AN ABSTRACT OF THE THESIS OF

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Title: THE EFFECTS ON FREE RECALL OF GENDER, TYPE OF STIMULUS, AND TYPE OF TRANSFORMATION

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This study explored the effects on free recall of gender, the type of stimulus presented (pictures, their simple word labels, or complex word groups completely describing the pictures), and the type of transformation performed on the stimuli (describing stimuli in words or imagining stimuli as pictures). Two hundred eighty-eight undergraduate student volunteers (102 males, 186 females) were visually presented the stimuli, and were instructed to either describe the items in words or imagine them as pictures. Following an interim activity, subjects were allowed five minutes to write as many items as they could recall. A 3 X 2 X 2 between-subjects analysis of variance showed that significantly more picture, as opposed to word, stimuli were recalled. Female subjects recalled more stimuli than male subjects, and more items were recalled by subjects instructed to imagine stimuli as pictures, rather than words. There was a significant Stimulus X Transformation interaction indicating that stimuli presented in picture form, or transformed into pictures were more easily remembered than stimulus items represented only by words. A strength of association measure (ω^2) showed that type of stimulus and type of transformation accounted for 11% and 14% of the variance respectively. Gender accounted for only 1% of the variance.

THE EFFECTS ON FREE RECALL OF GENDER, TYPE OF TRANSFORMATION, AND TYPE OF STIMULUS

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I wish to extend deepest appreciation to Richard Gloucester for his valuable inspiration through the years.

Shine out, fair sun, till I have bought a glass,
That I may see my shadow as I pass.

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Chapter 1

INTRODUCTION

This chapter has been devoted to information concerning the effects of certain factors on human memory. This study explored the effects on free recall of gender, the types of stimuli presented (pictures, their simple word labels, or groups of words completely describing the pictures), and the types of cognitive transformations (describing stimuli in words or imagining stimuli as pictures). The specific statement of problem, the purpose, and the null hypotheses have also been discussed. The limitations placed on this study by uncontrolled variables, as well as terms identified as needing further clarification, have been defined and included in this chapter.

Theoretical Formulation

In the study of human memory, free recall and the variables affecting it have been the subjects of several recent investigations. Some of these studies (Sampson, 1970; Paivio, 1971; Wittrock and Goldberg, 1975) have tested subjects' ability to recall stimuli presented in the form of word labels. Researchers consistently found recall of pictures to be superior to that of word stimuli. The most widely accepted explanation for the superiority of picture stimuli over verbal stimuli in free recall has been termed the double-encoding hypothesis (Paivio, 1971). According to the double-encoding hypothesis, the picture of a familiar object evokes both figural and verbal encoding, while words evoke only verbal

encoding. It is believed that this dual encoding of stimuli facilitates free recall because the subject has both figural and verbal material from which to draw during the recall process.

The difference in free recall of pictures as opposed to words is well established, but the form in which stimuli are presented is not the only important factor influencing free recall. Recent findings indicate that free recall is also affected by the manner of stimulus presentation, the form of recall, the number of times the stimuli are presented and recalled, the instructions to the subjects, the delay between presentation and recall, and the kinds of transformations performed on the stimuli (Joseph and Joseph, 1980; Joseph and Cowan, 1981; Joseph, Joseph, and Beasley, in press; Joseph, McKay, and Joseph, in press a; Joseph, McKay, and Joseph, in press b). Subjects' gender is a variable shown to be of importance in performance with verbal stimuli (Maccoby and Jacklin, 1974); however, a recent study has shown cognitive gender differences to be very small (Hyde, 1981).

The Problem

Do various mental and imagery activities affect the number of stimulus items the individual is able to freely recall? Do these factors combine in any way to affect free recall?

Statements of the Problem

Is there a significant difference in the recall of familiar objects as a result of cognitively transforming simple words into mental pictures, as a result of cognitively transforming complex verbal descriptions into mental pictures, as a result of merely saying the simple or complex words aloud, as a result of describing pictures in words, as a result of

imagining pictures as pictures, as a result of the sex of the subjects, or as a result of an interaction of the above cited variables?

Statement of the Hypotheses

Null Form

There is no significant difference in the number of correctly recalled stimuli as a result of the type of stimulus (pictures, simple words, complex words) presented, as a result of the cognitive transformations performed on the stimuli (imagining as picture or describing in words), as a result of the gender of the subjects, or as a result of an interaction of the above cited variables.

Purpose of the Study

The purpose of this study was to explore the effects on free recall of pictures and various types of word stimuli in conjunction with the variables of gender and type of transformation performed on the stimuli. This study was also used to help gain insight into what factors merit further study.

Significance of the Study

This study was part of a continuing effort to understand the human memory process through the replication of previous findings and the establishment of new knowledge. Questions answered by the study were as follows: 1. Is the double-encoding hypothesis subject to modification by the variables used in this study? 2. What is the magnitude of the "well established" difference in free recall between pictures and words? 3. What is the magnitude of the gender difference in free recall? 4. What is the rank order proportion of variance (ω^2) accounted for by each of the variables?

Factors studied in relation to free recall were type of stimulus, type of cognitive transformation, and gender. It was thought that the manipulation of those variables might add to the understanding of the human memory process.

Definition of Terms

Certain terms used in this study were identified as needing further clarification. Those terms were defined below.

Cognitive Transformation

Cognitive transformation requires the subject to perceive a stimulus in one form, and mentally transform it into another form. For example, certain subjects were shown simple word labels for familiar objects which they were required to alter cognitively into pictures.

Complex Words

Complex word stimuli consisted of twenty-four 3" X 5" cards containing detailed verbal descriptions of familiar objects.

Free Recall

Free recall was defined as the ability of the subject to reproduce the presented stimuli without support of re-exposure to the material.

Imagery

Imagery was defined as forming a mental image of a stimulus item.

Pictures

Picture stimuli consisted of twenty-four 3" X 5" cards containing drawings of familiar objects.

Simple Words

Simple word stimuli consisted of twenty-four 3" X 5" cards containing brief verbal labels for familiar objects.

Limitations of the Study

The study was limited to volunteer undergraduate students at Emporia State University. From the group of 288 volunteers, subjects were randomly assigned to twelve treatment groups.

