learned using repetition instructions were recalled no better than abstract nouns.

The explanation for this finding seems to lie in the function of the learning instructions. According to the dual coding hypothesis, repetition learning is best suited for abstract material, while imagery instructions are best suited for concrete material. Using repetition to learn concrete material would interfere with the imagery coding which is the natural, most efficient way of learning concrete material. If repetition does interfere with imagery coding as is being suggested, then dual coding could not occur and concrete nouns would have no better recall than abstract nouns, which is what occurred in the present study. This finding is consistent with the results obtained by Elliott (1973), who found no difference in recall between groups learning abstract words and groups learning concrete words with repetition instructions.

The prediction that concrete material would be recalled better than abstract in the one week delayed recall test was also supported. The significant Instruction x Retention Interval interaction, pictured in Figure 2, indicates that not only did groups receiving imagery instruction have significantly better immediate as well as delayed recall, their retention loss was less than groups receiving repetition instructions. Looking at the mean recall scores in Table 2, it can be easily calculated that the comparative recall loss from immediate to delayed recall was only 13% for the concrete noun-imagery instruction group, while the losses for the other groups were respectively; abstract noun-

imagery instructions, 31%; abstract noun-repetition instructions, 35%; and concrete noun-repetition instructions, 38%.

This finding, that the recall of subjects learning concrete material with imagery instructions is still very strong after 1 week, is in agreement with the study of mnemonic techniques by Wortman and Sparling (1974), the study by Elliott (1973) of cued recall of noun triads, and the PA cued recall study by Schnorr and Atkinson (1969), all of which found positive effects of imagery instructions with concrete material in delayed recall. That such an effect was found in the present study, without the use of mnemonic rhymes or cued recall, is strong evidence of the positive effect of imagery coding in delayed recall.

For abstract material, which is theoretically stored in the verbal-auditory memory system, it was predicted that recall of groups receiving imagery instructions would not be significantly better than groups receiving repetition instructions. This prediction was supported and contradicts MacDonald's (1967) finding that subjects can make effective use of imagery even when learning abstract material. The present finding is consistent with the dual coding hypothesis in that since it is very difficult to use imagery with abstract material, dual coding does not occur and thus the differential effect upon concrete and abstract material.

The recall contingency analysis was done to investigate the possibility that there were some systematic differences between groups in the proportion of delayed recall words that were present on the immediate recall protocols. The results of this analysis, presented in Table 7, indicate that there were no significant differences among the four treatment conditions.

Recall Organization

The organizational hypothesis, proposed by Begg (1972, 1973) as an explanation of the function of imagery in recall was tested in the present study. Based upon this hypothesis it was predicted that recall of concrete material should be more organized than recall of abstract material. In order to test for this organization, or clustering, the Adjusted Ratio of Clustering (ARC) developed by Roenker et al. (1971) was used. The analysis of variance of ARC scores presented in Table 9 indicates that there were no systematic differences in clustering among any of the groups, either in the immediate or the delayed recall protocols.

This result is in contrast to several studies that have reported that imagery and organization are related. Morris and Stevens (1974) used the same ARC that was used in the present study to test for clustering. They found that subjects who were instructed to form compound images of each successive three words in lists of 24 words (8 images) had better recall than a group told to imagine each word separately. They obtained a large ARC value (.95) for the group instructed to use compound imagery as compared to a value of .04 for the single imagery group.

Morris and Stevens (1974) concluded from this study that the only tenable explanation of the function of imagery is that it facilitates memory because it helps organize the material, and that imagery alone does not facilitate learning or recall. This study could be used to support the belief that organization facilitates recall, but their assertion that organization is the only function involved in imagery goes beyond their data.

Begg (1973) studied organization and imagery in a PA learning task using high imagery nouns. He tested immediate, cued recall (where one word of each pair was given in the recall test) and found that subjects receiving integration imagery instructions had significantly better recall than subjects receiving separation imagery instructions. Again, this lends support to the organizational hypothesis in so far as organization may facilitate recall. It is interesting to note that another part of Begg's study failed to support the organizational hypothesis. In this part, Begg found that there was no difference in free recall of high imagery noun pairs between the groups instructed to form separate images and groups instructed to form integrated images.

