AN ABSTRACT OF THE THESIS OF

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Title: The Effects of Types of Stimuli, Mediation, and Recall on Memory

Abstract approved: Christopher A. Joseph

It was hypothesized that the manner in which subjects transform stimuli, the types of stimuli presented to subjects, and the method of recall have an effect on memory. Eighty-eight randomly selected undergraduates were used in a 2X2X2 random groups design. Subjects were asked to imagine or trace words or pictures, and then the number of items remembered was tested through free recall or recognition. The results indicate that there is no significant difference in item recall if stimuli are traced as opposed to imagined. More picture stimuli were recalled as opposed to words, and recognition of items was superior to free recall. A significant interaction indicated that picture stimuli enhanced free recall more than it did recognition of stimuli. The results are in agreement with previous studies.

THE EFFECTS OF TYPES OF STIMULI, MEDIATION, AND RECALL ON MEMORY

A Thesis

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by

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Chapter 1

INTRODUCTION

This chapter is devoted to information concerning factors which affect memory. In this study three factors were manipulated; concreteness of response, type of stimuli, and type of recall. The significance of the problem, the purpose, and the null hypothesis have also been discussed. The limitations placed on this study by uncontrolled variables as well as terms unique to this study seen as needing further clarification have been defined and included in this chapter.

THEORETICAL FORMULATION

Past studies have shown that noun concreteness and the use of imagery facilitate memory. Paivio and Foth conducted a series of experiments on the interaction of type of mediation (imagery and verbal) and noun concreteness. The results showed imagery produced better recall on concrete nouns while verbal mediation improved recall of abstract nouns.[1] Kaplan, Kaplan, and Sampson found evidence of verbal encoding both for words and pictures. Since pictures appear to be coded visually

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[1]Allan Paivio and Dennis Foth, "Imaginal and Verbal Mediation and Noun Concreteness in Paired-Associate Learning: The Elusive Interaction", Journal of Verbal Learning and Verbal Behavior, 9, (1970), 386.

as well, then double encoding might provide an explanation for superior memory.[2] Evidence has been gathered by Schnorr and Atkinson which indicated that when presented a word as a stimulus, mental imagery increases recall better than does a repetition type study method.[3] Yuille and Paivio obtained results that support the argument for a two process memory:

> As a result of their constant association with a specific object and event, as well as with other words, concrete terms acquire a capacity to arouse sensory images as well as verbal processes as associative (meaning) reactions.[4]

Paivio and Csapo found results that substantiate, ". . . the generalization that auditory-motor factors, rather than meaning are crucial in short term memory."[5] This may only apply to sequential memory tasks such as immediate memory.

Generally all the above studies concern themselves with verbal type material. Currently there is some criticism of the results in the context of picture recognition memory. Goldstein and Chance stated that subjects are more familiar with words because they are exposed to them many times daily in the natural environment. While at the same time

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[2]Stephen Kaplan, Rachel Kaplan, and Jeffery Sampson, "Encoding and Arousal Factors in Free Recall of Verbal and Visual Material", Bulletin of the Psychonomic Society, 11(2), (1968), 74.

[3]J. A. Schnorr and R. C. Atkinson, "Repetition versus Imagery Instruction in the Short-and Long-term Retention of Paired-Associates", Bulletin of the Psychonomic Society, 15(4), (1969), 184.

[4]John Yuille and Allan Paivio, "Latency of Imaginal and Verbal Mediators as a Function of Stimulus and Response Concreteness-Imagery", Journal of Experimental Psychology, 75(4), (1967), 540.

[5]Allan Paivio and Kal Csapo, "Concrete Image and Verbal Memory Codes", Journal of Experimental Psychology, 80(2), (1968), 284.

the pictures subjects are exposed to are unfamiliar and pictures as a class are less frequently encountered by the subjects.[6] Due to this the authors of this study felt, ". . .there is no justification to equate visual recognition memory with picture recognition memory."[7] The results of research by Paivio and Csapo indicated that pictures were remembered best in free recall and recognition, followed by concrete words, and abstract words were least well remembered.[8] As Paivio stated, ". . .the findings indicate that recognition memory increases from abstract words to concrete words to pictures."[9]

THE PROBLEM

Do various mediational procedures affect the amount of information an individual is able to remember? Does the way the individual respond, as well as the type of recall procedure affect the number of items recalled by a given subject?

Statement of the Problem

Is there a significant difference in recall of stimuli as a result of level of concreteness of the response, the type of stimuli, and the type of recall?

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[6]A. G. Goldstein and J. Chance, "Some Factors in Picture Recognition Memory", Journal of General Psychology, 90, (1974), 72-73.

[7]Ibid., p. 74.

[8]Paivio and Csapo, op. cit., p. 283.

[9]Allan Paivio, "Mental Imagery in Associative Learning and Memory", Psychological Review, 76(3), (1969), 255.

Is there a significant difference in the number of correct responses due to the degree of concreteness?

Is there a significant difference in the number of correct responses as a result of type of recall?

Are there significant interactions between the variables cited above?

Statement of the Hypotheses (Null Form)

There is no significant difference in the number of correct responses as a result of type of stimuli (word vs. picture).

There is no significant difference in the number of correct responses due to the degree of concreteness (imagery vs. trace).

There is no significant difference in the number of correct responses as a result of type of recall (free recall vs. recognition).

There is no significant interaction of the variables cited above.

Purpose of the Study

There are several reasons for undertaking this investigation. One consideration was to substantiate some aspects of other studies, for example, which will show a higher number of retained items a recognition or free recall task? Which shows a higher recall, use of imagery or a tracing procedure? Does recognition memory differ from free recall type memory? Do any of the variables manipulated, adversely affect one type of memory while heightening the other? As far as practical applications are concerned, the results of this study could provide information on how one could improve one's ability to integrate new information for better recall.

Significance of the Study

Each time a study or a particular aspect of a study is replicated and the results follow those of past similar studies, more credence may be given to those factors used as variables, and this study can be viewed as part of the replication process which lends credence to the difference in recall of abstract and concrete stimuli. Also, when certain aspects of a study are added to new conditions and the results follow the same trend as in the original study, then this adds new dimensions to the significance of these factors. On the other hand, when a factor does not affect the results or in an opposing manner inhibit the results, then information is gained which limits the interpretation that may be placed on that particular variable or variables.

DEFINITION OF TERMS

Definitions unique to this area of research are listed and explained below.

Concreteness of Response

The least concrete response was for the subject to imagine the stimulus after it had been presented. The most concrete response was for the subject to trace, with a wooden stylus, the word or picture presented.

Type of Stimuli

One set of stimuli was presented as simple line drawings. The other set of stimuli was the printed label of each drawing.

Recall Trial

There were two types of recall: free recall and recognition. Free recall is the availability of the individual items for active reproduction without support from re-exposure to the original learning material.[10] In this case the subject wrote as many words as he could remember. Recognition is the differentiation of the learning series from other members of the same population of verbal items (words).[11] Those subjects in this group viewed a list of words and identified the words as "old" or "new".

Memory

Memory is the number of words that are produced in free recall or those marked as "old" in the recognition task.

Imagery

Imagery is defined as forming a mental picture of the stimulus item.

Trace

The tracing task involved each subject, using the wooden stylus to either print the name of the stimulus item or to draw the stimulus item.

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[10]Leo Postman and Lucy Rau, "Retention as a Function of the Method of Measurement", University of California Publications in Psychology, 8(1), (1957), 217-270.

[11]Ibid.

LIMITATIONS OF THE STUDY

In this study a sample of eighty-eight subjects was used. Approximately ten observations were made under each condition. The subjects used were undergraduate college students from Emporia State University.

The use of college students brings two uncontrolled variables into play. One variable is the fact that as a whole, college students are experienced in handling verbal units. Secondly, these individuals tend to find this type of experiment dull and stressful. It is stressful because they do not wish to appear bored or dull, and college subjects tend to exert a lot of effort in an attempt to succeed.[12]

SUMMARY

Several studies have been discussed in this chapter which provide support for the idea that memory can be affected by various mediational processes. Evidence was also provided to show that memory is improved when the stimulus items are pictures instead of words, and when the items are concrete instead of abstract. The problems presented were: Do various mediational procedures affect the amount of information an individual is able to remember? Does the way the individual respond during the learning trial, as well as the type of recall affect the number of items recalled? The null hypothesis stated that there is no significant difference in the number of correct responses as a result of type of stimulus, degree of concreteness, or type of recall. The purpose of

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[12]M. R. D'Amato, Experimental Psychology: Methodology, Psychophysics and Learning, (New York: McGraw Hill, 1975), p. 546.

this study was to replicate some aspects of past studies as well as add new dimension to this general framework. Terms unique to this study have been included in this chapter. The limitations of the study are discussed in terms of using college students in the experimental sample.

