

RECOGNITION MEMORY FOR VERBAL AND NONVERBAL ITEMS:

AN INVESTIGATION OF EXPERIMENTAL PROCEDURES

by

JESSIE CHI-HAY WONG

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Supervisor: Dr. Richard B. May

ABSTRACT

One scaling study and three memory experiments were carried out with verbal and nonverbal stimulus items. A total of 124 students participated in this series of studies. In Experiment I, 60 students scaled line drawings, checkerboard patterns (black-white matrices), and pseudowords along the parameters of imagery (I) and meaningfulness (m). This was done to match verbal and nonverbal items on these parameters. Thirty-six items with homogeneous ratings within each set were selected for Experiments II, III, and IV.

In Experiment II, selected items and matched real words from Paivio, Yuille, and Madigan (1968) were used in a test of recognition memory. Thirty-two subjects were presented items for 500 msec each with 4500 msec between items, and were tested with a forced choice retrieval task. Items with high *I* and *m* ratings (real words and line drawings) were recognized better than low rated items (pseudowords and checkerboard patterns). There were no significant differences in recognition performance between verbal and nonverbal items within either the high or low rated categories.

Experiment III compared performance for real words and line drawings at a faster rate of presentation, with 250 msec exposure and 1550 msec interstimulus interval. Recognition scores of 16 subjects were significantly lower than in Experiment II, but there was still no reliable difference between recognition of words and drawings.

Experiment IV presented words and drawings at the fast rate used in Experiment III but retention was tested with a single-item, yes/no retrieval task. Recognition memory tested by a yes/no retrieval task was significantly inferior to that tested by a forced choice procedure, but still no difference was found between recognition of words and drawings.

Overall, this study raises serious questions about procedures used in previous experiments of verbal/nonverbal memory, which may have confounding effects in results reported.

Examining Committee:

Richard B May

C. Green

X9 Liles

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CHAPTER I

INTRODUCTION

The existence of mental images in the process of learning and memory has been one of the most controversial topics in the history of psychology. The theories in mental imagery appeared primarily in two forms: first, imagery was the prototype of stimulus trace theories, as manifested in the "wax tablet" model of memory (Gomulicki, 1953) and second, associative imagery (Yates, 1966) was assumed to play a mediational role in mnemonic techniques. It is precisely these views that were rejected by behaviorists, and primarily by Watson (1913), partly on different philosophical grounds and partly on the evidence provided by research which concluded that images are "mere ghosts," unobservable and unmeasurable. Therefore, their existence should not be presumed. Until very recently, this emphasis on "observables" dominated research on problems of meaning and mediational processes in learning and memory. As an echo to Watson's original objections, concepts such as association value (Glaze, 1928) and meaningfulness (Noble, 1952) appeared in consistency with the contemporary theories, such as the theory of associative probability (Underwood & Schulz, 1960) and the "grapnel" theory proposed by Glanzer (1962). "The possibility that nonverbal imagery may be functionally involved was generally ignored" (Paivio, 1970, p. 4). In a way, the avoidance of mental imagery in the study of mediation processes contributed to an upsurge of research in the area of verbal behavior, since the verbal units, i.e., words, are observables, thus can be easily

measured and manipulated. Deese (1965) summarized the current view of experimental psychologists as follows:

The modern experimental psychologist works almost exclusively with linguistic associations for the good reason that these provide controllable material for his laboratory studies; he ignores the extra existence of perceptual imagery. . . . Without necessarily denying either their reality or their importance, the contemporary psychologist finds images difficult to manage in empirical study. Partly for this reason and partly for others, association theory in modern psychology has become a theory of the succession of elements in verbal behavior (p. 4).

In recent years, the grim outlook for imagery has changed. Firstly, the negative attitude projected by Watson has softened; secondly, theorists, such as Osgood (1961) and Staats (1961), in their dissatisfaction with traditional behavioristic approaches to verbal learning, argued in favor of nonverbal mediational processes; finally, active research revealed evidence that there is a possible role for imagery in mediational processes (e.g., Bower, 1967; Paivio, 1965; Smith & Noble, 1966). Paivio (1975) called this change, this renewal of an old interest, Neomentatism.

With the revival of interest in the investigation of inner, mediational, and coding processes in human learning and human memory, it appears inevitable that this interest should extend itself to both verbal and nonverbal memory processes. Further studies in memory coding processes are needed to investigate how stimulus materials (verbal or nonverbal) are being coded in our memory system(s), and how these codes are decoded when retrieval of processed information is required. This thesis was designed to compare recognition performance of verbal and nonverbal stimulus material under different experimental

conditions: namely, varying presentation rates; and different retrieval tasks. Recognition is defined as the process of identifying the stimuli as having been previously presented under certain circumstances. The major question in this thesis: Is superior recognition memory of nonverbal stimuli over verbal stimuli a true finding, or is it an artifact of experimental procedures?

The two factors of primary interest were: (a) differences in imagery and meaningfulness across stimuli, and (b) verbal-nonverbal differences. There is a need for the re-investigation of differences in verbal and nonverbal recognition performances while maintaining control of factors such as imagery and meaningfulness, presentation rates, and retrieval tasks.

The two major contributions of this study were the attempt to match verbal and nonverbal stimulus material on the common grounds of imagery and meaningfulness through a scaling procedure; and the evaluation of recognition performance for both verbal and nonverbal stimulus material under different experimental conditions. Some conclusions about verbal and nonverbal recognition memory which have previously been reported, and a review of these findings will bring the present study into its proper perspective.

Three Factors Affecting Verbal and Nonverbal Recognition Memory

Paivio (1975) stated that there are three general classes of operations, "the attributes of stimulus material, various experimental manipulations, and individual differences variables. Each of these can

be used systematically to increase the probability that a particular kind of mental process will be involved in a given task" (p. 270). This study investigated three major factors affecting verbal and nonverbal recognition memory: (1) verbal-nonverbal mode of stimulus difference, (2) presentation rates, and (3) retrieval tasks.

In an early study, Strong (1912) presented 150 full-page advertisements to subjects at a rate of one per second. These advertisements were then mixed with 150 other advertisements which served as distractors to make a series of 300 items. The subjects were given a multiple choice retrieval task. Their task was to separate the stimuli into different piles depending on whether they seemed familiar or not. The subjects correctly recognized 52% of the original set as familiar, while recognizing 87% of the new stimuli as unfamiliar.