The use of college students as subjects in a study of free recall raised the possibility of an uncontrolled variable. Given the nature of his academic work, the student may be more frequently exposed to recall situations than a non-student subject, and therefore, may be more capable of performing well in a test of free recall.

Summary

Considerable evidence has supported the hypothesis that a double-encoding of picture stimuli results in superior free recall of picture stimuli over word stimuli. Apparently, word stimuli evoke only verbal encoding, while picture stimuli evoke both verbal and figural encoding. In addition to mode of presentation (word or picture), other variables shown to affect free recall are manner of stimulus presentation, form of recall, number of times stimuli are presented and recalled, instructions to subjects, delay between presentation and recall, kinds of transformations performed on the stimuli, and to a small extent, subjects' gender.

Chapter 2

REVIEW OF RELATED LITERATURE

This chapter presented a review and summary of literature related to factors affecting free recall. Studies examining the effects on free recall of type of stimulus presented were discussed in the context of the double-encoding hypothesis. In addition, studies exploring effects on free recall of gender of the subjects and transformations performed on the stimuli were examined.

Types of Stimuli and the Double-Encoding Hypothesis

A study conducted by Ducharme and Fraisse (1965) was perhaps the first to reveal the superiority of picture stimuli over word stimuli in recall. Since that time, it has been repeatedly shown that subjects presented with picture stimuli remember significantly more stimulus items than subjects presented with the same stimuli in the form of words (Joseph and Joseph, 1980).

The most widely accepted explanation for the picture superiority has been termed the double-encoding hypothesis (Paivio, 1971), which demonstrated that picture stimuli are coded in both a figural and a verbal manner, while word stimuli are coded only verbally. Kaplan, Kaplan, and Sampson (1968) described the process as follows:

> . . . when a subject views the picture of an object, he tends to think of its name as well; when he views the name of an object, he does not tend to think of the picture or image of the object. This double coding would help explain the superior recall for pictures

(p. 74) . . .

Further elaboration on the hypothesis was provided by Paivio and Csapo (1973):

> The approach distinguishes between nonverbal imagery and verbal symbolic processes, which are assumed to involve independent but partially interconnected systems for encoding, storage, organization, and retrieval of stimulus information. The imagery system is specialized for dealing with nonlinguistic information stored in the form of images, that is, memory representations corresponding to concrete things. The verbal code refers to stored representations corresponding most directly to linguistic units (p. 177).

Empirical support for the Paivio and Csapo position was supplied by Sperry (1968). Sperry studied epileptic patients who had undergone forebrain commissuratomy in hopes of reducing the intensity of epileptic convulsions. On the surface, patients' behaviors gave no indication of cognitive or perceptual effects resulting from the removal of tissues connecting brain lobes. However, Sperry discovered definite effects that were behaviorally camouflaged and compensated for without the patients' awareness. Sperry believed that the human brain possesses a "major lobe" which controls speech and writing, serving as the main language and calculation center, and a "minor lobe" which has little language or calculation ability, and is mostly concerned with nonverbal ideation. More specifically, Sperry (1968) wrote:

> Visual material projected to the right half of the field (left hemisphere system of the typically right handed patient) can be described in speech and writing in an essentially normal manner. However, when the same visual material is projected into the left half of the

> field, and hence the right hemisphere, the subject consistently insists that he did not see anything or that there was only a flash of light on the left side. The subject acts as if he were blind or agnostic for the left half of the visual field. If, however, instead of asking the subject to tell you what he saw, you instruct him to use his left hand to point to a matching picture or object presented among a collection of other pictures or objects, the subject has no trouble as a rule in pointing out consistently the very item that he has just insisted he did not see (p. 725).

The results of Sperry's work, therefore, point to the existence in the brain of separate verbal and figural centers. Further support for that idea was supplied by results of studies in which subjects were presented mixed combinations of word and picture stimuli, and upon recall, were easily able to remember which stimuli were presented in word form, and which were presented in picture form (Madigan, 1974; Kaplan, Kaplan, and Sampson, 1968; Sperry, 1968). Madigan (1974) believed that such ease of discrimination was due to a kind of representational storage in terms of symbolic modality.

Still another study, the authors of which believed lent support to the double-encoding hypothesis, recorded the Galvanic Skin Response readings of subjects being presented word and picture stimuli (Kaplan, Kaplan, and Sampson, 1968). The authors detected different levels of arousal in subjects depending on the type of stimulus (word or picture) presented. Maintaining that under the word stimulus condition, GSR "scores" predicted both word and picture recall, while "picture GSR scores" did not, the authors interpreted these data to indicate that both words and pictures were encoded verbally, but only pictures were encoded both verbally and

visually.

Although the double-encoding hypothesis is the most widely accepted explanation for the superior recall of picture over word stimuli, it is not the only explanation. There are several points of view which oppose or seek to modify the double-encoding hypothesis.

Pictures as a stimulus category is vague and overinclusive, according to Goldstein and Chance (1974), and they suspected that picture superiority was simply an artifact of experimentation because laboratory conditions were biased in favor of picture memory. Goldstein and Chance argued in favor of an interference theory which stated that word stimuli are so common that they are easily lost among the many familiar words the subjects encounter in the course of a day. Picture stimuli, however, are probably new to the subjects, and so, are easier to remember because they are unique. Goldstein and Chance also referred to a partial learning theory which explained that with word stimuli, the subject must recall the entire item (word), but he could manage to correctly recall the more elaborate picture stimulus having remembered only a part of the picture. Remembered parts of the pictures, then, could act as triggers, bringing forth the correct response without the subject necessarily having to remember the whole picture. Rower, Linch, Levin, and Suzuki (1967), Jones (1978), and Peeck, van Dam, and Uhlenbeck (1979) have advanced ideas similar to the partial learning theory.