Chapter 2

REVIEW OF RELATED LITERATURE

This chapter presents a review and summary of literature related to the present investigation. Consideration is given to the major variables involved in the current study, including a summary of a general theory of memory processes.

In a strictly behavioristic approach, variables which can not directly be observed tend to be ignored or overlooked. Recently there has been a movement toward paying more attention to these intervening variables and their effect on verbal learning among other things. It has been found that mediational processes greatly facilitate this verbal learning. As Yarmey and Paivio found, learning is greatly enhanced if the subjects are told to employ mediation during a learning experiment.[1] Several of these mediational variables have been considered in the present investigation. Among them are noun concreteness and the use of imagery.

USE OF IMAGERY AND NOUN CONCRETENESS

Of all the factors considered in memory studies, imagery is the most powerful item attribute in verbal learning and memory tasks invol-

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[1]A. Daniel Yarmey and Allan Paivio, "Imaginal and Verbal Mediation Instruction and Stimulus Attributes in Paired-Associate Learning", Psychological Record, 18, (1969), 191-199.

ving real words.[2] In a study conducted by Smythe and Paivio the results show that recall was better for items with high, rather than low imagery values. Most important was stimulus evoked imagery rather than some verbal association.[3] This type of result is consistent across several types of memory measurements. For example, in a study by Schnorr and Atkinson where a paired-associate learning task was used, remembering words from a list was enhanced by use of imagery as opposed to the use of a repetition type study method, (i.e., to repeat the paired-associate item slowly four times).[4] In experiments where the measurement was recognition, similiar results have been obtained. Groinger, Bell, Cymar, and Wess obtained results which indicate imagery instructions increase the number of pairs of words correctly discriminated from distractor items by twenty-five percent.[5] In a related study by Groinger it was found that imagery instruction at the time of presentation creates superior recognition. This study was in agreement with the above mentioned studies, in that higher imagery ratings produced better

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[2]Allan Paivio and Edward J. Rowe, "Noun Imagery, Frequency, and Meaningfulness in Verbal Discrimination", Journal of Experimental Psychology, 85(2), (1970), 264-269.

[3]P. C. Smythe and Allan Paivio, "A Comparison of the Effectiveness of Word Imagery and Meaningfulness in Paired-Associate Learning of Nouns", Bulletin of the Psychonomic Society, 10(2), (1968), 49-50.

[4]J. A. Schnorr and R. C. Atkinson, "Repetition Versus Imagery Instruction in the Short-and Long-term Retention of Paired-Associates", Bulletin of the Psychonomic Society, 15(4), (1969), 183-184.

[5]L. D. Groinger, B. Bell, W. Cymar, and B. Wess, "Storage Aspects of Noun Presented Under Imagery and Acoustic Coding Instructions", Journal of Experimental Psychology, 95(1), (1972), 195-201.

recognition than low imagery ratings.[6] As Groinger stated:

> . . . when a person attends to a word a dynamic system operates on the word. With highly imaginable words one facet of this meaning analysis involves the formation of an image from the word. It is at this point that imagery instruction affect retrieval by increasing the strength of the image representation during storage rather than creating a search set for an image feature during retrieval.[7]

In an experiment by Paivio and Foth it was found that there is a definite relationship between concreteness of an item and the use of imagery. Imagery resulted in significantly higher recall than did verbal mediation when items were concrete. However, imagery was inferior to verbal mediation when the items were abstract.[8] These conclusions can be explained in the following manner. Concrete items, (e.g., boat) derive their meaning through association with concrete words and events as well as through associations with other words and thereby obtain the capacity to bring into play both nonverbal processes as well as verbal processes as associative reactions. On the other hand abstract items, (e.g., truth) derive their meaning through intraverbal experience and more effectively arouse verbal associations rather than imaginal processes.[9] At this point one may ask, could this imagery value of the concrete items also be interpreted as the meaningfulness of the item. Early research

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[6]L. D. Groinger, "The Role of Images within the Memory System: Storage or Retrieval?", Journal of Experimental Psychology, 103(1), (1974), 178-180.

[7]Ibid.

[8]Allan Paivio and Dennis Foth, "Imaginal and Verbal Mediators and Noun Concreteness in Paired-Associate Learning; the Elusive Interaction", Journal of Verbal Learning and Verbal Behavior, 9(3), (May 1970), 384-190.

[9]Allan Paivio, "Mental Imagery in Associative Learning and Memory", Psychological Review, 76(3), (May 1969), 241-263.

had provided such a point. Upon further investigation of these studies it was found that when the imagery value was held constant the effect of meaningfulness became insignificant.[10]

At this point all the research has indicated that imagery and concreteness are two of the most powerful factors in facilitating memory. These factors can be seen to operate in a manner as proposed by Yuille and Paivio. Verbal symbolic processes and imagery are equally available as mediators when the items are concrete, but only verbal mediators are readily available when the items are abstract.[11] In other words, memory can be seen to operate according to two processes, a verbal system and an image system. These two processes can act independent of one another or in an additive fashion and increase the rate of remembering. This paradigm can be further expanded by adding two additional variables, words and pictures. In general, this system can now be hypothesized to operate in the following manner: The effect of concreteness on memory is a direct function of the availability of each code. Images from pictures and verbal coding in the case of words have the highest availability, while the verbal code to pictures is second, imagery to concrete words third, and imagery to abstract words fourth. Thus, the summative availabilities of both codes is highest in the case of pictures, intermediate for concrete nouns, and lowest for abstract nouns.[12]

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[10]Paivio and Rowe, loc. cit.

[11]John C. Yuille and Allan Paivio, "Latency of Imaginal and Verbal Mediators as a Function of Stimulus and Response Concreteness-Imagery", Journal of Experimental Psychology, 75(4), (1967), 540-544.

[12]Paivio, loc. cit.

PICTURES AND WORDS AS VARIABLES

There have been several investigations into the varying effects of pictures or words on the rate of remembering a series of items. In a study by Lieberman and Culpepper, actual objects were compared with the verbal label of the object. Those subjects who saw the objects made fewer errors (intrusions) in free recall than did those who viewed the list of the names of the objects.[13] Along the same line, Shepard found more intrusion errors for words than for pictures.[14] In a study by Fischler and Puff, their results also substantiate the idea of a two process memory.[15] Kaplan, Kaplan, and Sampson also found evidence to support a two process memory by comparing words and pictures. The results of their study found much higher memory rates for pictures than for words. The research suggested a verbal encoding both for words and pictures. Since pictures appear to be coded visually as well, then a double encoding concept may explain this phenomena. As stated by the author:

> If indeed pictures were encoded differently from words, and both pictures and words were coded verbally, the simplest hypothesis would be that pictures are coded both verbally and visually while words are coded only verbally.[16]

The author went on to explain that when subjects are told to learn a list

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[13]L. R. Lieberman and J. T. Culpepper, "Words Versus Objects: Comparison of Free Recall", Psychological Report, 17, (1965), 983-988.

[14]W. O. Shepard, "Pictures Versus Words: Some Discrepant Results", Psychological Reports, 32, (1973), 620-624.

[15]I. Fischler and R. Puff, "Organization in Free Recall with Verbal and Pictorial Modes of Input and Output", Bulletin of the Psychonomic Society, 22(2), (1971), 85-86.

[16]Kaplan, Kaplan, and Sampson, loc cit.

of items, and these items are pictures, then the subject tends not only to see the picture but to give it a verbal label as well. On the other hand when the subject sees the name of the object, he does not tend to think of the picture or image of the object. In essence then, with a word there is only a single encoding, while with the picture there is a double encoding. Paivio and Csapo took this line of reasoning one step further. They showed subjects words or pictures by means of a filmstrip, which showed them at very fast presentation rates. The rationale was that at very high rates the subjects would be unable to give a verbal label to the picture because more time is needed than to apply a code to a word. The results were that memory for pictures was lower at the fast rate in both sequential memory (to remember the items in the order they were presented) and memory span (the number of items an individual is able to retain at any given time), because verbal codes essential to performance in such tasks were less available than in the case of verbal stimuli. Memory for pictures benefited most by a slow rate of presentation, presumably because both memory codes were highly available. The results also showed that memory for abstract words did not fluctuate much under the fast or slow rate of presentation, because only (or mainly) the verbal code was involved.[17] It should be pointed out that in this study a verbal code refers specifically to an implicit labeling or naming response rather than a verbal associate.