Shepard (1967) conducted a recognition memory study using pictures, words and sentences. He selected 612 pictures which were individually of "high salience and memorability" from a larger population, 540 English words (270 were common words and 270 were rare words), and approximately 600 sentences. The stimuli were inspected at the subjects' own pace, at an average inspection time of 5.9 seconds per item. The subjects were then tested for recognition memory using a test series of "old" stimuli paired with "new" stimuli not previously exposed to them. The results showed remarkably high recognition memory for all stimulus types, but pictures had the highest percentage correct. The medians of the percentage correct on the immediate test were: 98.5% for pictures, 90.0% for words, and 88.2% for sentences. Picture recognition memory was also tested in varying intervals up to 120 days. Performance

declined over the time period, but even after one week, picture memory was similar to that found for verbal material with no delay.

In a study designed to explore the vast memory for pictures, Standing, Conezio and Haber (1970) presented 2560 photographic stimuli to subjects and found evidence for an extended capacity of picture recognition memory. These stimuli were presented over a period of 2 or 4 days at a rate of 10 seconds per item. This was followed by forced choice test trials 60 minutes after the presentation of the last learning series. They found a 90.5% retention (i.e., over 2000 items were recognized) of information even after a time lag of 3 days. They concluded that "since high performance was maintained on both colored and black-and-white pictures . . . and for both magazine photographs, and snapshots, it is clear that the phenomenon under study is robust and does not require a set of special conditions" (p. 74).

The definitive study on the capacity of picture recognition memory for different types of stimuli was performed by Standing (1973). In this study, 10,000 pictorial slides were presented at a rate of 2000 per day, and 5 seconds per item. Immediately following the presentation of all the items on the fifth day, the subjects were tested on their recognition memory. A test series, consisting of 160 pairs of items, were given. The overall performance was 87% correct. In a separate experiment of the same study, Standing compared recognition performance for pictures, visually presented words, auditory words, visual nonsense syllables, and 12-second music segments. The stimuli were presented in sets of 200 at 5 seconds per item. Subjects were then given a forced choice recognition test. The results were: 94% for pictures, 84% for

visual words, 62% for nonsense syllables, and 82% for music segments. Standing concluded that when pictures are compared to words, "picture superiority appears to be a robust phenomenon, this is found under a wide variety of experimental tasks" (Standing, 1973, p. 219).

In view of the impressive array of evidence, Paivio (1970) attempted to explain the superiority of picture memory in terms of his dual coding hypothesis. He stated that recognition memory is a direct function of stimulus concreteness: "Recognition increases from abstract to concrete words, to pictures" (Paivio, 1970, p. 184). Pictures, if familiar and easily named objects, would readily evoke both a nonverbal image and a verbal code. "The availability of the verbal code is lower because an extra transformation is involved. . . . The verbal code would even be less available if the pictures are unfamiliar or ambiguous" (Paivio, 1970, p. 179). The verbal code is readily available in the case of concrete words and abstract words, but the concrete words are more likely to evoke images. Paivio concluded as follows:

Image coding of pictures and verbal coding of printed words have the highest probability; verbal coding of pictures second; imaging to concrete words, third; and imaging to abstract words fourth. The summative availability of both codes is accordingly highest for pictures, next for concrete words, and lowest for abstract words (Paivio & Csapo, 1973, p. 178).

The assumption that pictorial recognition memory is superior to verbal recognition memory has been widely accepted as an empirical fact, and research has proceeded on this assumption, despite the fact that verbal and nonverbal stimuli were not matched on some common grounds. Goldstein and Chance (1974) realized this problem and were very quick to point out that "picture" as a stimulus category is often found to be

vague, undefined, and ambiguous. No one seems to know what a "picture" is. Are all nonverbal stimuli pictures? If not, how can anyone differentiate among them? How do we quantify these differences? Goldstein and Chance (1974) have criticized studies by Shepard (1967), Standing, Conezio and Haber (1970), and Standing (1973) that have used methods of choosing stimuli which were biased in favor of high pictorial recognition memory. The results of these studies may be only an artifact of the stimulus selection procedure and were not actually an index of picture and word recognition memory.

To support their argument that "recognition of visual stimuli must be dependent, in part, on the particular stimuli employed" (Goldstein & Chance, 1970, p. 239), Goldstein and Chance (1970) selected three sets of highly homogeneous picture stimuli (female faces, inkblots, and snow crystals) in a recognition memory study. Subjects were presented with 14 target items and then asked to identify the target items from a total series of 84 slides in a single item, yes/no retrieval task. They found that recognition rates were 46% for inkblots, 33% for snow crystals, and 71% for female faces. These results suggested that "within homogeneous, as opposed to heterogeneous arrays of stimuli, recognition of pictorial stimuli is by no means clearly superior to recognition of non-pictorial stimuli" (p. 239). In other words, if generalization about picture superiority were to be made, they may have to be fairly narrow.

Koen (Note 1) investigated recognition memory for complex visual stimuli while varying systematically the effects of association value and realistic-abstractness dimension. The stimuli were 12 reproductions of realistic paintings (represented real world objects), 6 of which were

scaled to have high association values and 6 low association values; and 12 abstract pictures, also divided into high and low association groups. He presented these stimuli to two groups of subjects (one group was shown realistic paintings and the other group, abstract paintings) at .5 second exposure, and then the subjects were asked to identify the 12 paintings among an array of 60 similar paintings. The overall effects of both the realistic-abstract dimension and association value were significant. The realistic paintings were recognized more accurately than abstract paintings; and pictures with high association values were more easily recognized than those with low association values. A further analysis revealed a significant difference between high and low association values of the abstract paintings but not with the realistic paintings. Koen concluded that the imaginal mediators are more basic and more independent than the verbal mediators. His results were in agreement with Goldstein and Chance's (1974) argument that recognition memory does vary depending upon what kind of stimuli were being presented.

The second factor to be investigated in this thesis is presentation rates. Presentation rates (exposure time plus interstimulus interval) have often been found to be a factor affecting both the perception and organization of incoming information, and subsequently influence recognition performance. The accuracy of picture recognition is dependent, to a certain degree, on the amount of time allowed for the processing of pictorial stimuli. Potter and Levy (1969) presented 16 unrelated pictures in an uninterrupted sequence, at rates of .5, 1, 2, 3, 4, 6, or 8 per second (i.e., exposure times of 2000, 1000, 500, 333, 250, 167, and 125 msec). They found recognition performance had a direct positive

correlation with exposure duration. The shorter the exposure time, the lower the overall probability of making a correct recognition. Memory improved with more time per picture: With 333 msec per picture, 42% were remembered, 500 msec, 62%, and 92% at 2 seconds per picture (Potter, 1976).