Physical vividness and the compounding of stimulus elements were the primary variables involved in picture superiority in free recall according to Bousfield, Esterson, and Whitemarsh (1957). The authors found that nouns presented with colored pictures were remembered best, followed by nouns presented with non-colored pictures, which were

followed by nouns presented alone. The more vivid and compound the stimuli, the easier they were to remember, according to the researchers. Paivio, Rogers, and Smythe (1968) performed a similar experiment in which colored and uncolored sets of both pictures and their noun labels were used as stimulus items. They reasoned that if the physical vividness or compounding of stimulus elements affected recall, then recall should be better for colored words as well as colored pictures, compared to their respective uncolored conditions. The authors found that in free recall, subjects actually remembered fewer colored items compared to uncolored items, although the color effect was not statistically significant. As was usually the case, subjects recalled significantly more picture items than word items, and the authors concluded that the picture superiority was due to factors other than physical vividness and compounding of stimuli.

Another alternative explanation for the superior recall of picture stimuli was an image-encoding hypothesis examined by Paivio and Csapo (1969). According to Paivio and Csapo, the image-encoding hypothesis stated that picture recall was superior to word recall simply because images were easier to remember and pictures produced images more readily than did words. Therefore, this simple position denied the necessity of double-encoding in production of superior picture recall. Paivio and Csapo refuted the image-encoding hypothesis by presenting lists of pictures and nouns at a fast rate (5.3 items per second), or a slower rate (2 items per second). The examiners expected the fast rate of presentation to prevent verbal encoding of picture items, while the slower rate was expected to allow verbal encoding of picture items. In free recall, there was no significant difference between the number of word and

picture stimuli remembered when items were presented at the fast speed. A significant difference, however, was found between the number of picture and word stimuli remembered when stimuli were presented at the slow speed. Paivio and Csapo concluded that the double-encoding hypothesis was upheld because speed of presentation should not have affected recall if the image-encoding hypothesis were correct.

Earlier studies of picture and word recall were criticized by Sampson (1970) because subjects in those studies always knew in advance that they would be expected during recall to respond only with the name of the stimulus item, regardless of the form in which it was presented. Sampson examined subjects who were not told that a memory test would be administered, and he tested other subjects who were instructed to remember stimulus items in the forms in which they were presented. He found that the double-encoding hypothesis was upheld whether subjects expected a test or not, and he found that verbal reports of figural items could be used without changing picture over word superiority.

Other studies have apparently confirmed the double-encoding hypothesis, presenting verbal and figural stimuli in many forms. Lieberman and Culpepper (1965) found that objects or photographs of objects were more successfully remembered than their noun labels. Paivio and Csapo (1969) and Wittrock and Goldberg (1970) examined meaningfulness and imagery value of stimulus items as they related to recall. Gunter (1980) compared recall of television news items reported with and without the aid of pictures. Stimulus items were presented auditorily in studies conducted by Joseph and Joseph (1980), Joseph and Cowan (1981), Joseph, Joseph, and Beasley (in press), Joseph, McKay, and Joseph (in press a), and Joseph, McKay, and Joseph (in press b) subjects were instructed to

respond to stimuli in such ways as printing words, drawing pictures, tracing words or pictures, imagining words or pictures, and grouping stimuli.

Gender Differences

A review of literature by Maccoby and Jacklin (1971) indicated that females possess ability superior to males in dealing with verbal material. Joseph, McKay, and Joseph (in press a) found no difference between male and female performance in a free recall task, but the authors suspected that that result may have been due to effects of other factors in the study; therefore, further research into the gender variable was recommended.

A study by Joseph, McKay, and Joseph (in press b) revealed significantly better free recall performance by female subjects than male subjects. Hyde (1981), however, questioned the strength of female superiority in verbal tasks. Although these differences were statistically significant, Hyde believed that analyses of gender difference should be subjected to stength-of-association measures in order to determine the amount of variation which was attributable to the gender-related differences found.

Transformations

The effects on recall of cognitive transformations of word and picture stimuli were explored by Fischler and Puff (1971). Sixteen nouns were presented (as words or as simple drawings) to subjects who either wrote the verbal labels for recalled items or drew simple pictures of the items. This resulted in four combinations of stimulus-recall

conditions: pictures recalled as pictures, pictures recalled as words, words recalled as pictures, and words recalled as words. Results showed no significant difference in ease of recall among the four conditions, suggesting that cognitive transformations had no effect on recall.

The Fischler and Puff (1971) results contradicted the results of a previous study undertaken by Paivio and Foth (1970). Paivio and Foth instructed subjects to think of a word or image to mediate or link together noun pairs. It was found that imagery-type mediators produced better recall of items than did verbal mediators.

A study by Joseph and Joseph (1980) examined the effects on free recall when transformed nouns were presented auditorily. Nouns were presented via tape recording, and subjects were instructed to transform the nouns into printed words, pictures, or mental images. Significantly more items were recalled after having been transformed into pictures, as opposed to items transformed into printed words. As a form of recall, however, drawing pictures was significantly inferior to printing words. Further, there was no significant difference in recall between words, pictures, and a control activity when subjects were instructed to imagine the nouns in printed or drawn conditions, rather than actually printing or drawing the items. The authors concluded that some sort of physical presentation of stimuli may be necessary in order for cognitive transformations to have a significant effect on free recall. These findings were supported by Joseph, McKay, and Joseph (in press a).

It was found by Joseph and Cowan (1981) that the concreteness of the transformations and the form of the presented stimuli were not crucial variables influencing free recall because, ". . . there were no differences if the stimuli were presented visually or auditorily, or whether

subjects imagined, traced, or penciled their responses." That conclusion was reinforced by Joseph, McKay, and Joseph (in press b), and by Joseph, Joseph, and Beasley (in press).

Summary

A review of pertinent literature revealed that in many studies, subjects exposed to picture stimuli performed better in recall tests than subjects exposed to word stimuli. The most widely accepted explanation for this picture stimulus superiority has been termed the double-encoding hypothesis, which states that picture stimuli are coded in both a figural and a verbal manner while word stimuli are coded only verbally. Many studies have lent support to the double-encoding hypothesis, but other theories do exist which challenge the double-encoding notion. These alternative points of view include the interference theory, the image-encoding hypothesis, and the partial learning theory. A position was also discussed which stated that figural superiority was a result of physical vividness of picture stimuli and the compounding of picture stimulus elements.

Literature reviewed showed that females frequently perform significantly better than males in recall activities. Some researchers have, however, questioned how effective the gender variable actually is. Few studies have explored the question, and further examination is in order.