Consistent with the two process memory model is an explanation by Madigan of why pictures are remembered better. The results of his

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[17]Allan Paivio and Kal Csapo, "Concrete Image and Verbal Memory Codes", Journal of Experimental Psychology, 80(2), (1969), 279-285.

investigation show that memory for the symbolic (word or picture) modality is at least as good as that for a sensory modality (an auditory labeling of the picture or word). In this sense there seems to be some clear representational aspect of picture memory, and, therefore, pictures are remembered best.[18]

Another similar interpretation as to the greater effect of pictures over words is offered by Paivio, Rodgers, and Smythe. Their contention was that pictures of familiar objects can be readily coded and stored in memory in a verbal form, and, in addition, they associatively arouse concrete memory images of the thing they represent as distinguished from immediate images of the stimulus pictures. Paivio et al., postulated that recall is higher because the appropriate verbal response can be retrieved from either symbolic mode.[19] Paivio refined this theory by stating that the imagery system is specialized for dealing with nonlinguistic information stored in the form of images, that is, memory representation corresponding to concrete items; the verbal code refers to stored representation corresponding most directly to linguistic units.[20]

CRITICISM OF PICTURES-AS-STIMULUS RESULTS

There are some critics of the dual process theory to explain the superiority of pictures over words. Among these critics are Goldstein

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[18]Stephen Madigan, "Representational Storage in Picture Memory", Psychonomic Society, 4(6), (1974), 567-568.

[19]Allan Paivio, T. B. Rodgers, and P. C. Smythe, "Why are Pictures Easier to Recall than Words?", Psychonomic Society, 11(4), (1968), 137-138.

[20]Allan Paivio and Kal Csapo, "Picture Superiority in Free Recall: Imagery or Dual Coding?", Cognitive Psychology, 5, (1973), 176-206.

and Chance. Their feeling was that the two (picture or word) cannot be compared because, among other things, it is possible that pictures are more familiar and they occur with greater frequency in the environment.[21] Paivio and Csapo investigated various attributes of both words and pictures and correlated these with the mean recall scores of the subjects involved. Among the attributes obtained for verbal representation were: ratings of printed familiarity, rated pronunciability, frequency counts, and latency and consistency of labeling pictures. Availability of images was ascertained by subject's ratings of imagery values and ratings of imaginability of pictures and words. The results indicated that with a few exceptions these measures did not correlate significantly with recall scores for pictures and words. These exceptions were that incidental recall scores (the subjects did not know they would be required to remember any of the items presented to them) for pictures correlated significantly with the printed familiarity, Thorndike-Lorge frequency, and the Ducera-Francis frequency. This correlation suggests that pictures with readily available labels were more likely to be dually encoded during input than ones with less available labels.[22] Sampson also obtained similar data in regard to the superiority of pictures over words in relation to incidental learning and over a retention period of up to twenty-four hours.[23]

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[21]A. G. Goldstein and J. Chance, "Some Factors in Picture Recognition Memory", Journal of General Psychology, 90 (1974), 69-85.

[22]Paivio and Csapo, loc. cit.

[23]J. Sampson, "Free Recall of Verbal and Nonverbal Stimuli", Quarterly Journal of Experimental Psychology, 22, (1970), 215-221.

Another criticism often leveled at the idea that pictures produce greater memory rates, offered by Goldstein and Chance, was that pictures, when used as stimuli are less "rigorous" than the words due to complexity of pictures offering a large number of cues. In other words, "pictures stimuli may (and probably do) vary along several unknown and uncontrollable dimensions."[24] Paivio, Rodgers and Smythe also investigated this aspect by comparing recall for simple uncolored line drawings, colored pictures, uncolored words, (the label of the picture), and colored words. Paivio et al., were operating on the assumption that vividness or multiplicity of cues should cause superior recall of the colored items. The results indicated higher recall for pictures than words and that the effect of color was insignificant.[25]

CONSOLIDATION OF THE DUAL PROCESS THEORY

Throughout much of this chapter, in an effort to present various aspects of research concerning the role of words and pictures in the memory system, mention has been made of the dual process theory of memory. The following information is presented in an effort to present, in as concise a form as possible, a summary of this theory.

According to the theory, there are two basic coding systems or two ways of representing information in memory. One is a verbal code, the other an imaginal or nonverbal code. These two systems can operate independently of one another, or in an additive fashion with one another. They are interconnected so that it is possible to obtain an image from a

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[24]Goldstein and Chance, loc. cit.

[25]Paivio, Rodgers, and Smythe, loc. cit.

verbal label or a verbal label from an image. Thus, information held in both the verbal and the imaginal systems should be more accesible than information held in only one of the systems. One should be able to locate this information by either a verbal or nonverbal retrieval process.[26] Though these two systems can and do operate on an interrelated basis, there are certain types of information best suited to one or the other method due to basic differences in the two processes.

The imaginal system deals best with concrete items which have physical referents in the environment. The verbal system operates best on abstract type information. When processing various types of information the two systems operate in different manners. The verbal system operates in a sequential manner; when listening to a conversation, the meaning in part is derived from the order of the words. With visual information the processing is handled in a spatially-paralleled manner; in other words, all the information is simply processed in a particular area of space simultaneously.[27] There is some physiological basis for this theory. Research conducted with individuals with "split brains" (the Corpus Callosum had been severed), tends to support these concepts. The right cerebral hemisphere seems to play an important part in the imagery process, while the left hemisphere operates mainly in the verbal symbolic process.[28]

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[26]Robert L. Klatzky, Human Memory-Structures and Processes, (San Francisco, W. H. Freeman and Company, 1975), 230.

[27]Paivio, loc. cit.

[28]Ernest R. Hilgard, Richard C. Atkinson, and Rita L. Atkinson, Introduction to Psychology, (New York, Harcourt Brace Jovanovich, 1975), 243.

SUMMARY

This chapter presented a review of the literature relevant to the current investigation. Of the mediational processes available for use in information processing, imagery appears to be the most significant. Data were provided to support this contention.

The use of imagery shows its strongest effect when the stimulus items are real words. The results have been consistent in several different types of memory studies. For example, when comparing the use of a repetition study method, the imagery factor showed much higher recall. Also, when the amount of recall was measured by a recognition task, use of imagery greatly enhanced the number of items recognized. It was found that when this imagery was employed it also was an important factor. Much better recall is achieved when imagery is used during stimulus presentation than at the time of retrieval. The data also revealed that if the items were concrete, imagery was more influential than if the items were abstract. These conclusions can be explained in the following manner: Concrete items derive their meanings not only from association with other words, but from objects and with other concrete words, using both verbal and nonverbal processes, while abstract items derive their meanings only from the verbal process.

From the observations that concrete words help produce better memory, studies have been conducted to investigate the effect picture stimuli, as opposed to words as stimuli, may have on memory. Several studies are presented which tend to substantiate the conclusion that pictures as stimuli do enhance memory. This phenomenon is explained by using a dual process concept of memory. When a subject views a picture,

he not only sees the picture but gives it a verbal label as well. While with a word, a subject will not usually apply an image to it. Working on the assumption more time was required to process a picture than a word, a study was conducted which varied the speed of presentation of both words and pictures. The data from this study support this assumption. As the rate of presentation increased, recall of picture stimuli decreased, while recall of words remained fairly constant.

There are some criticisms of the data regarding the superiority of pictures over words. One such criticism is that pictures are more familiar and they occur with greater frequency in the environment than do words, thus the two cannot be compared. A study was cited which correlated recall scores of pictures and words with various attributes of each. These did not correlate significantly with the recall scores except for one instance. This instance would indicate that pictures are dually encoded because the labels were readily available.

Another criticism was that, as a class, pictures are less rigorous than words, in that there are a multiplicity of cues available to the subject when retrieving the information. This was investigated by using words and pictures with varying degrees of complexity. The pictures presented were either simple black and white line drawings or colored drawings; the words presented were also either black and white or colored. The results showed the pictures were remembered best, and there was no significance between color and no color for the words.

The conclusions from the studies presented can be formulated into a dual process theory of memory. There are two ways of representing information in memory. One is as a verbal code, the other as an imaginal or nonverbal code. These two systems can operate independently of one

another or in an additive fashion. They are interconnected in such a way that it is possible to obtain an image from a verbal label, or a verbal label from an image. It stands to reason then, that information available from both systems should be more accessible than information available from only one system. These two systems also specialize in different types of information, and process it in different ways. Also provided in this discussion was biological support for this theory. The biological aspect was discussed in terms of research done on individuals with split brains.

Chapter 3

METHODS AND PROCEDURES

This chapter pertains to the construction of the investigation. Included is information concerning the sample, the method of selection and the population from which it was taken. Also provided is the procedure used to obtain the stimulus items, including the source of the items as well as method of presentation. The chapter is concluded by a discussion of the procedure employed in actually conducting the experiment and the materials provided to the subject. The design and the method of analysis are also explained.