Shaffer and Shiffron (1972) presented 120 heterogeneous black-and-white and colored slides to subjects at rates of 200, 500, 1000, 2000, and 4000 msec. These exposure times were factorially combined with three levels of interstimulus intervals: 1, 2, and 4 seconds. During recognition, subjects viewed 60 targets and 60 distractors in a random sequence and were asked to indicate their confidence about whether or not they had seen a slide during the learning period. The confidence ratings were performed on a 6-point scale, where six indicated that the slide had "certainly been seen before" and one meant that the slide had "certainly not been seen before." A mean confidence rating for all slides was 4.95. Shaffer and Shiffron (1972) stated that the confidence ratings of recognition were affected only by exposure duration and not by the amount of blank time (interstimulus interval) between slides. They did not report recognition rates for the various presentation durations, so no direct comparisons with other studies were possible.

Tversky and Sherman (1975) further examined the effects of exposure durations and interstimulus interval (which they termed "on" and "off" times) in a recall test and a discrimination test. Their results showed both recognition and recall for pictures were improved by the increase in exposure duration and interstimulus intervals. This implied that the processing of a picture would continue even after the offset of

the item but prior to the onset of the next item.

In a study of effects of exposure duration and mask delays in picture recognition, Hulme and Merikle (1975) presented the pictures at rates ranging from 50 to 550 msec and mask delays from 0 to 500 msec. They found that:

For exposure durations of 300 msec and longer, recognition memory was primarily determined by exposure duration, and mask delay had no significant effect. For exposure duration of less than 300 msec, post-exposure processing continued up to 250 msec following the offset of a target picture and recognition accuracy was a function of total processing time: the total time separating target and mask onsets (p. 31).

Paivio (1970) in his discussion of the dual-coding hypothesis, stated that the superiority of picture memory over verbal memory can be attributed to the potency of the imagery variable. The potency of the imagery variable cannot be accurately detected when investigations of information processing emphasize the importance of the availability of both verbal and imagery memory codes for storing information. In a study designed to explore the availability of the imagery code, Paivio and Csapo (1969) manipulated presentation rate as a variable to control the availability of imagery codes. They presented pictures and words at either a fast rate (exposure time = 62.5 msec, interstimulus interval = 125 msec) or a slow rate (exposure time = 62.5 msec, interstimulus interval = 500 msec) to affect the relative availability of visual and verbal codes. They found that the slow rate was sufficient to allow activation of both codes, while the fast rate prevented the activation of verbal codes in pictorial stimuli and visual codes in concrete words. At the fast rate, the words and the pictures yielded similar recognition performance, while at the slow rate, the recognition performance for

pictures was found to be superior to that of words.

The third factor of interest is type of retrieval task. Kintsch (1968) and Underwood (1972) observed that verbal recognition performance tends to decrease as the numbers of distractors presented with a single target item increase. Franken and Rowland (Note 2) outlined the problem of the recognition paradigm: "if the accuracy scores are to be used as an index of the number of pictures that have been stored, it must be assumed that the distractor picture conveys no information as to the newness of the picture" (p. 2). In other words, in order to obtain scores which accurately measure recognition memory, the subjects should only be able to recognize the "oldness" of the target items and not the "newness" of the distractors. Although it has been reported that the problem of varying retrieval methods may affect the outcome of an experiment, little has been done to investigate recognition memory as a function of the type of retrieval task and type of stimuli used.

May and Adamowicz (Note 3) used three types of retrieval methods: an absolute test with a series of single items (yes/no) procedure, forced choice procedure, and a multiple choice procedure to collect data for verbal (words) and nonverbal (checkerboard patterns, black-and-white matrices) recognition memory. Their results in varying retrieval methods were: for single item, yes/no procedure, 83.01% for words and 61.72% for checkerboard patterns; for forced choice procedure, 94.5% for words and 65.62% for checkerboard patterns; for the multiple choice procedure, 74.42% for words and 52.54% for checkerboard patterns. They concluded that recognition scores not only differed as the type of stimulus used changed, they also varied significantly when different

retrieval tasks were used.

Table 1 summarizes the results reported by a set of studies in the area of verbal and nonverbal recognition memory. Factors such as the type of stimulus used, exposure duration (presentation rates), and the retrieval tasks, varied from study to study. The mean recognition performance for heterogeneous pictures, homogeneous pictures, words, and nonsense syllables are: 82%, 51%, 86%, and 62% respectively. When the presentation rates differ, recognition performance for 10 seconds was 90%; 6 seconds, 91%; 5 seconds, 87%; 3 seconds, 50%; and 500 msec, 52%. The mean performance for each of the retrieval tasks also varied: 52.60% for multiple choice method, 61.20% for single item, yes/no procedure, and 88% for forced choice procedure. The results reported in these studies were so confounded by the different experimental procedures used, that made comparisons between them difficult. The question is: How do we know which is the main factor facilitating or inhibiting recognition memory? It could be any one of the three factors discussed above. It is the primary concern of this thesis to isolate some of the various factors affecting recognition memory, in such a way that the three effects can be systematically observed.

In this thesis, four studies were carried out:

1. Investigation of the attributes of both verbal and nonverbal stimulus materials: The major interest was to scale three sets of stimuli, namely, pseudowords, checkerboard patterns and line drawings, along the parameters of imagery and meaningfulness. The purpose of this experiment was to enable the author to match verbal and nonverbal material according to their imagery and meaningfulness values, in order

TABLE 1

Summary of Studies in Verbal and Nonverbal Recognition Memory

Study	Type of Stimuli	Exposure Time	Retrieval Tasks	% Correct
Strong (1912)	Full page advertisement	1 sec	Multiple choice	53
Nickerson (1965)	Black-and-white photos	5 sec	Yes/no	95
Shepard (1967)	Words	6 sec	Forced choice	88
	Sentences	6 sec	Forced choice	89
	Pictures	6 sec	Forced choice	97
Koen (note 2)	High meaning abstract pictures	500 msec	Multiple choice	48
	Low meaning abstract pictures	500 msec	Multiple choice	34
	High meaning realistic pictures	500 msec	Multiple choice	68
	Low meaning realistic pictures	500 msec	Multiple choice	60
Standing, Conezio, & Haber (1970)	Pictures	10 sec	Forced choice	90
Goldstein & Chance (1970)	Female faces	2-3 sec	Yes/no	71
	Snow flakes	2-3 sec	Yes/no	33
	Inkblots	2-3 sec	Yes/no	46
Standing (1973)	Vivid pictures	5 sec	Forced choice	98
	Normal pictures	5 sec	Forced choice	95
	Common words	5 sec	Forced choice	85
	Nonsense syllables	5 sec	Forced choice	62
Porteous (Note 4)	Abstract pictures	5 sec	Forced choice	82
	Representational pictures	5 sec	Forced choice	97
	Short descriptions	5 sec	Forced choice	95