Studies recording the effects on recall of cognitive transformations performed on word and picture stimuli have achieved mixed results. Some studies reported significant differences in recall due to the effects of transformations, while other similar studies have reported no significant differences. Clearly, more research is needed in this area.

This literature review illustrated that there were many areas in the study of human memory which, while not totally neglected, do need further research. This investigation was an attempt to advance the study of human memory in those areas.

Chapter 3

METHODS AND PROCEDURES

The procedures followed in this study have been discussed in this chapter. This chapter included population and sampling, design of the study, materials and instrumentation, procedures, data collection, and methods of data analysis.

Population

Male and female university students enrolled in introductory psychology, social psychology, applied psychology, and developmental psychology classes at Emporia State University were used as subjects. This population was selected due to its availability.

Sample

Volunteers were solicited from the aforementioned psychology classes and were given extra credit points for their participation. The sample of 288 subjects consisted of 102 males and 186 females. The variables of age, race, and academic classification were left uncontrolled.

Design

A 3 X 2 X 2 between-subjects design was used with the dimensions being gender, type of stimulus (pictures, simple words, or complex words), and type of cognitive transformation (describing stimuli in words or imagining stimuli as pictures).

Materials and Instrumentation

The stimuli were pictures and words arranged individually on 3" X 5" cards. The picture stimuli consisted of twenty-four drawings of easily identifiable objects or concepts (see appendix B). For each of the pictures there was also a 3" X 5" card bearing a simple word label. The stimuli in their simple word conditions were: HAT, SHEEP, CAR, GLASS OF WATER, TREE, JUDGE, SNAKE, AIRPLANE, PRISONER, CHAIR, GLOVE, DOLL, CIRCLE, COAT, HAMMER, CARROT, CLOCK, LION, CAR WRECK, BEE, BROKEN ARROW, BABY, MONKEY, BANANAS (see appendix C). A third set of twenty-four 3" X 5" cards bore the stimuli in their complex word conditions (see appendix D). The complex word stimuli included simple word labels and complete verbal descriptions of the pictures. The complex word descriptions were developed by submitting the picture stimuli repeatedly to two undergraduate psychology classes, instructing the students to list in words the attributes of the pictures until there was virtually unanimous agreement that the lists fully described the pictures.

Procedures and Data Collection

Individual testing procedures were used. As the subject arrived at the testing room he was informed that he was taking part in an experiment, but he was not told the nature of the experiment. A general instruction sheet (see appendix E) was given to the subject and he was asked to read the instuctions silently to himself. The examiner then read aloud one of the following sets of specific instructions to the subject:
PICTURE/IMAGINE AS PICTURE: Twenty-four pictures will be presented visually with up to fifteen seconds between each presentation. Your task will be to look at the item presented, then imagine it as a picture.

PICTURE/DESCRIBE IN WORDS: Twenty-four pictures will be presented visually with up to fifteen seconds between each presentation. Your task will be to look at the item presented, then describe the item in words.

SIMPLE WORDS/IMAGINE AS PICTURE: Twenty-four words or phrases will be presented visually with up to fifteen seconds between each presentation. Your task will be to look at the item presented, then imagine it as a picture.

SIMPLE WORDS/SAY ALOUD: Twenty-four words or phases will be presented visually with up to fifteen seconds between each presentation. Your task will be to look at the item presented, then say the word aloud.

COMPLEX WORDS/IMAGINE AS PICTURE: Twenty-four items will be presented visually with up to fifteen seconds between each presentation. Your task will be to look at the item presented, then imagine it as a picture.

COMPLEX WORDS/SAY ALOUD: Twenty-four items will be presented visually with up to fifteen seconds between each presentation. Your task will be to look at the item presented, then say the words aloud.

After the twenty-four items were presented to the subject, he engaged in an interim control activity for two minutes (see appendix F). The subject was given a typed sheet instructing him to "Begin at 300 and write backwards by twos. Continue to do so until you are told to stop."

The subject was then instructed to write on a prepared sheet (see appendix G) as many of the items as he could recall. The recall period lasted five minutes. Following the recall period, the subject was asked to rate on a scale of 1 to 7, his own performance of the required task (see appendix H).

Data Analysis

A three-way between-subjects analysis of variance was used to analyze the data collected. Newman-Keul's test was used to reveal differences between the levels of variables referred to as stimuli. Tukey's test for unconfounded means was used to determine differences between interaction means. A strength-of-association measure (ω^2) was calculated in order to determine how much of the variance was accounted for by the significant results. See appendix I for descriptions of the above statistical tests.

Chapter 4

ANALYSIS OF DATA

The purpose of this chapter was to present the analysis of collected data. This study investigated the effects on free recall of certain mental and imaginary activities. A three-way between-subjects analysis of variance was used to determine any significant differences between experimental groups. See table 1.

Statistical Analysis

The type of stimulus presented to the subjects (pictures, simple words, or complex words) accounted for a significant difference in the number of stimuli recalled $F(2,276) = 26.54$, $p < .01$. The Newman-Keul's test indicated that picture recall (mean = 12.75) was significantly higher ($p < .01$) than the conditions of complex words (mean = 10.94) and simple words (mean = 9.99). There was also a significant difference between complex words and simple words ($p < .05$). A significant gender difference was evident $F(1,276) = 5.77$, $p < .05$ with females (mean = 11.51) recalling more stimuli than males (mean = 10.72). The third factor, type of transformation, also resulted in a significant main effect $F(1,276) = 65.71$, $p < .01$. Imagining the stimuli in the form of a picture (mean = 12.50) resulted in higher recall scores than describing the stimuli in words (mean = 9.95). One significant interaction (Stimuli X Transformation) was evident $F(2,276) = 33.23$, $p < .01$. Tukey's test for unconfounded means was used to determine differences between interaction means. Under the experimental condition in which subjects described the

Table 1

Analysis of Variance Source Table

Source	df	SS	MS	F	
A (Type of Stimulus)	2	377.71	188.86	26.54	*
B (Gender)	1	41.08	41.08	5.77	**
C (Transformation)	1	467.67	467.67	65.71	*
AB (Stimuli X Gender)	2	20.86	10.43	1.47	
AC (Stimuli X Transformations)	2	472.96	236.48	33.23	*
BC (Gender X Transformations)	1	1.82	1.82	.26	
ABC (Stimuli X Gender X Transformations)	2	7.97	3.98	.56	
Total	287	3354.33			