POPULATION AND SAMPLING

The population for this study was all those students enrolled in Social Psychology classes at Emporia State University, Emporia, Kansas. The sample consisted of eighty-eight subjects drawn randomly from the 1976 spring semester of these classes.

MATERIAL AND INSTRUMENTATION

Stimulus items consisted of a list of fifteen words (Appendix A, p. 45) drawn from a list prepared by Paivio, Yuille, and Madigan. The list consisted of nine hundred twenty-five nouns scaled on abstractness-concreteness (C), imagery (I), and meaningfulness (m). C and I were

rated on seven point scales, m, in terms of mean number of written associations in thirty seconds.[1]

For this list of fifteen nouns, imagery ranged from a high of 6.90 to a low of 6.47, with a mean of 6.44. The range of the concreteness nouns was 7.00 to 6.66, with a mean of 6.97. For the meaningfulness of the nouns, the range was 8.67 to 6.00, with a mean of 7.08.

The pictures used as stimulus items were simple line drawings of the stimulus words (Appendix B, p. 47). Before the pictures were used, a pilot study was run to ascertain the labeling consistency of each picture selected. Eighteen freshmen from an Introductory Psychology class were used for this procedure. Each subject was given a mimeographed sheet with all fifteen pictures on it, and was asked to write the verbal label for each item, (Appendix C, p. 50). With one exception, all the pictures were labeled correctly at least eighty-three percent of the time. From this normative data the pictures were enlarged and placed separately on five by eight inch cards. The words were also placed on individual five by eight inch cards. Care was taken to insure that each stimulus item occupied the same area on each card. Each item was no more than one and one-quarter inches in height to insure each item occupied the same area on the cards.

The thirty items selected for the recognition task were also drawn from the noun pool prepared by Paivio et al. Fifteen were the original stimulus items and fifteen were new items. For this list the range of the imagery values was from 6.90 to 6.47, with a mean of 6.44.

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[1]A. Paivio, J. Yuille, and S. A. Madigan, "Concreteness, Imagery, and Meaningfulness Values for 925 Nouns", Journal of Experimental Psychology, 76, 1(2), (1968), 10-25.

The range of concreteness was from 7.00 to 6.66, with a mean of 6.97. For meaningfulness the range was from 8.67 to 6.00 with a mean of 7.08 (Appendix D, p. 52).

DESIGN OF THE STUDY

The design used in the study was a 2X2X2 random groups design. Factor A was the type of stimulus, the levels being A_1 words, and A_2 pictures. Factor B was the concreteness of response, the levels being B_1 image, and B_2 trace. Factor C was the type of recall, the levels being C_1 recognition, and C_2 free recall. The dependent variable was the number of correct responses, as measured by a free recall task or a recognition task (Appendix E, p. 54).

DATA COLLECTION

In this study the instrument was administered individually to all subjects over a period of ten days during the spring semester of the 1975-1976 academic year. Upon arrival in the testing room, each subject was told, "You are participating in a memory experiment, items will be presented for you to remember."

Each subject sat at a table across from the experimenter, a distance of about three feet. The subject was given a small tablet to record his responses. Each tablet was four inches square, made up of sixteen sheets; each tablet included one extra sheet in case a subject turned two pages at one time they would still have a page for all fifteen stimulus items. Attached to each tablet was the written instructions explaining the particular task (Appendix F, p. 56), indicating the subject was to record only one response on each page. As the subject read

his instructions silently, the experimenter read them aloud. Under each condition two examples were given to indicate correct responding procedure. In every case the sample items were the same and they were items which were not included in the stimulus list.

The stimulus items were printed or drawn, each on a separate five by eight card and presented individually for six seconds. During this six-second period the subject was required to view the item and engage in the particular task he had been assigned.

After all fifteen stimulus items had been presented, the subject's tablet was collected, and in its place the subject was given a blank standard size, (8½" by 11") sheet of paper. The subject was told to write backward from five hundred to zero. This was done to act as an intermediary task so the subject would be unable to rehearse the stimulus items. Two minutes were allowed for this. Upon completion of the task the sheet was collected. Next, depending on the type of recall task the subject was to engage in, each subject was given either the recognition list, included in the appendix, or a blank sheet of paper to recall all possible items. Once again the subject was given a copy of the instructions (Appendix G, p. 58), which he read to himself while the experimenter read them aloud. For the recall task each subject was given a maximum of five minutes to finish. For the free recall task the subject was to write as many of the items as he could remember. For the recognition task the subject was required to mark each of the thirty items with either an "O", indicating an old item, (i.e., the subject had seen the item during the stimulus presentation), or an "N", indicating a new item (i.e., the subject had not seen the item during the presentation).

DATA ANALYSIS

For this study a three-way, between-subjects analysis of variance was used to analyse the data collected. In addition a Strength-of-Association measure was calculated.[2]

SUMMARY

This chapter presented information concerning procedures followed in conducting the present investigation. The sample of eighty-eight subjects was randomly drawn from an undergraduate psychology class. Presented to each subject was a list of fifteen stimulus items, all controlled for three factors, concreteness, imagery, and meaningfulness. Information was also provided concerning the noun pool from which this list was obtained. Also discussed was the method of developing the pictures used as stimulus items, and how they were validated as to their ability to represent the verbal label.

The method of data collection was discussed in detail, including the materials which needed to be given to each subject (tablets, sheets of blank paper, and a wooden stylus). The time limits for each task were explained. These tasks were: presentation procedure, intermediary task, and the recall procedure. The method of presenting the instructions for the various tasks was also discussed, as well as presented verbatim in the appendix.

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[2]M. Linton and P. S. Gallo, Jr., The Practical Statistician: Simplified Handbook of Statistics, (Monteray, California: Brooks/Cole, 1975), pp. 297, 316-319, 335-337.

Consideration was also given to the design of the study, a 2X2X2 random groups, and the method of analysis, a three-way analysis of variance. The Omega squared procedure, a Strength-of-Association measure was used.

Chapter 4

ANALYSIS OF DATA

This study was designed to investigate various mediational procedures. Its primary purpose was to see if there was a significant difference in recall of stimuli as a result of the concreteness of response, the type of stimuli, and the type of recall.

A 2X2X2 random groups analysis of variance was employed in order to determine if there was any significant difference between the six experimental groups. A second procedure was applied, a Strength-of-Association measure. As was mentioned above, the analysis of variance was used to obtain an estimate of the level of significance, not the magnitude of the difference between the groups. This magnitude can be determined by a Strength-of-Association measure, in this particular case the Omega Squared procedure.[1] All raw score data may be found in Appendix H, p. 60.

STATISTICAL ANALYSIS

The data presented in the following tables and figures represent the number of correct responses from either a free recall task or from a recognition task. The method of analysis used was the analysis of variance and the Omega Squared test.

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[1]Robert Plutchik, "Foundations of Experimental Research", (New York: Harper and Row, 1974), pp. 148-149.

Table 1 (page 30) presents the summary table for the analysis of variance. Factor B, concreteness of response (tracing vs. imagery) was found not to be statistically significant ($p>.05$). Factor A, type of stimuli (word vs. picture) was found to be statistically significant, word mean = 10.31, and picture mean = 12.02 ($p<.05$). Factor C, type of recall (free recall vs. recognition) yielded a statistically significant difference, free recall mean = 8.81, and recognition mean = 13.52 ($p<.05$). From this data one is able to reject the following null hypotheses: There are no significant differences in the number of correct responses as a result of type of stimuli. There are no significant differences in the number of correct responses as a result of type of recall. Also from this data one must retain the following null hypothesis: There are no significant differences in the number of correct responses due to the degree of concreteness of response. In other words the manner in which the subject responded to the stimulus items did not significantly affect the rate of recall.

Concerning the interactions produced by the experimental design, one was found to be statistically significant. This is the interaction between type of stimuli and type of recall, (Figure 1, page 31). There is a much higher rate of recall for recognition over free recall. The picture stimuli increase the number of items recalled in both the free recall and recognition tasks. There was no statistically significant interaction between concreteness of response and type of stimuli, nor was the interaction between concreteness of response and type of recall found to be statistically significant.