Table 1 (continued)

Study	Type of Stimuli	Exposure Time	Retrieval Tasks	% Correct
Porteous (contd.)	Variable length words	5 sec	Forced choice	98
	Fixed length words	5 sec	Forced choice	86
Potter & Levy (1969)	Pictures	125 msec	Yes/no	11
		333 msec	Yes/no	42
		500 msec	Yes/no	62
		2000 msec	Yes/no	90
May & Adamowicz (Note 4)	Words	2 sec	Forced choice	94.53
			Yes/no	83.01
			Multiple choice	74.42
	Checkerboard patterns	2 sec	Forced choice	65.62
			Yes/no	61.72
			Multiple choice	52.54

to produce three homogeneous sets of material for the following experiments. A fourth set of items, i.e., common words, was selected from the pool of words provided by Paivio, Yuille, and Madigan (1968) according to their imagery and meaningfulness values. These sets of stimuli were used as stimuli in the following three experiments.

2. Replication of studies in verbal and nonverbal recognition memory (e.g., Shepard, 1967): Experiment II presented the four sets of stimuli provided by Experiment I at a slow rate of 5 seconds from onset to onset, and 500 msec exposure duration. The subject's performance was measured by the response obtained by a forced choice retrieval task.

3. Effects of presentation rates: Experiment III presented two sets of items, i.e., common words and line drawings, to subjects at a fast rate of 250 msec exposure time and 1800 msec from onset to onset. The subjects were also tested by a forced choice procedure.

4. Effects of retrieval tasks on recognition performance: Experiment IV presented also common words and line drawings at the fast rate used in Experiment III, but the subjects were tested by a single item, yes/no retrieval task.

Haber (1970) stated that memory "depends on whether what we see is pictorial (scenes, photographs and so forth) or linguistic (words, numbers, and so on). Experiments indicate that the linguistic memory is different from the pictorial" (p. 104). Before each of the confounding factors are controlled, this statement may be in doubt. When these factors are isolated and controlled, we might find that there is primarily one memory mechanism processing both verbal and nonverbal information instead of the two memory processes suggested by Haber.

CHAPTER II

EXPERIMENT I: INVESTIGATION OF STIMULUS ATTRIBUTES

Numerous studies in the area of verbal learning and verbal behavior were concerned with the effects of various attributes of words in relation to verbal memory. They have investigated the effects of word frequency (e.g., Bousfield, Cohen, & Whitmarsh, 1958; Hall, 1954; Mandler & Campbell, 1957; Thorndike & Lorge, 1944), abstractness and concreteness (e.g., Kusyszyn & Paivio, 1966; Paivio, 1963, 1965, 1966, 1967; Paivio & Madigan, 1968; Spreen & Schulz, 1966), imagery (Paivio, 1967, 1971; Paivio & Csapo, 1973), and meaningfulness (e.g., Glaze, 1928; Noble, 1952; Paivio, 1968; Spreen & Schulz, 1966) in the process of memory storage and retrieval. In view of the ever accumulating research in this area and the emergence of "a need for normative data on the relevant attributes of a greater number of stimulus words (nouns)" (Paivio, Yuille, & Madigan, 1968, p. 1), nonsense syllables, and CCC trigrams, Glaze (1928), Krueger (1934), and Witmer (1935) scaled the value of meaningfulness of CVC trigrams and CCC trigrams; Thorndike and Lorge (1944) performed a normative frequency count; Paivio, Yuille, and Madigan (1968) scaled 925 nouns on the parameters of concreteness, imagery and associative meaningfulness.

If future research in the area of human learning and cognition could be restricted in the realm of verbal stimuli, then the various scaling studies of verbal material performed through the years would be sufficient to present a good indication of the nature of the stimulus

material for a particular method of scaling. Nevertheless, this is not the case. In recent years, many studies investigated not only verbal memory but nonverbal memory as well. A classical experiment was performed by Shepard (1967). He found a remarkably high recognition memory for the three types of stimuli used (pictures, words and sentences), but the pictures had the highest percentage correct (98.3%). Similar conclusions were reported by Standing, Conezio, and Haber (1970), Standing (1973), Snodgrass and McClure (1975), and others. In view of the evidence provided by these studies, some generalizations can be made: Recognition memory seems to increase from abstract words to concrete words, and to pictures, "in increasing order of concreteness" (Paivio, 1969, p. 243).

As the number of studies in nonverbal memory increases, and conclusions such as those discussed were made, we found ourselves in the same situation that Thorndike and Lorge (1944), Noble (1952), Krueger (1934), and Paivio, Yuille, and Madigan (1968) were in some years ago. The need for normative data for nonverbal stimuli becomes more and more urgent. This need became more obvious when researchers tried to compare verbal and nonverbal memory, because the stimulus materials used in their studies come from two very different populations. The verbal stimulus materials are usually carefully selected from a population of scaled verbal stimulus material, thus the various properties of the stimulus used can be controlled. By using this stimulus selection procedure, the investigator could be assured of a homogeneous, well-controlled set of stimuli. However, in nonverbal memory studies, the pictorial stimuli were often randomly drawn from a pool of stimuli

consisting of photographs, magazines, slides or advertisements.

"Picture" as a stimulus category is undefined, vague, and inconclusive.

It has been found that "recognition memory capacity varies from poor to excellent depending on the 'pictures'" (Goldstein & Chance, 1974, p. 69).

This statement was supported by data reported by Goldstein and Chance (1970) and Koen (Note 2).

Goldstein and Chance (1974) discussed the stimulus selection procedure for nonverbal stimuli and stated that there are two major problems generated by this kind of selection procedure. The first problem is

Control of the independent variable in picture recognition memory studies is far less rigorous than found in verbal recognition memory research. Whereas stimulus attributes of verbal material have been described and classified and are routinely employed by researchers in the selection of stimuli presented to subjects in verbal recognition memory investigations, no comparable statement can be made for pictorial material. In other words, picture stimuli may vary along several unknown and uncontrolled dimensions (Goldstein & Chance, 1974, p. 73).