* significant at .01 level

** significant at .05 level

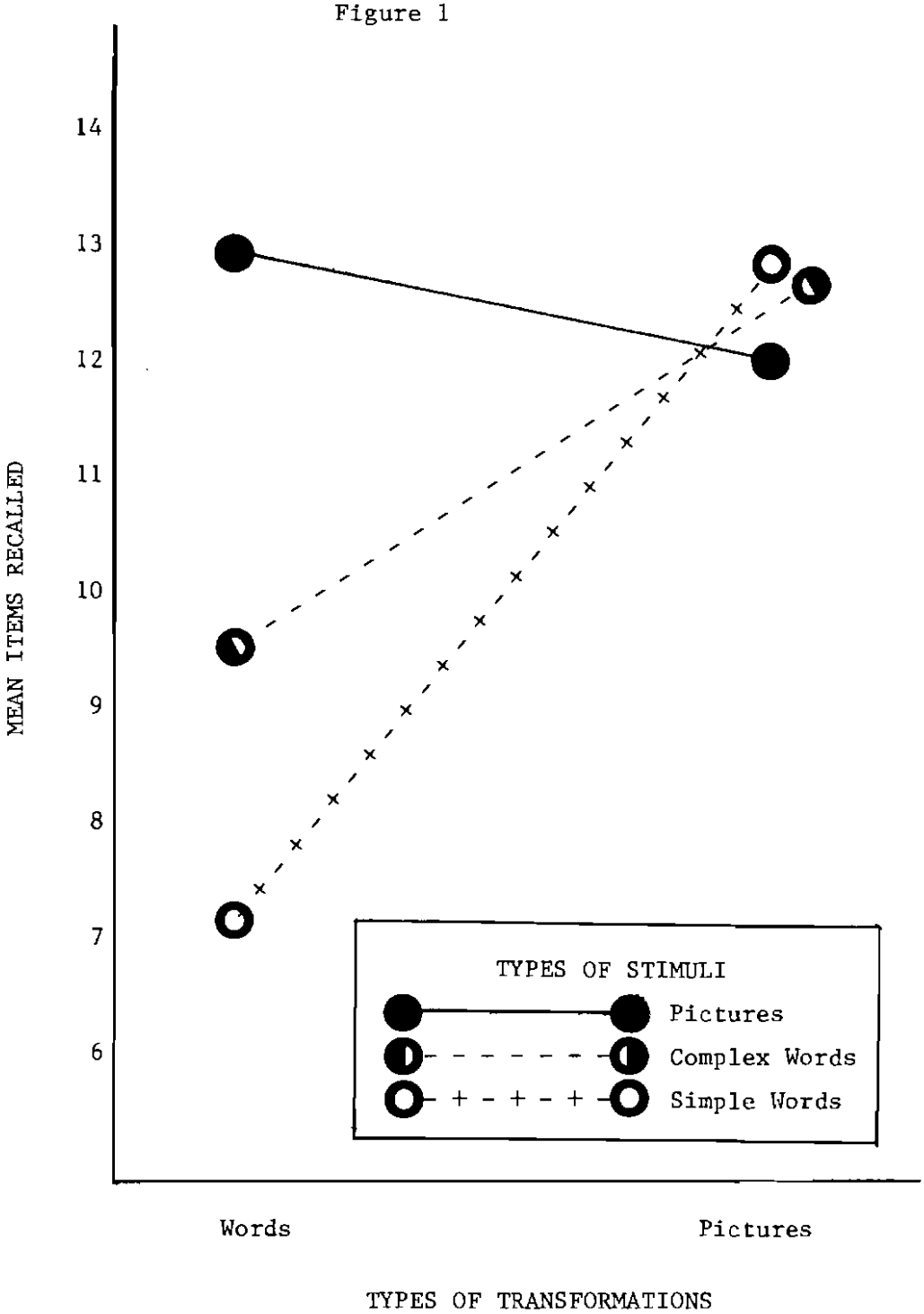
stimuli in words, recall for pictures (mean = 12.97), complex words (mean = 9.51), and simple words (mean = 7.11) were all significantly different from one another ($p < .01$), critical value = 1.79. Under the experimental conditions in which subjects imagined the stimuli as pictures, recall for pictures (mean = 12.26), complex words (mean = 12.36), and simple words (mean = 12.47) were not significantly different from each other ($p > .05$). Picture stimuli when verbally described (mean = 12.97) was not significantly ($p > .05$) different from picture stimuli imagined as pictures (mean = 12.26). Complex word stimulus condition, when items were verbally described (mean = 9.51), was significantly lower ($p < .01$) than when items were imagined in picture form (mean = 12.36). Likewise, simple word stimuli, when verbally described (mean = 7.11), were significantly lower ($p < .01$) than when imagined in picture form (mean = 12.47). See figure 1.

In order to determine how much of the variance the significant results accounted for, a strength-of-association measure (ω^2) was calculated. Stimuli differences accounted for 11% of the population variance; gender differences accounted for 1%; treatment differences and Stimuli X Transformation differences each accounted for 14%.

Summary

As determined by the analysis of variance, all three main effects were found to be statistically significant. A significantly higher number of stimulus items was correctly recalled by subjects who were presented the stimuli in picture form as opposed to complex word form and simple word form. Further, statistically significant superiority of complex word stimuli over simple word stimuli in subjects' recall of

Figure 1


14
13
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MEAN ITEMS RECALLED
TYPES OF STIMULI
Pictures
Complex Words
Simple Words
Words
Pictures
TYPES OF TRANSFORMATIONS

items was shown.

Significantly more stimulus items were recalled by subjects who were instructed to imagine the stimuli as pictures, compared to the subjects who described the items in words. Female subjects recalled more items than male subjects, but the difference in recall attributed to gender, although statistically significant, was quite small.

Significance was found in the Treatment X Stimuli interaction. Significance was not found in the other interactions.

The current data indicate that the type of stimulus (pictures) and the type of transformation (into pictures) are the most potent factors influencing free recall. Gender appears to account for only a small portion of variance.