Table 1

Analysis of Variance Source Table

Source		df	SS	MS	F
A	(Stimuli)	1	.921	.921	20.101*
B	(Concreteness)	1	63.921	63.921	.290
C	(Recall)	1	486.921	486.921	153.120*
AB	(Concreteness X Stimuli)	1	12.374	12.374	3.891
AC	(Stimuli X Recall)	1	31.92	31.92	.604
BC	(Concreteness X Recall)	1	1.92	1.92	10.038*
ABC	(Concreteness X Stimuli X Recall)	1	.103	.103	.032
N-abc	(Error)	80	254.364	3.180	- - - -
Total (N-1)		87	852.444	9.764	- - - -

*significant at .05 level

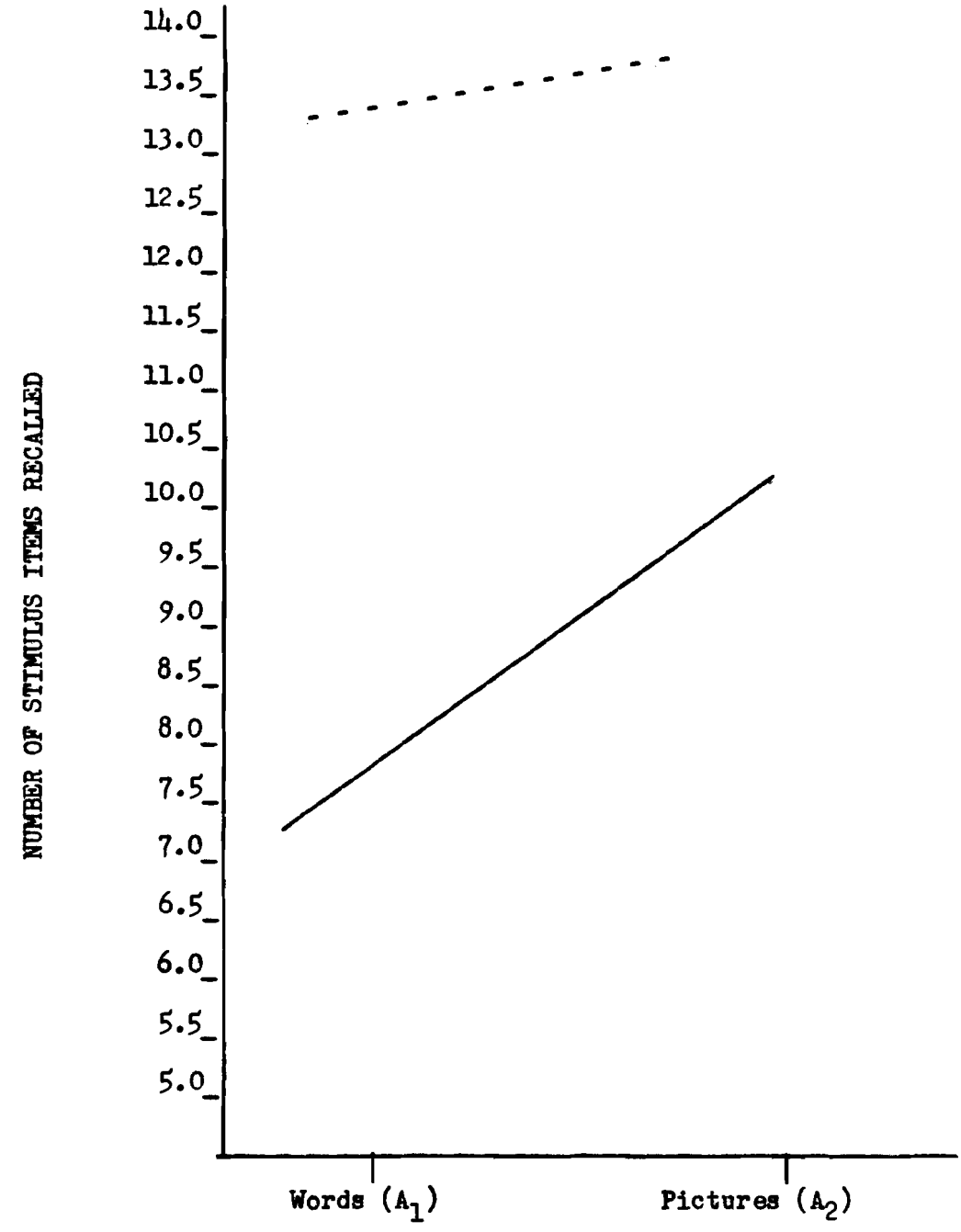

Figure 1

A X C Interaction
Type of Stimuli X Type of Recall

One further statistical procedure was applied to these data, the Omega Squared (w^2), a Strength-of-Association measure. As has been mentioned, the analysis of variance will show if a significant difference exists between two groups, but it tells nothing of the actual experimental effect. Thus it would be possible to obtain a highly significant F value with a large sample size, yet the actual effect of the experimental manipulation may be quite small.[2] The Omega Squared is applied then, in order to determine the degree to which two factors are significant. The closer the Omega Squared result is to 1.0 the stronger the significance is.

When this procedure was applied to this investigation the following results were obtained: Factor A, w^2 = .071, Factor C, w^2 = .565, and for interaction AXC, w^2 = .034. Thus for Factor B, type of stimuli the significance is fairly weak, for Factor C, type of recall, the significance is comparatively strong, with the interaction for concreteness X recall being the weakest of the significant results. Computational procedures may be found in Appendix I, p. 62.

SUMMARY

This chapter gave a description of the analyses of the raw data produced by this investigation. Included in this discussion was the rational for using the particular type of statistical procedures. The primary procedure used was a three-way analysis of variance. This

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[2]Plutchik, loc. cit.

procedure was used in order to determine if there were any differences between the factors under investigation. The Omega Squared procedure was used as a Strength-of-Association measure to determine how great the magnitude of the difference was.

The primary purpose of the study was to determine if there was a significant difference in recall of stimuli as a result of the concreteness of response, the type of stimulus, and the type of recall.

As determined by the analysis of variance, two main effects were found to be statistically significant. One of these main effects was the type of stimuli. Pictures presented as stimulus items resulted in significantly higher recall scores than did words as stimulus items. The other main effect found to be statistically significant was the type of recall. A recognition task as a recall procedure produced significantly higher recall scores than did a free recall task.

One interaction was found to be statistically significant. The interaction was type of stimuli X type of recall. This interaction indicates when a subject engages in a recognition task, the number of items recalled will increase. Also the number of items recalled will increase when the stimuli are pictures in both a free recall and recognition task.

From this data one is able to reject the following null hypotheses: There are no significant differences in the number of correct responses as a result of type of stimuli. There are no significant differences in the number of correct responses as a result of type of recall. Also from this data one must retain the following null

hypothesis. There are no significant differences in the number of correct responses due to the degree of concreteness of response.

Chapter 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

SUMMARY

The problem investigated in this study was: Do various mediational procedures affect the amount of information an individual is able to remember? Does the way the individual respond during the learning trials, as well as the type of recall affect the number of items recalled?

The null hypotheses stated that there would be no significant differences in the number of correct responses as a result of type of stimuli, degree of concreteness, or type of recall. The purpose of the study was to replicate some aspects of previous research and to add new dimensions to this general framework.

The factors manipulated in this study were selected on the basis of earlier research. This previous research revealed a number of critical factors. It has been found that the use of imagery is a very powerful factor in facilitating memory. In conjunction with imagery, the concreteness of the stimulus items was found to be important. When items are placed on a continuum from abstract to concrete, the use of imagery is most helpful when the items are concrete.

The type of stimulus item has been found to affect the amount of material recalled. Pictures seem to produce a higher rate of recall than do words. The combined use of imagery with concrete words or pictures

produce higher number of items recalled across various types of recall procedures. For example, recall is higher for pictures in experiments using a recognition procedure as well as those experiments employing a free recall task.

Based on these studies, three factors were chosen as independent variables; Factor B was concreteness of response during learning trial, the two levels being imagery and tracing. Factor A was type of stimuli, the two levels of this factor were pictures and words. Factor C was type of recall, free recall or a recognition task. A total of eighty-eight subjects were used in this investigation. All subjects were randomly selected from an undergraduate psychology class.

The administration of the experiment consisted of three parts. First was the presentation procedure. The subject was given a set of instructions which were read aloud to the subject as he read them silently. Included in this were two examples of how to respond to the stimulus items. Following the instructions and examples the subject was presented fifteen stimulus items, either words or pictures, for a period of six seconds each. These items were presented manually by the experimenter. The subjects responses were recorded on four inch square tablets. The second part of this experiment consisted of an intermediary task. During this segment of the experiment the subjects were given two minutes to write backward from five hundred to zero. The purpose of this task was to keep the subject from rehearsing the stimulus items. The final segment of this study was the recall procedure. For this, the subject was to engage in one of two procedures. They either had a recognition or a free recall task to determine the number of items each subject could recall. As in the presentation each subject was given

a list of thirty items, fifteen being the original stimulus items and fifteen new items. Each was to be marked "N" for new or "O" for old. For the free recall task the subjects were given a blank sheet of paper and required to write as many of the stimulus items as they could remember. A maximum of five minutes were allowed for this task.