The second major problem encountered in selecting pictorial stimulus material is that "a picture and a word in a recognition study are different from each other in a way which makes them unequal competitors . . . because they are members of two populations of stimuli which differ in their ecological occurrence" (Goldstein & Chance, 1974, p. 73).

As the number of studies in nonverbal memory increases, the two problems outlined by Goldstein and Chance (1974) become more and more important, and the necessity for the development of a set of scaled nonverbal stimuli becomes essential. In order to minimize confounding variables in future research, and at the same time develop an initial

understanding of the nature and properties of both verbal and nonverbal stimuli, Experiment I scaled three sets of stimuli, in accordance to the parameters of imagery and associative meaningfulness used by Paivio, Yuille, and Madigan (1968): (1) simple line drawings drawn from a population of similar drawings found in a children's reading readiness test (Evanechko, Downing, & Braun, 1973); (2) black-and-white checkerboard patterns drawn from a population of patterns generated by Adamowicz (1976); (3) pseudowords composed of consonants in sequences generated by random number tables. It should be noted that these stimuli by no means exhaust the population of possible stimulus materials, but were used to satisfy three main purposes: (1) to generate a set of nonverbal stimuli which can be equated to a set of verbal stimuli in their imagery and meaningfulness value; (2) to develop a usable scaling technique for various types of verbal and nonverbal stimuli for future investigation; (3) to provide a basic understanding of the properties of nonverbal stimuli.

Method

Items. A total of 156 stimulus items were chosen to constitute the sample of stimulus material to be scaled. Of these, 52 items were pseudowords (strings of consonants), generated by random number tables. These pseudowords were 5, 6, or 7 letters in length (similar to the length of real words), and were expected to be of low frequency, imagery, and meaning. Another 52 items were line drawings, drawn from a sample in a children's reading readiness test (Evanechko, Downing, & Braun, 1973). These were expected to be of high frequency, imagery, and meaning.

The remaining 52 items were black-and-white checkerboard patterns (4x4 matrices with eight black and eight white squares randomly determined) selected from a pool of items used by Adamowicz (1976). These were expected to be of low frequency, imagery, and meaning. Figure 1 presents a sample of the stimulus materials in this experiment.

Ratings of imagery. Ratings of imagery were obtained following the general procedure used by Paivio, Yuille, and Madigan (1968). The subjects rated the individual items at their own pace along a 7-point scale, ranging from low imagery (1) to high imagery (7). The instructions for the rating of line drawings, checkerboard patterns, and pseudowords were identical and are presented in Appendix A. Three types of response booklets were made, with one type of stimuli for each booklet. The items in each booklet were randomly arranged before being given to subjects.

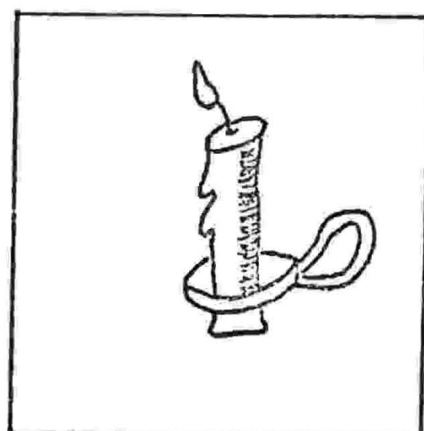
Each booklet page (8" x 5½") consisted of one stimulus item in a 2" x 2" square and the scale was printed at the back of the page. The subjects were instructed to: (a) study the item, (b) turn the page whenever they wished, (c) count backwards from 100 to 50 by tens, and (d) rate the item. This procedure was used to prevent the subjects from spending too much time studying each item before scaling it. There were a total of 52 pages of items per booklet.

Rating of meaningfulness. As this study is more or less a replication of the study by Paivio, Yuille, and Madigan (1968), with different stimulus material, the production method (Noble, 1952) was used for obtaining ratings of meaningfulness. The same 156 items which were rated for imagery were again rated and were randomly arranged into

Pseudoword

XMZFLV

Line Drawing



Checkerboard
Pattern

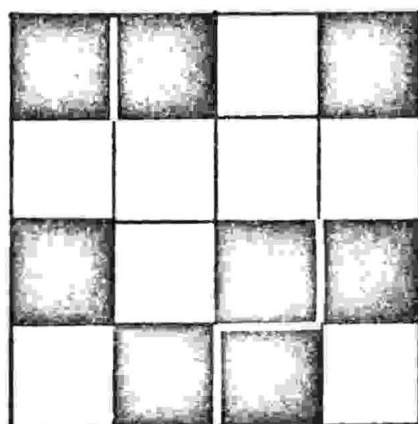


FIGURE 1. Sample of items scaled in Experiment I.

booklets of 52 pages each. The first page contained the mimeographed instruction (presented in Appendix A) and was read aloud by the experimenter. The booklets for rating pseudowords had one pseudoword appearing on each page, repeated 16 times on the page. The booklets for rating line drawings and checkerboard patterns had one item appearing at the top of the page, in a 2" x 2" square, and the 16 blanks appearing below it. The subjects were instructed to write down as many associations as they could in 30 seconds for each item, and to work on the next item when they heard the signal.

Subjects. The subjects were 60 university students between the ages of 20 and 51, who had volunteered to participate in this experiment. Their mean age was 29. The subjects were not paid and had not previously participated in a scaling experiment. Subjects were randomly assigned to 6 groups, with 10 subjects per group. Three groups were randomly assigned to rate the imagery values, and three to rate the meaningfulness values of pseudowords, line drawings, and checkerboard patterns respectively.

Results and Discussion

The scaled values of the items were determined directly by the average response frequency of the subjects. The means, standard deviations and ranks for the imagery (*I*) and meaningfulness (*m*) scores for each item are presented in Appendix B (Tables 11 to 13) along with the *I* and *m* scores of common real words (4 to 7 letters in length, and with the highest *I* and *m* values in the list) selected from the pool presented by Paivio, Yuille, and Madigan (1968) (Table 14 of Appendix B).

Table 2 presents the overall means and standard deviations on the two attributes for 52 pseudowords, 52 common real words, 52 checkerboard patterns, and 52 line drawings.