Chapter 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The problem investigated in this study was: Do various mental and imagery activities affect the number of stimulus items the individual is able to freely recall? The null hypothesis stated that there would be no significant difference in the number of correctly recalled stimulus items as a result of the type of stimulus presented, as a result of the cognitive transformations performed on the stimuli, as a result of the subjects' gender, or as a result of an interaction of the above cited variables. The purpose of this study was to explore the effects on free recall of pictures and various types of word stimuli in conjunction with the variables of gender and type of transformation performed on the stimuli.

It has been found that the type of presented stimulus (word or picture) affects recall. Numerous studies have demonstrated that subjects exposed to stimuli in the form of pictures (drawings colored or uncolored, photographs, or the objects themselves) recall more stimulus items than subjects who were exposed to the same stimuli in word form (Joseph and Joseph, 1980). The subjects in this study were presented stimulus items in the forms of pictures (simple line drawings), simple words (brief labels for each picture), or complex words (detailed verbal descriptions of each picture).

Until recently, it had been accepted that females perform

considerably better than males in verbal tasks (Maccoby and Jacklin, 1974). Hyde (1981) and Joseph, McKay, and Joseph (in press b) doubted that the gender effect was one of great magnitude, and suggested further research in that area. To gather more data on cognitive gender differences, this study compared the free recall performance of male and female subjects.

Concerning the effects of cognitive transformations on recall, cited studies rendered conflicting conclusions (Paivio and Foth, 1970; Fischler and Puff, 1971; Joseph and Joseph, 1980), implying the need for further research. The effects on free recall of cognitive transformations were measured in this study.

The administration of the experiment involved random assignment of subjects to the following experimental groups: picture/imagine as picture, picture/describe in words, simple words/imagine as picture, simple words/describe in words, complex words/imagine as picture, complex words/describe in words. Twenty-four stimulus items were presented visually, followed by a two minute interim activity designed to prevent the subjects from rehearsing the items. Following the interim period, subjects were allowed five minutes in which to write all the items they could recall. The subjects completed the task by subjectively rating their own recall performance on a scale of 1 to 7. The subjects' self-ratings were not, however, used in the data analysis of this study.

A total of 288 subjects participated in the experiment (102 males, 186 females). All subjects were undergraduate psychology students who volunteered to participate in return for extra credit.

A three-way between-subjects analysis of variance was used to analyze the data collected. Newman-Keul's test was used to reveal stimulus

variable differences, and Tukey's test for unconfounded means was used to determine differences between interaction means. A strength-of-association measure (ω^2) was calculated in order to determine how much of the variance was accounted for by the significant results.

A significantly higher number of stimulus items was correctly recalled by subjects who were presented the stimuli in picture form as opposed to complex word form and simple word form. Female subjects recalled significantly more items than did male subjects. Significantly more items were recalled by subjects who were instructed to imagine the stimuli as pictures, compared to subjects who described the items in words. Significance was found in the Stimuli X Transformations interaction, while significance was not found in the other interactions. It is therefore possible to reject the following null hypotheses: There is no significant difference in the number of correctly recalled stimuli as a result of the type of stimulus presented (pictures, simple words, or complex words), as a result of the cognitive transformations performed on the stimuli (imagining as pictures or describing in words), as a result of the gender of the subjects, or as a result of an interaction of the above cited variables.

Conclusions

The mean scores of subjects exposed to picture stimuli were significantly higher than those of subjects exposed to simple word stimuli. These results support the double-encoding hypothesis (Paivio, 1971). As in previous studies (Joseph, McKay, and Joseph, in press a; Joseph, McKay, and Joseph, in press b), there was a statistically significant gender difference found in favor of female subjects in the free recall

of stimulus items. Supporting the results of other studies (Paivio and Foth, 1970; Joseph and Joseph, 1980), this experiment revealed that free recall was significantly facilitated by the transformation of stimuli into picture form.

It was also of interest to determine the relative potency of the independent variables, i. e., what portion of the variance was attributable to each of the significant effects. In agreement with Hyde (1981), it was found that gender only accounted for 1% of the variance, even though statistical significance was found. The type-of-stimulus variable accounted for 11% of the variance, indicating that the strength-of-association between the variable of stimulus form and the dependent variable of free recall was considerably more potent than that of the gender variable. An even more potent strength-of-association (14% of the variance) was attributable to the type of cognitive transformation performed on the stimuli. The Stimuli X Transformations interaction also accounted for 14% of the variance, and it is evident that stimuli presented in picture form or transformed into pictures result in storage processes that enhance memory. The storage processes undoubtedly involve storing information in both brain hemispheres (Sperry, 1968; Wittrock and Goldberg, 1975), which is the basis of the double-encoding hypothesis.

Recommendations

The subjects who participated in this study were students at Emporia State University enrolled in undergraduate psychology courses. The variables of race, nationality, age, and academic classification were not controlled. Further research may involve controlling those

variables.

As was previously indicated, the employment of university students as subjects may have had an effect which should be considered by persons wishing to generalize from the conclusions of this study. Students may be more familiar with recall tasks than are other individuals, and students may be more capable of performing well under such circumstances.

The current data indicated that the type of stimulus (pictures) and the type of transformation (into pictures) were the most important factors influencing free recall. Gender appeared to account for only a small proportion of the variance (ω^2). More studies, however, are needed to replicate the present study, and to explore possible interaction effects of gender, type of recall, various types of stimuli and transformations, and perhaps other factors.