In both of the above studies supporting the organizational hypothesis, imagery organization was controlled as an independent variable. If the facilitating effects of imagery upon memory are due to the organization of the material into chunks as a normally occurring process (i.e., this is the way imagery works per se) we would expect to find evidence of this in the recall protocols of subjects instructed to use imagery, but not limited to either separate or integrated images. If this type of organization could be found, it would seem to provide stronger support for the theory than manipulating organization as an independent variable. This is particularly so if this organization occurred in a free recall task like the present study, as free recall is more difficult than cued recall.

In the present study, this type of organization or clustering did not occur, even though a strong positive effect was found for imagery instructions and concrete nouns. Pairs of words were used as the conceptual unit of clustering in this study, the pairs being words that

occurred together in the original presentation order. Although this was assumed to be the simplest type of clustering that could occur, there are several other possibilities. One of these other possibilities is semantic organization. Two or more words could be categorized together according to a general category, such as the words "alcohol" and "kerosene". A third type of clustering or organization that could occur is subjective clustering of the words according to personal experience or meaning. An example of subjective clustering might be the concrete words "grandmother, accordion, and jelly", grouped together into a composite image because some individual actually had a grandmother who played an accordion and made good jelly. The word lists used in the present study were not specifically constructed to enable measuring semantic or other types of organization. The recall strategy questionnaire was used to investigate the possibility that either of these or even some other strategy was used to learn the words.

Recall Strategies

A brief review of the procedure used to obtain the recall strategies may help to explain the results. After the subjects had completed the delayed recall test, they were asked to put a code number next to each word they had recalled. Number 1 was to be used if they "recalled an image or mental picture" first; number 2 was to indicate "recalled the word" first; and number 3 indicated some other method which they were to describe. Table 11 presents the results of the analysis of variance of subjects' reported use of imagery as a recall strategy. As this table shows, there were no significant differences among groups in their reported use of imagery. It was expected that the groups receiv-

ing imagery instructions to learn concrete nouns would show an unquestionably higher incidence of using imagery than other groups, particularly the abstract noun-repetition group.

The most plausible explanation of these results seems to be that the subjects were confused about how to respond. It may be that subjects interpreted the "recalled an image" response as meaning recalling an image of the word, possibly as it appeared on the screen, rather than forming some representational image of what the word stood for. Subjects may also have been uncertain about the "recalled the word" response, as the task was to recall the words and write them down. Introspection about whether a word or an image occurs first in memory is probably a rather poor way of determining what actually occurred, and it is certainly less than objective.

Taken together, the results of this study demonstrate that both immediate and delayed recall are better for concrete material learned using imagery instructions. Repetition as a mode of learning concrete material results in inferior recall performance when compared with the use of imagery. Although there was no control group with neutral instructions with which to compare the repetition-concrete noun group's recall scores, it is most probable that such a control group would have had better recall than the concrete noun-repetition instruction group. Abstract material was learned equally well with either repetition or imagery instructions. Retention loss was less for delayed recall in imagery coded concrete material than for any other combination of material and learning instructions. Recall was not found to be correlated with organization in this study. The results are generally in agreement with Paivio's dual coding hypothesis, and fail to support the organizational

hypothesis by Begg (1972).

APPENDIX

Abstract Nouns	Concrete Nouns
knowledge	goblet
custom	body
justice	string
mastery	abdomen
nonsense	overall
occasion	rod
position	letter
rating	square
soul	alcohol
style	machine
length	kerosene
ability	blood
belief	woman
chance	jelly
discipline	iron
evidence	professor
freedom	village
gravity	tweezers
hope	grandmother
theory	accordion

unit

spirit

amount

idea

crisis

capacity

vigilance

welfare

truth

attitude

officer

nail

elbow

forehead

dress

gentleman

strawberry

ambassador

boulder

breast

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