The results seemed to show that the checkerboard patterns and the pseudowords do not significantly differ in their meaningfulness ($t < 1$) since both of them were randomly generated, and would be assumed to possess only minimal meaningfulness. The only significant difference between these two sets of items (pseudowords and checkerboard patterns) was their imagery value ($t(102) = 7.37, p < .001$), checkerboard patterns having a higher imagery value. It was also found that the line drawings and checkerboard patterns, both nonverbal items, differ from each other in terms of the meaningfulness ($t(102) = 4.87, p < .001$) and their imagery value ($t(102) = 5.98, p < .001$), with the line drawings having both higher meaningfulness and imagery value than checkerboard patterns. This showed that nonverbal stimulus materials do vary along the parameters of meaningfulness and imagery. Therefore, nonverbal stimuli can have varying properties, and in order to accurately compare verbal and nonverbal memory, homogeneous populations of stimulus material must be first produced. This is what Experiment I has attempted to do.

Researchers in the area of verbal and nonverbal memory should not only bear in mind the properties of stimulus material, but also the scaling procedures used to obtain quantification of the properties. In Experiment I, the scaling procedures were replications of methods used by Paivio et al. (1968), where homogeneous response booklets of one kind of item (common words, checkerboard patterns, or line drawings) were presented to subjects, and they rated the item for either imagery or

TABLE 2

Means, Standard Deviations, and Ranges for Four Sets of Stimuli*

According to Their Meaningfulness (*m*) and Imagery (*I*) Values

	Low-Rated Items		High-Rated Items	
	<i>m</i>	<i>I</i>	<i>m</i>	<i>I</i>
	<i>Pseudowords</i>		<i>Common Real Words</i>	
Range	2.60-7.50	1.77-5.10	7.04-9.22	6.00-6.80
Mean	5.85	3.02	7.59	6.47
SD	0.73	0.81	0.52	0.20
	<i>Checkerboard Patterns</i>		<i>Line Drawings</i>	
Range	4.60-7.60	1.70-7.00	5.40-10.10	4.80-6.80
Mean	5.87	4.61	8.50	5.79
SD	0.67	1.33	0.82	0.51

*The four sets of stimuli are: pseudowords, real words (selected from Paivio, Yuille, and Madigan [1968]), checkerboard patterns, and line drawings. Fifty-two items per set.

meaningfulness values. Appendix E presents an ancillary analysis of the scaling for imagery values, where mixed response booklets, consisting of all three kinds of items were presented to subjects. It was found that the *I* values rated by subjects presented with the mixed booklet varied significantly from those presented with homogeneous or unmixed booklets. A word of caution: It is important to realize that ratings from scales not only vary with different items but also vary with the type of response booklets as well.

CHAPTER III

EXPERIMENT II: REPLICATION OF RESULTS REPORTED IN PREVIOUS STUDIES

Shepard (1967), Standing (1973), Standing, Conezio, and Haber (1970) and other researchers concluded that pictorial (nonverbal) memory is not only superior to verbal memory, but also has a large if not unlimited capacity. On the other hand, Goldstein and Chance (1974) and Koen (Note 2) disagreed and concluded that recognition performance varies as the type of nonverbal stimuli used changes. In view of the opposing points of view, we are in a position to ask: Is it true that picture (nonverbal) memory is superior to verbal memory? Are there different memory processes for words and pictures as proposed by Haber (1970)? Could there be basically one memory mechanism processing both verbal and nonverbal material, given that the properties of the stimulus material selected are carefully controlled to provide a homogeneous stimulus set? In short, is it a real phenomenon we are observing or is it only an artifact of careless stimulus selection procedure? The present experiment attempted to replicate the results reported by Shepard (1967) or Goldstein and Chance (1970). Experiment II used four sets of stimulus items: real words, pseudowords, line drawings, and checkerboard patterns in a recognition memory study.

Hypotheses. If, in fact, nonverbal (pictorial or checkerboard patterns) stimuli are superior to verbal stimuli, as suggested by Shepard (1967) and Standing (1973), the recognition performance for

line drawings and checkerboard patterns should be significantly better than words and pseudowords. On the other hand, if recognition performance depends on the type of stimuli used, as suggested by Goldstein and Chance (1970), then recognition scores for line drawings should be significantly better than common real words and pseudowords, while the recognition scores for the checkerboard patterns should not be significantly better than either words or pseudowords.

If the results of Experiment II replicate results presented by Goldstein and Chance (1970), it could be possible to redefine both verbal and nonverbal stimuli in terms of their meaningfulness and imagery values. Instead of stating that pictures are better recognized than checkerboard patterns, and words better than pseudowords, it could be possible to state: Stimuli (verbal or nonverbal) with a high meaningfulness and imagery value would be better recognized than low meaningfulness and imagery value items. It would also mean that both verbal and nonverbal stimuli can be matched on the common grounds of meaningfulness and imagery, so that in future research, comparisons between verbal and nonverbal memory would be made only when meaningfulness and imagery are controlled. It would also imply that meaningfulness and imagery values are important properties present in all stimulus items, regardless of whether the items are verbal or nonverbal, and should warrant more attention from researchers to investigate other properties of stimulus materials.

Method

Items. Four sets of items were selected from the pool of scaled items in Experiment I (presented in Tables I to IV in Appendix B) and

were chosen according to the following rules: (1) Minimize overlaps in imagery and meaningfulness values between the sets of high-rated and low-rated stimulus material. (2) Items more than two standard deviations from the mean were omitted. These items were then made into 35 mm slides. Each set consisted of 36 items, and was first rank ordered in terms of their imagery values. This was done in accordance to Koen's (Note 2) and Paivio's (1970) conclusion that imagery is often found to be a more potent variable than association values.

Within each set, the 36 items were divided into subsets of 18 targets and 18 distractors according to the following procedure: The first two items of the rank ordered list constituted the first pair; the third and the fourth items, the second pair; and so forth. This made 18 pairs of items, closely matched in imagery values within each pair. The targets in each pair were determined by using a random number table. One restriction was made in the determination of targets and distractors for the sets of real words and pseudowords: The targets should not differ from the distractors by more than one letter in word length. Also, in the order of presentation for the study and test lists, the first pair of items should not differ from the second pair for more than one letter in word length. Set I consisted of line drawings with high imagery (*I*) and meaningfulness (*m*) values. Set II consisted of real words with High *I* and *m* values, selected from the words scaled by Paivio, Yuille, and Madigan (1968). Set III consisted of checkerboard patterns with low *I* and *m* values. The pseudowords constituted the last set, also with low *I* and *m* values. The empirical ranges, means, and standard deviations of these four sets of items are presented in Table 3.