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APPENDICES

APPENDIX A

FACTORIAL DESIGN

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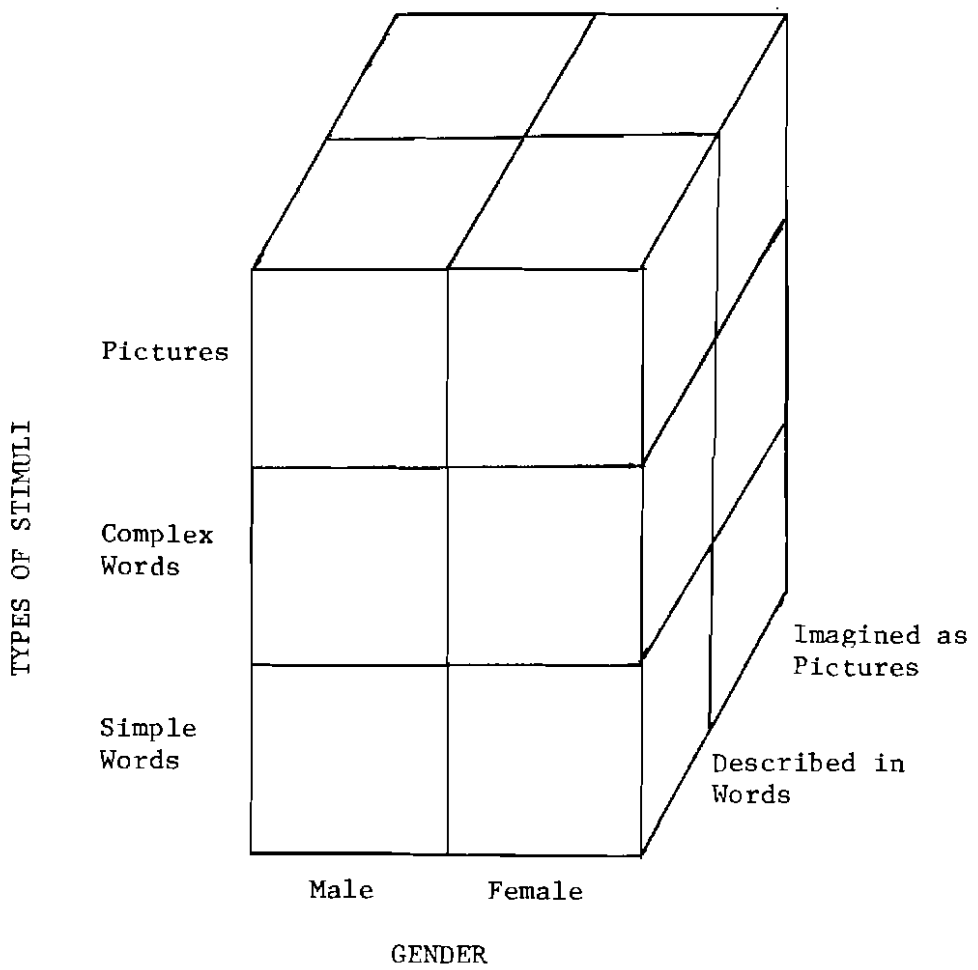
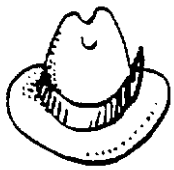


APPENDIX B

PICTURE STIMULI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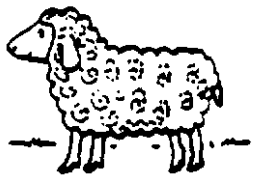
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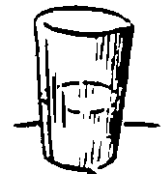
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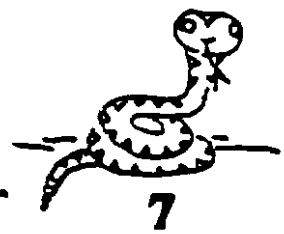
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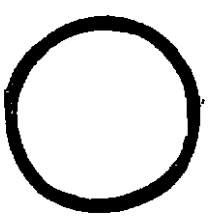
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APPENDIX C

SIMPLE WORD STIMULI

HAT -1-	SHEEP -2-	CAR -3-	GLASS OF WATER -4-
TREE -5-	JUDGE -6-	SNAKE -7-	AIRPLANE -8-
PRISONER -9-	CHAIR -10-	GLOVE -11-	DOLL -12-
CIRCLE -13-	COAT -14-	HAMMER -15-	CARROT -16-
CLOCK -17-	LION -18-	CAR WRECK -19-	BEE -20-
BROKEN ARROW -21-	BABY -22-	MONKEY -23-	BANANAS -24-

APPENDIX D

COMPLEX WORD STIMULI

A HAT Front view-male hat-hat band-feather-groove in top-medium brim. -1-	A SHEEP Standing left side view-wooly body-bare four legs and face-tail-ear eye-nose-mouth-hoofs-background grass. -2-	A CAR Right side view-old model-two side doors with windows showing-fenders half covering the two wheels-front and rear bumpers-right headlight and tail light-patch on rear tire- hood, side of top, and part of front and rear windshields visible. -3-
A GLASS Transparent (clear)-cylinder shaped-larger at open top-approximately half filled-standing on a surface. -4-	A TREE Medium thick trunk-bushy with a lot of leaves-two main branches in a V from the trunk-branches -top of roots visible-on level ground. -5-	A JUDGE Front view-looking to his right-seen from chest up-holding wooden gavel in right hand on surface before him-wearing robe, collar, tie, bowless glasses-stern looking-mouth-nose-ear-hair thin and parted on the left. -6-
A RATTLE SNAKE Front view of head-two eyes-forked tongue out-coiled body on a surface-head erect-dark triangular markings on light background-rattle on tail. -7-	AN AIRPLANE Top view-nose pointed slightly upward to viewer's right-four propeller motors-USAF on right wing-on left wing a circled star-two wings-each side has six windows-front window-rudder-tail has dark line markings. -8-	A MAN IN JAIL Front view-seen from chest up in window-three bars in thick window-wearing hat-grasping bars-stern looking-mouth-nose-eyes-part of hair and left ear visible-unshaven or rough full face-horizontal striped shirt with numbers 1242 on chest. -9-
A CHAIR Front view-facing slightly to the right-wood patterned-solid wooden seat-five spaced slats on the back with a solid board at the top-four legs connected with four rungs. -10-	A GLOVE Top view-fingers pointed slightly upward to viewer's right-left handed-four fingers and thumb-three lengthwise pleats on top-stitching at seams-fur sticking out opening. -11-	A RAG DOLL Standing front view-smiling-shaggy hair-eyes-nose-mouth-dimples-eyebrows-arms hanging-wearing short sleeve blouse with a dress, jumper, or apron on top-legs-horizontally striped stockings-shoes-slip or panty showing on left leg. -12-