After the raw data had been collected two statistical procedures were applied to the data. The first procedure was a three-way analysis of variance, and secondly the Omega Squared procedure, a Strength-of-Association measure was used.

Of the three main effects possible in this study, two of them did yield statistically significant effects. One of these was type of stimuli; pictures presented as stimulus items resulted in significantly higher recall scores than did words as stimulus items. The other factor found to produce a statistically significant difference was type of recall; a recognition procedure produced significantly higher recall scores than did a free recall procedure. The other main effect possible concerned the concreteness of response during the learning trial, this factor did not cause a statistically significant difference in amount of stimulus items recalled.

In relation to the two main effects found to be significant one interaction was also found to be statistically significant. This interaction was type of stimuli by type of recall. This indicates that when a subject engages in a recognition task the number of items recalled will increase. Also the number of items recalled will increase when the stimuli are pictures in both a free recall and recognition task.

As a result of this data, one is able to reject the following null hypotheses: There are no significant differences in the number of

correct responses as a result of type of stimulus. There are no significant differences in the number of correct responses as a result of type of recall. The data also show that one of the null hypotheses must be retained. There are no significant differences in the number of correct responses due to the concreteness of response.

CONCLUSIONS

In almost all aspects this investigation revealed results consistent with past studies. Concerning the factor controlling type of stimuli (word or picture), the results follow the trend established in previous research. Pictures produce higher memory rates. This is consistent with such studies as those conducted by Madigan, which showed items from the symbolic modality are remembered better than those from a sensory modality.[1]

These results are also consistent with the results obtained by Kaplan, Kaplan, and Sampson, who also found much higher memory rates for pictures than words.[2] Also consistent with previous studies were the results indicating higher amounts of recall from a recognition task over a free recall task. An explanation for this may be the idea that recognition memory can be considered more perceptual in nature; thus, more sensitive to such variables as distinctiveness and imagery.[3] A further extension of this concept is an explanation offered by Bernsback and Kupchak. Through the use of statistical procedures they obtained

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[1]Madigan, loc. cit.

[2]Kaplan, Kaplan, and Sampson, loc. cit.

[3]Allan Paivio, Imagery and Verbal Processes, (New York: Holt, Rinehart, and Winston, 1971), 182.

correlational data which indicates more information is required in memory to support recall than recognition. Bernsback and Kupchak derived two parameters: Parameter "a" indicates "something more" is required in memory for recall than for recognition. Parameter "r" is a measure of the probability that there is enough information in memory for the item to be considered remembered for the purpose of recognition. The correlation between r and a is .97.[4]

It is interesting to note, that the number of items remembered, with one exception, increased when the stimuli were pictures. This one exception is when the subject was required to imagine a picture with recognition as the recall task. In this case the mean number of items recalled showed a slight decrease over the same condition when the stimulus items were words. The explanation of this discrepant result may be due to the following: The subject has stored a visual representation and is then required to recognize the label. If the subject had a "mental set" to deal with pictures, this switch in modalities may prove confusing. This particular aspect may warrant further investigation. Possibly these two conditions could produce higher amounts of items recalled if the subject were to recall or recognize pictures instead of the label of the picture.

Another area of further study may be the tracing procedure. Although there was no significance found with this variable, there seems to be some indication that it does produce some difference. When the subject was required to trace, it did seem to improve recognition as well

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[4]Harley A. Bernsback and Patricia G. Kupchak, "Recognition and Recall in Short Term Memory", Journal of Mathematical Psychology, 9, (1972), 237-242.

as result in some improvement in free recall of pictures over words. One explanation for this could be due to the fact that the subject was required to "concentrate" more on the item to reproduce it on paper than to imagine it. The actual effect could possibly be ascertained with more controlled procedures.

There are some confounding variables in this study which may limit any generalization made from the investigation. There is no way to state with certainty that when asked to engage in an imagery procedure that the subject actually did so. Perhaps the subject had a personal mnemonic strategy he felt worked "better", thus employing his own, or the subject may have let himself wander from the task at hand, and attended to various imaginal associations triggered by the stimulus item; this could be in conjunction with the aforementioned idea that college students may find these types of tasks boring. Another aspect which limits this study could be the method of presentation. In the present investigation the stimuli were presented manually. It would be advantageous to do this mechanically, eliminating any possible difference in timing; in addition, it could prove interesting to present a slide presentation along with a tape recording as two different modes of presentation.

SUMMARY

The purpose of this chapter was to summarize the entire research project and in addition to provide some conclusions. This study investigated the way individuals respond during learning trials and the influence that type of stimuli and type of recall has on the number of

items recalled. The study used the null hypothesis format to determine if there were any significant differences evident as a result of the independent variables.

Based on a review of related literature three factors were chosen for the independent variables: concreteness of response during learning trials (imagery or trace), type of stimuli (words or pictures), and type of recall (free recall or recognition).

For this experiment eighty-eight subjects were randomly selected from an undergraduate psychology class. The administration of the experiment consisted of three parts. First was the presentation procedure, followed by an intermediary task and finally a recall procedure. In each case the subject was given standard instructions explaining what was required for each task.

To analyze the data two statistical procedures were used: A three-way analyses of variance and the Omega Squared. Two of the main effects were found to be statistically significant: Type of recall and type of stimuli. This investigation revealed results which are consistent with past similar studies. Pictures tend to produce a higher amount of recalled items than do words. Also, recognition appears to increase the number of items recalled over a free recall procedure. Information is provided which offers an explanation for these results. The statistical study indicates "something more" is required in memory for free recall than for recognition. Included in this discussion are some limitations which should be placed on the conclusions. One of these is the idea that the subject involved may not have followed the instructions or did not attend to the task at hand. To overcome some

of these limitations, suggestions are offered for further research. A more controlled presentation procedure is discussed as well as other types of presentation which may be applied to this general framework.

APPENDIXES

APPENDIX A

Rated Values for Imagery (I), Concreteness (C), and meaningfulness (m) for Stimulus Items

APPENDIX A

Rated Values for Imagery (I), Concreteness (C), and meaningfulness (m) for Stimulus Items[1]

	I	C	m
Apple	6.73	7.00	7.67
Arrow	6.57	7.00	7.67
Car	6.87	7.00	6.38
Cat	6.80	7.00	6.76
Chair	6.63	7.00	7.20
Cigar	6.80	6.96	6.22
Door	6.60	7.00	7.96
Elephant	6.83	7.00	7.90
Hammer	6.73	6.96	6.92
Shoe	6.63	7.00	7.52
Snake	6.90	7.00	6.88
Strawberry	6.80	7.00	6.71
Tree	6.77	7.00	6.79
Trumpet	6.70	7.00	6.80
Umbrella	6.60	7.00	6.76
Mean	6.73	6.99	6.95