Table 3
Means, Standard Deviations, and Ranges for
Four Sets of Selected Stimuli*

	Low-Rated Items		High-Rated Items	
	<i>m</i>	<i>I</i>	<i>m</i>	<i>I</i>
	<i>Pseudowords</i>		<i>Common Real Words</i>	
Range	4.70-6.20	1.60-3.77	7.05-8.32	6.00-6.73
Mean	5.69	2.83	7.54	6.46
SD	0.43	0.59	0.36	0.19
	<i>Checkerboard Patterns</i>		<i>Line Drawings</i>	
Range	4.70-6.50	2.60-5.60	6.80-10.10	5.50-6.80
Mean	5.64	4.01	8.09	6.01
SD	0.46	0.86	0.70	0.40

*Four sets of items used in Experiment II are selected from items scaled in Experiment I. Thirty-six items per set.

m = meaningfulness value

I = imagery value

Subjects. Thirty-two university students (16 male and 16 female) from an introductory psychology course volunteered to participate in this recognition task. The subjects were not paid and had not participated in the scaling task in Experiment I. Their ages ranged from 17 to 23 years, and the mean age was 18.7. They were randomly assigned to four groups, with the restriction that there were four males and four females in each group. A factorial arrangement of the groups is presented in Table 4 to provide a description of the design.

Apparatus. The experiment was conducted in a small quiet room with no windows. The slides were projected with two Kodak Carousel projectors on a Knox 300 portable screen. The projectors were placed approximately 8 feet from the screen and the subjects sat approximately 5 feet from the screen. The illumination of the screen was constant throughout the experiment. When one projector was used to project the study items, the illumination measured by a light meter (Weston, model no. 703-60) was 1 footcandle, and it was 2 footcandles when both projectors were used during the recognition task. Exposure duration was controlled by an electronic timer connected to the shutter. Answers in the test series were written on a provided form (Appendix C).

Procedure. This design was a 2(high-rated items and low-rated items) $\times$ 2(verbal-nonverbal mode of stimuli) $\times$ 2(sex of subjects) factorial arrangement. At the beginning of the experiment, the instructions were presented in a mimeographed sheet and were read aloud by the experimenter (Appendix A). The learning series of 18 slides was presented continuously without breaks. These 18 slides were projected on the screen at a rate of 5 seconds from onset to onset, with a 500 msec

Table 4

Factorial Arrangement of Four Groups of Subjects in Experiment II
 (Four Males and Four Females per Condition)

	Low-Rated Items	High-Rated Items
Verbal Items	Eight Ss were given pseudowords as stimuli.	Eight Ss were given common real words as stimuli.
Nonverbal Items	Eight Ss were given checkerboard patterns as stimuli.	Eight Ss were given line drawings as stimuli.

exposure time, and 4500 msec interval between the slides. Immediately after the learning series was presented, the subjects were given a forced choice retrieval task. Eighteen target slides and 18 distractor slides constituted the test series. These pairs (with one target and one distractor in each pair and their positions randomized) were presented side by side simultaneously for 8 seconds with 1 second between pairs. The subjects were instructed to identify the items (targets) which had been presented in the learning trials and to make a response on the response sheet, while the test pair was being presented.

Results

The means and standard deviations of the percentage correct in recognition for the four types of stimuli are presented in Table 5. It is obvious that there is heterogeneity of variance in the results and the conventional analysis of variance cannot be legitimately carried out. The sex of subjects as a factor was found to be insignificant ($t < 1$). The recognition performance for both common real words and line drawings had reached a ceiling effect (15 of 16 subjects achieved 100% correct in performance), hence, no difference was found between these two groups. A simple t test revealed no significant difference between the pseudowords and the checkerboard patterns as well [$t(14) = 0.56$, $p < .50$]. The only significant difference in recognition performance was between the high-rated and low-rated items. The words were much better recognized than pseudowords [$t(14) = 7.67$, $p < .001$] and line drawings were much better recognized than checkerboard patterns

Table 5

Means, Standard Deviations of the Percentage Correct
in Recognition for Four Types of Stimuli

		<i>Pseudowords</i>	<i>Common Real Words</i>
Verbal Items	Mean	59.02	100.00
	SD	15.12	0.00
	N	8	8
		<i>Checkerboard Patterns</i>	<i>Line Drawings</i>
Nonverbal Items	Mean	63.18	99.30
	SD	14.22	1.97
	N	8	8

$[t(14) = 7.12, p < .001].^1$

In Tables 15 to 18 in Appendix D, the recognition scores of the 18 targets for each set of stimuli are presented along with their imagery and meaningfulness values. To understand the relationship between imagery (*I*) and meaningfulness (*m*) and recognition performance, more fully, a series of correlation coefficients was calculated and is presented in Table 6. The results show that within the four sets of items, the *I*, *m*, and recognition performance in percentage correct, did not correlate as significantly as those presented by Paivio, Yuille, and Madigan (1968) ($r = 0.72$). A further analysis of the scores, by correlating the percentage correct with *I* and *m* values for all verbal items (real words and pseudowords) and all nonverbal items (line drawings and checkerboard patterns) revealed that the six correlations were all significant at the .001 level.

Discussion

According to previous studies (Shepard, 1967; Standing, 1973) the performance for the line drawings should be significantly better than that of the real words. This was not found in the present study, and may be attributed to the ceiling effect (both groups have 100% correct recognition). The difference between high-rated verbal and nonverbal memory will be further investigated in Experiments III and IV.

¹Median tests (Fisher exact tests) were carried out on the data and have arrived at the same conclusion: Common words and pseudowords were significantly different from each other ($p = .0006$); line drawings and patterns were significantly different from each other ($p = .0006$); high-rated items (words and drawings were not different ($p = .50$) and low-rated items (pseudowords and patterns) were also not different from each other ($p = .38$).