A CIRCLE Medium thick, dark circular ring-empty center. -13-	A COAT ON A HANGER Front view-a short coat with wide lapels-one pocket on its right side-two front buttons-strap on sleeve with button-patterned lining-draped on a triangular wire hanger-hanger hook at top with end to viewer's right. -14-	A HAMMER Side view-head pointed slightly down to the viewer's right-claw on the back for nail pulling-front of head circular with flat end for pounding nails-wood patterned handle. -15-
A CARROT Stock slanted upward to viewer's left-stock has bushy leaves at top-root is triangular cone shape, tapering to a point-root pointing right and down-patterned with circular markings. -16-	AN ALARM CLOCK Front view-two bells on top-round face-all numbers marked in position and dots indicate minutes-hands show about eight minutes before two o'clock-two front legs-standing on flat surface. -17-	A LION Right side view-standing high on four legs-head held high-bushy mane-mouth open-eye-ear-nose visible-tail curved and pointed upward-tall grass in background-four paws visible. -18-
AUTOS IN COLLISION Two autos in accident-left side of right car in view-top view of left car-fronts of both cars pushed in and dented-parts strewn around-body to right foreground below right car-tire off left car and below it and water shooting from radiator-door open on right car. -19-	A BEE Top view-head pointed up-two eyes-two veined wings-two antennae-six legs spread out-bands around body-tail stinger-thick rear legs. -20-	A BROKEN ARROW Broken and the front end is shorter than the tail-tail with feathers is pointing upward to the left-arrowhead end pointing steeper than tail upward to the right-lines suggesting impact where arrow is broken. -21-
A BABY Face view-smiling-leaning on pillow-feet pointed downward and to his left-left arm up in a wave-right arm on pillow-wearing a diaper-a little wavy hair on head-hands-eyes-nose-ears-legs-feet-bellybutton-eyebrows-dimpled. -22-	A MONKEY Smiling left side view-flat top head-standing high on four limbs grasping branch-tail pointed upward with end curled toward rear-trees in background-eye-nose-ear visible. -23-	THREE BANANAS Side view-attached together at one end-curved and pointed upward to the right-front one largest-rear smallest-bruise or ripe spots. -24-

APPENDIX E

GENERAL INSTRUCTION SHEET

EMPORIA STATE UNIVERSITY

1 2 3 4 5 6

M F

Student's Name (print)_____

Instructor_____ Section_____

Thank you for participating in this research project. When we have collected and analyzed all the information, we will convey the results to your instructor so that he or she can discuss the project with you. In the meantime, please do not tell your fellow students anything about this study.

APPENDIX F

INTERIM CONTROL ACTIVITY SHEET

Begin at 300 and write backwards by twos. For example 300, 298, 296, etc. Continue until you are told to stop.

APPENDIX G

RECALL SHEET

EMPORIA STATE UNIVERSITY

List as many of the items that were presented on the cards as you can. Continue until you are told to stop.

APPENDIX H

SUBJECT SELF RATING SHEET

Rate how well you were able to recall the items you were presented. Make your rating by marking with an X below.

Very poorly _____:_____:_____:_____:_____:_____:_____: Very well

APPENDIX I

STATISTICAL TEST DESCRIPTIONS

STATISTICAL TEST DESCRIPTIONS

In this study, it was possible to reject the null hypothesis using a three-way between-subjects analysis of variance. Rejecting the null, however, did not always provide precise information concerning differences among the various groups. Furthermore, the test of statistical significance did not measure the strength of relationships between the independent variables and the dependent variable (Linton and Gallo, 1974). Two specific-comparison tests and a strength-of-association measure (ω^2) were therefore used to supplement the findings of the analysis of variance.

Three-Way Between-Subjects Analysis of Variance

The analysis of variance dealt with three independent variables (A, type of stimulus; B, gender; C, type of transformation). This design tested for differences among the levels of A (pictures, simple words, complex words), among the levels of B (male, female), and among the levels of C (described in words, imagined as pictures). Also tested for were interactions between AB, AC, BC, and the interaction among ABC.

Each on of A, B, and C (main effects) were found to have a significant effect on free recall. Concerning the interaction effects, significance was found only in the Stimuli X Transformations interaction (AC). This indicated that stimuli presented in picture form, or transformed into pictures were more easily remembered than items represented only by words (see figure 1).

Newman-Keul's Test

Since the type-of-stimulus variable included three levels (pictures, simple words, complex words), the Newman-Keul's test was used to reveal any significant differences among the three conditions. The results of the Newman-Keul's test showed that picture recall (mean = 12.75) was significantly higher than complex word recall (mean = 10.94), which was significantly higher than simple word recall (mean = 9.99).

Tukey's Test for Unconfounded Means

Tukey's test for unconfounded means allows pairwise comparisons of interaction means (Linton and Gallo, 1974). It was used in this study to determine differences between the above mentioned interactions. It showed that under the experimental condition in which subjects described the stimuli in words, recall for pictures, simple words, and complex words were all significantly different from each other. There was no significant difference in recall between pictures, simple words, and complex words when stimuli were imagined as pictures. Recall of pictures imagined as pictures was not significantly different from recall of pictures described as words; recall of simple words verbally described was significantly lower than that of simple words imagined as pictures. Recall of complex word stimuli verbally described was significantly lower than complex word stimuli imagined as pictures.

Strength of Association Measure (ω^2)

The analysis of variance did not measure the relative strength of the relationship between the independent variables (stimuli, gender, transformations) and the dependent variable (free recall). It is

possible that, although a relationship between variables is statistically significant, the relationship may be so small as to have no practical significance (Linton and Gallo, 1974). In the present investigation, authors were cited (Hyde, 1981; Joseph, McKay, and Joseph, in press b) who doubted the strength of the statistically significant superiority of females over males in verbal tasks (Maccoby and Jacklin, 1974). It was considered appropriate in this study, therefore, to calculate a strength-of-association measure (ω^2) to evaluate the relative potency of the independent variables.

It was found that transformations performed on the stimuli accounted for 14% of the variance in the dependent variable (free recall). The Stimuli X Transformations interaction also accounted for 14% of the variance, while the type of stimulus presented accounted for 11%. Gender of the subjects was responsible for only 1% of the variance. Linton and Gallo (1974) implied that an effect which accounts for less than 10% of variance, although it may be statistically significant, should not be considered significant from a practical standpoint.