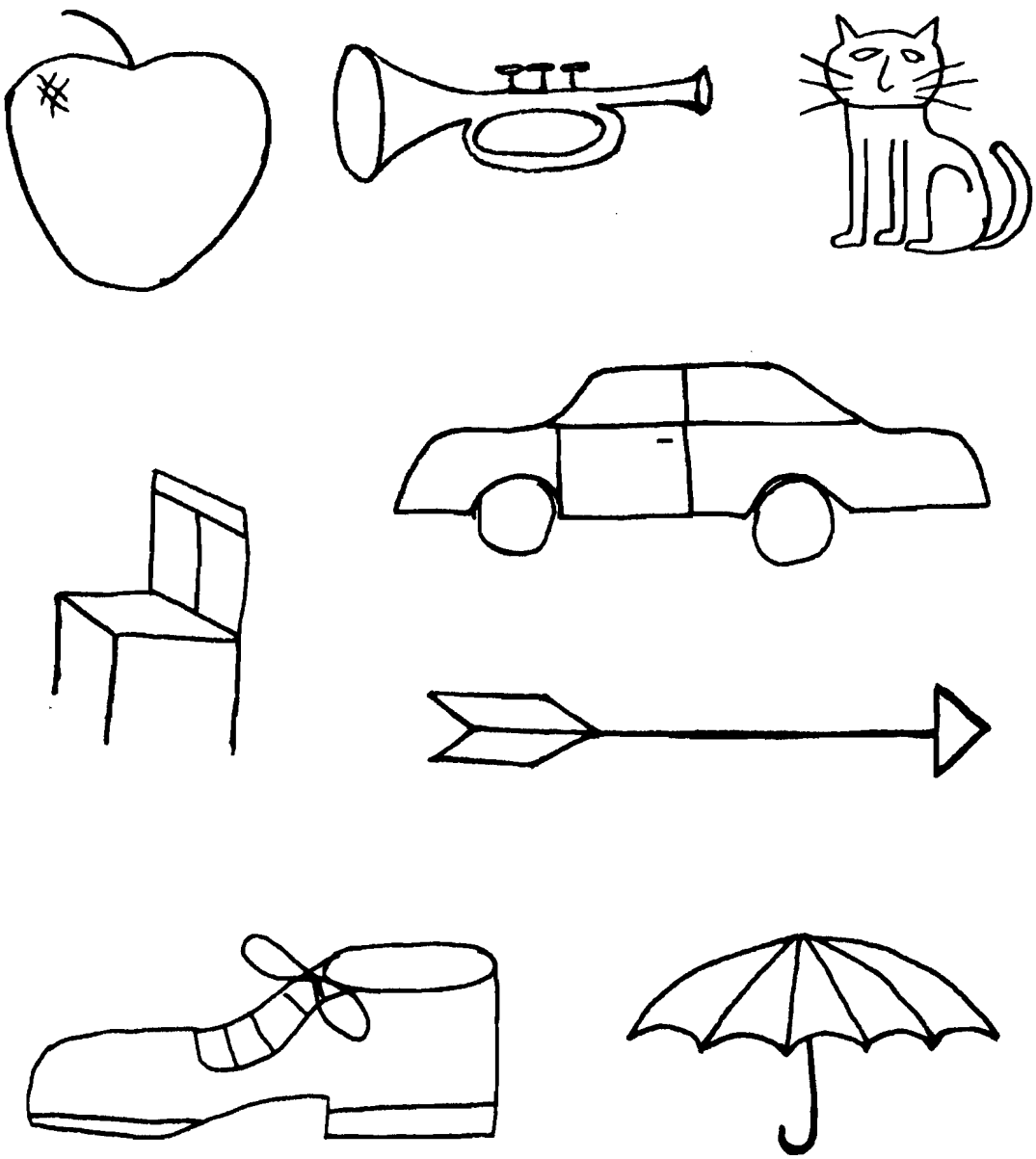
[1]Allan Paivio, John Yuille, and Stephen Madigan, "Concreteness, Imagery and Meaningfulness Values for 925 Nouns", Journal of Experimental Psychology, 76, 1(2), (1968), 10-25.

APPENDIX B

Stimulus Items-Pictures

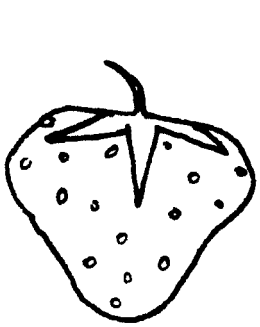
APPENDIX B

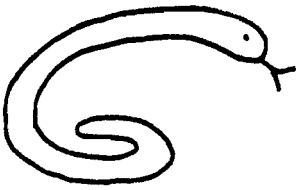
Stimulus Items-Pictures

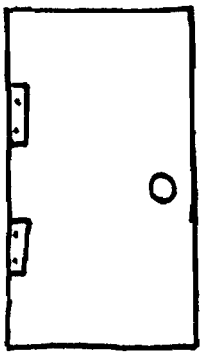


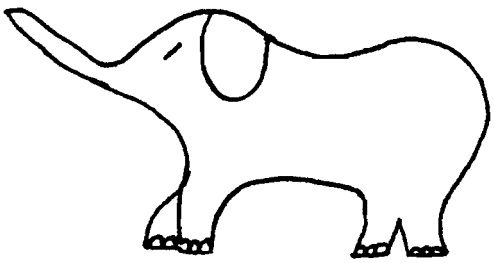
APPENDIX B

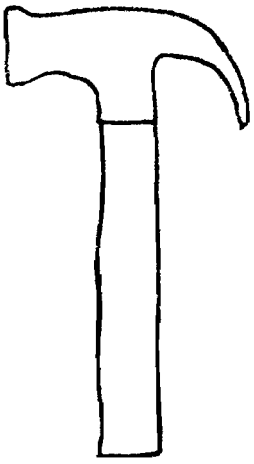
Stimulus Items-Pictures

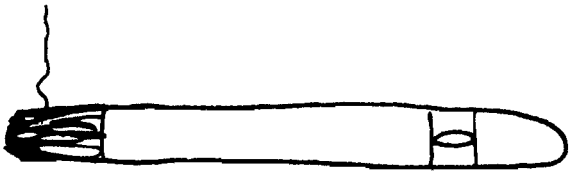


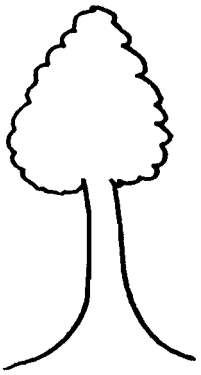










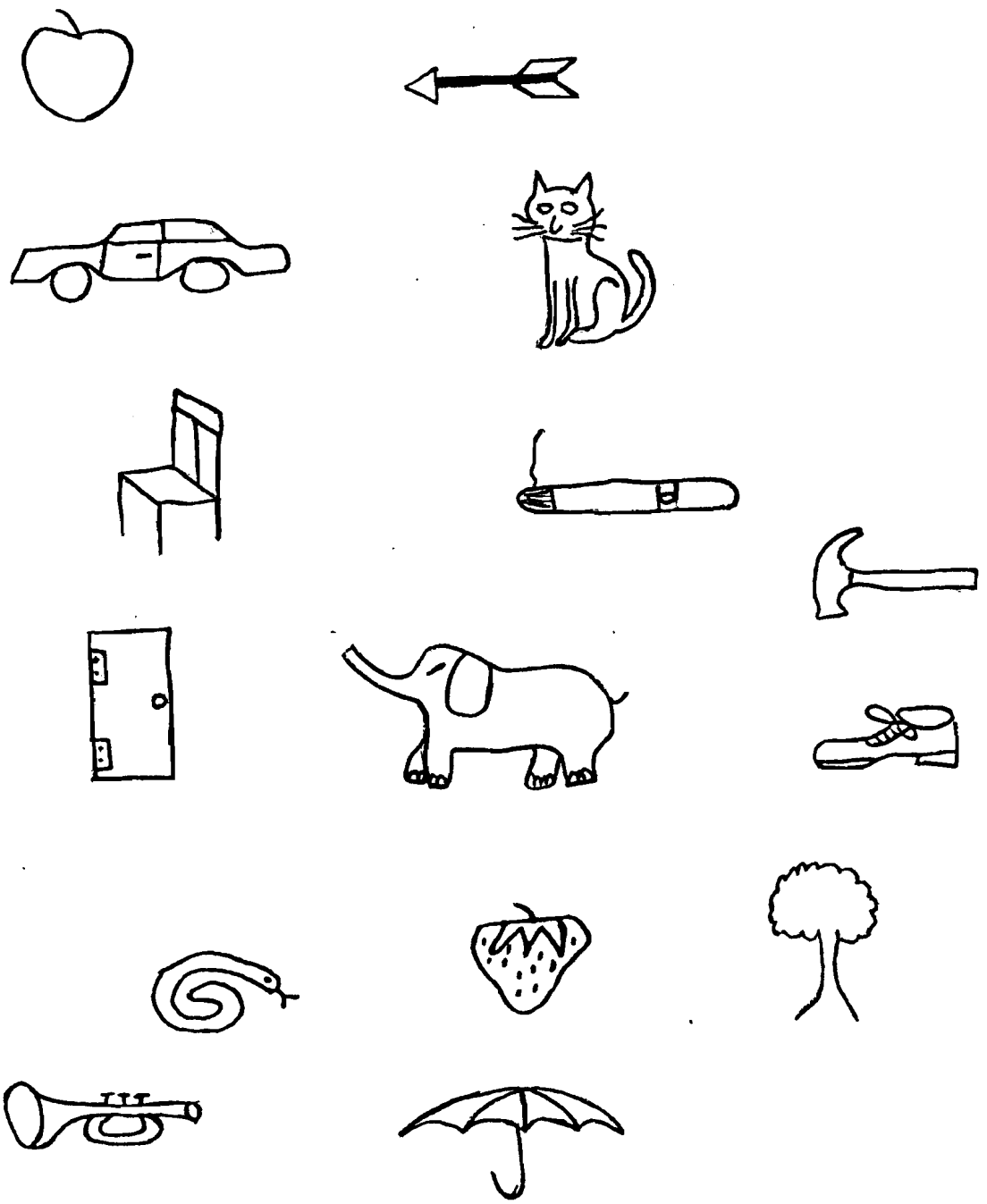


APPENDIX C

Picture Sheet used to Determine Labeling Consistency

APPENDIX C

Picture Sheet used to Determine Labeling Consistancy



APPENDIX D

Rated Values for Imagery (I), Concreteness (C), and meaningfulness (m) for Recognition List

APPENDIX D

Rated Values for Imagery (I), Concreteness (C), and meaningfulness (m) for Recognition List[1]

	I	C	m
Hammer	6.73	6.96	6.92
Door	6.60	7.00	7.96
Diamond	6.67	6.94	7.84
Horse	6.80	6.94	8.67
Nail	6.50	6.96	6.08
Snake	6.90	7.00	6.88
Car	6.87	7.00	6.38
Shotgun	6.60	6.96	7.88
Fork	6.57	6.94	7.08
Cat	6.80	7.00	6.76
Trumpet	6.60	7.00	6.80
Tree	6.77	7.00	6.79
Flag	6.60	6.94	6.54
Chair	6.63	7.00	7.20
Harp	6.60	6.94	6.00
Butterfly	6.63	6.93	7.80
Apple	6.73	7.00	7.67
Umbrella	6.60	7.00	6.76
Elephant	6.83	7.00	6.88
Strawberry	6.80	7.00	6.71
Fire	6.70	6.66	7.36
Cigar	6.80	6.96	6.22
Clock	6.50	6.94	7.08
Arrow	6.57	7.00	6.80
Shoes	6.63	7.00	7.52
Bird	6.67	6.96	7.88
Table	6.50	7.00	7.63
Potato	6.50	7.00	7.13
Macaroni	6.47	7.00	6.00
Fox	6.73	7.00	7.40
Mean	6.44	6.97	7.08

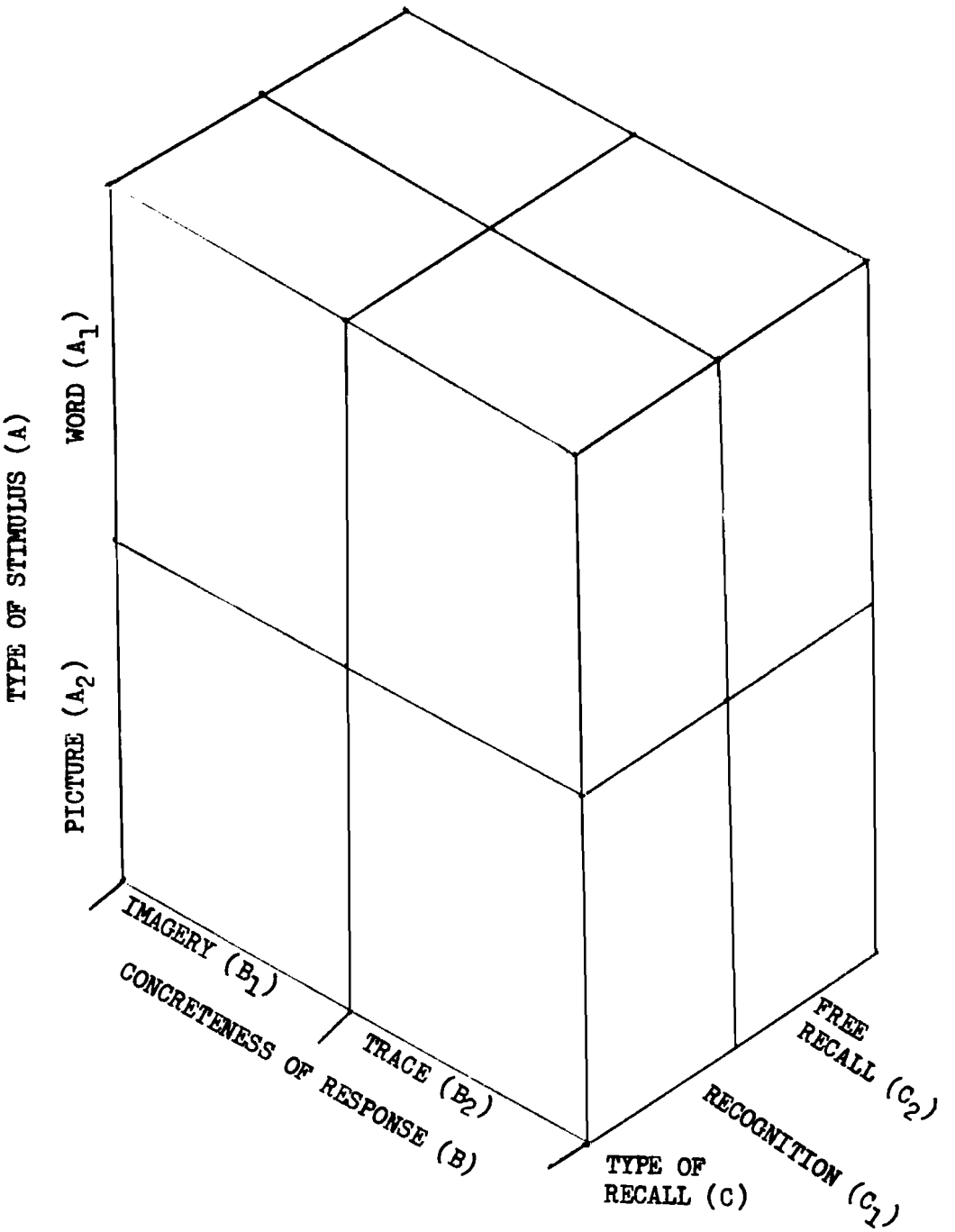
[1]Paivio, Yuille, and Madigan, loc. cit.

APPENDIX E

Factorial Design

APPENDIX E

Factorial Design



DV: Number of Correct Responses

APPENDIX F

Presentation Instructions

APPENDIX F

Presentation Instructions

TRACE-WORD INSTRUCTIONS

Fifteen items will be presented to you with six (6) seconds between each word. Your task is to trace the name of each thing presented. After the time interval turn the page of your booklet for the next item. Remember your task is to trace the name.

TRACE-PICTURE INSTRUCTIONS

Fifteen items will be presented to you with six (6) seconds between each word. Your task is to trace a picture of each thing presented. After the time interval turn the page of your booklet for the next item. Remember your task is to trace the picture.

IMAGERY-PICTURE INSTRUCTION

Fifteen items will be presented to you with six (6) seconds between each word. Your task is to imagine a picture of each thing presented. After the time interval turn the page of your booklet for the next item. Remember your task is to imagine a picture.

IMAGERY-WORD INSTRUCTIONS

Fifteen items will be presented to you with six (6) seconds between each word. Your task is to imagine the name of each thing presented. After the time interval turn the page of your booklet for the next item. Remember your task is to imagine the word.

APPENDIX G

Instructions for Recall Task

APPENDIX G

Instructions for Recall Task

FREE RECALL

On the sheet of paper provided, write down, in any order all the words you can remember from the presentation. You have five (5) minutes for this task.

RECOGNITION

A list of words will be given to you. Your task is to mark each with an "O" or "N". O for old, meaning you saw the word in the presentation. N for new, meaning you did not see the word in the presentation. Be sure to mark each word. You have five (5) minutes for this task.

APPENDIX H

Raw Score Data

APPENDIX H

Raw Score Data

	A_1				A_2			
	B_1		B_2		B_1		B_2	
	C_1	C_2	C_1	C_2	C_1	C_2	C_1	C_2
	11	4	11	6	11	13	15	11
	15	8	11	7	15	7	14	12
	14	11	15	10	12	7	14	11
	15	11	14	7	11	10	14	12
	14	10	14	5	14	9	14	12
	15	8	14	5	15	12	15	10
	12	5	14	11	15	13	15	10
	11	7	15	7	15	11	14	9
	13	5	13	5	13	10	15	10
	14	7	14	6	14	7	13	10
	13	10	10	7	10	10	15	10
$\bar{X}$	13.36	7.82	13.18	6.91	13.18	9.91	14.36	10.64

A_1 Type of Stimulus-Word

A_2 Type of Stimulus-Picture

B_1 Concreteness of Response-Imagery

B_2 Concreteness of Response-Trace

C_1 Type of Recall-Recognition

C_2 Type of Recall-Free Recall

APPENDIX I

Omega Squared, Strength-of-Association Measure

APPENDIX I

Omega Squared, Strength-of-Association Measure[1]

$$= \frac{SS_A - (df_A)\ (MS_{error})}{MS_{error} + SS_{total}}$$

All data for this formula may be obtained from the summary table, page 30.

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[1]Linton and Gallo, op. cit. pp. 335-337.

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