Table 6

Correlations of Imagery (*I*), Meaningfulness (*m*), and
Recognition Performance for Four Sets of Thirty-Six Items

<i>Pseudowords</i>			<i>Common Real Words</i>		
	<i>I</i>	<i>m</i>		<i>I</i>	<i>m</i>
<i>m</i>	-0.26		<i>m</i>	0.09	
%	-0.12	0.18	%	1.00*	1.00*
<i>Checkerboard Patterns</i>			<i>Line Drawings</i>		
	<i>I</i>	<i>m</i>		<i>I</i>	<i>m</i>
<i>m</i>	0.16		<i>m</i>	-0.03	
%	-0.13	-0.06	%	0.31	0.12
<i>Verbal Items</i>			<i>Nonverbal Items</i>		
	<i>I</i>	<i>m</i>		<i>I</i>	<i>m</i>
<i>m</i>	0.89*		<i>m</i>	0.75*	
%	0.76*	0.77*	%	0.63*	0.71*

* $p < .001$

The results confirmed the conclusions reported by Goldstein and Chance (1970, 1974) and Koen (1969). It was found that recognition performance varied significantly as the type of nonverbal stimuli used changed from line drawings to checkerboard patterns. It was also found that nonverbal memory is not always superior to verbal memory. It depends on: (1) the type of nonverbal stimuli used, and (2) the type of verbal stimuli used. When the performance for line drawings was compared to that of pseudowords, then the nonverbal memory was better than the verbal memory. But this difference cannot be attributed to the verbal-nonverbal difference, because the line drawings have higher I and m values than the pseudowords, and thus would make them unequal competitors. However, when the performance on line drawings was compared to that on real words (both having high I and m values), it was found that the performance did not differ. No significant difference was found between the checkerboard patterns and the pseudowords as well. The only significant finding in this set of results was on the high-low ratings dimension. The high-rated items elicit better performance than the low-rated items. In more specific terms, recognition memory not only varies when verbal material changes from low I and m values to high I and m values, the same situation was found with nonverbal items as well.

By going through an extra step to define the stimuli in terms of imagery and meaningfulness, we have produced four sets of homogeneous stimuli and found that the verbal-nonverbal difference is not as potent as it has been reported to be (Shepard, 1967; Paivio & Csapo, 1969; and others). The more important difference is the nature and properties of

the stimuli used. If two sets of stimuli have similar properties, i.e. similar in their imagery and meaningfulness values, their recognition performance would not differ from each other. If research in the area of verbal and nonverbal memory is to be carried out in the future, it is of the utmost importance that the stimuli chosen for the study must be equal competitors on some common grounds. Each kind of stimulus item must be clearly defined to minimize confounding variables. The present experiment has attempted to demonstrate how this could be done, and has found that imagery and meaningfulness are two usable dimensions to define both verbal and nonverbal stimuli. Further research in this area is needed to retest the procedure used and to replicate the results reported.

CHAPTER IV

EXPERIMENT III: EFFECTS OF VARYING PRESENTATION RATES

The experiment was designed to fulfill two main purposes: first, to compare recognition performance between real words and line drawings when a shorter presentation time was used; second, to lower the ceiling effect found in Experiment II, so that a comparison between the two sets of items, i.e. common real words and line drawings, can be carried out.

The studies by Shepard (1967), Nickerson (1965), Koen (Note 2), Paivio and Csapo (1969), Standing, Conezio, and Haber (1970), Standing (1973), Snodgrass and McClure (1975), and Goldstein and Chance (1970), summarized in Table 1 (pp. 13-14), show that recognition performance not only varied with the type of stimulus used, but also with the amount of exposure time, and interstimulus interval (presentation rates). The usual finding of superiority of picture memory may be confounded by the effect of varying exposure durations. Shepard's (1967) study found 98% retention of pictorial stimuli with 6 seconds exposure time; Goldstein and Chance (1970) found 71% retention for female faces, 46% for inkblots, and 53% for snow crystals with 2 or 3 seconds exposure; and Koen (Note 2) found 67% for realistic paintings with a 500 msec exposure time.

Hypothesis. Experiment III was designed to examine the problem of a possible confounding error in previous reported studies. Recognition performance for real words and line drawings presented at a fast rate was compared to the performance for the same stimuli presented at a

slower rate reported in Experiment II. It was hypothesized that recognition performance for both words and drawings would be lower when presented at the fast rate, but the verbal-nonverbal difference would remain insignificant.

Method

Items. Set I (line drawings) and Set II (real words) used in Experiment II were also used in this experiment.

Procedure. The organization of the items, the instructions to the subjects, and the apparatus were identical to those in Experiment II. After the instructions were read to the subjects, the study lists were presented at a rate of 250 msec exposure duration, 1550 msec inter-stimulus interval, with 1800 msec from onset to onset. Immediately after the presentation of the study list, a test series was presented in the same procedure as in Experiment II. The subjects were given a forced choice retrieval task and their task was to identify the items previously presented in the study trials. They were instructed to mark on the response sheet whether the familiar slide was on the right or left on the screen. The test series was presented at a rate of 8 seconds per pair of items, with 1 second in between each pair of slides.

Subjects. Sixteen university students (8 males and 8 females) volunteered to participate in this part of the study. None of these subjects had participated in any part of Experiment I or II. Their ages ranged from 17 to 25 years, and the mean age was 20. They were randomly assigned to two groups, with the restriction that there were 4 males and 4 females in each group.

Results

In order to explore the effects of presentation rates, the recognition performances for real words and line drawings, presented at a slow rate (5 seconds from onset to onset, 500 msec exposure duration, and 4500 msec interstimulus interval) in Experiment II were compared to the recognition performance for the same two sets of stimuli presented at a fast rate (1800 msec from onset to onset, 250 msec exposure duration, and 1550 msec interstimulus interval) in Experiment III. This constituted a 2(verbal-nonverbal mode of stimulus) x 2(presentation rates) x 2(sex of subjects) design. Accordingly, a 2 x 2 x 2 analysis of variance was performed on the percentage of correct recognition responses. The analysis yielded a significant main effect on presentation rate, $F(1,24) = 4.70$, $p < .04$, percent of variance accounted for = 16.06%. The main effects of verbal-nonverbal mode of stimulus material ($F < 1$) and the sex of subjects ($F < 1$) were found to be nonsignificant. Interactions involving the verbal-nonverbal factor and the sex of subjects factor were also nonsignificant ($p > .10$) in each case.

Table 7 presents the means and standard deviations for the four conditions (collapsed across the sex of subjects factor). It is clear that the results have heterogeneity of variance and the conventional method of analysis of variance would be inappropriate. A simple t test was carried out to compare the performance between the two groups of subjects presented with real words and line drawings at the fast rate.

TABLE 7

Means ($\bar{X}$) and Standard Deviations (SD) on
 Percentage Correct for Common Real Words and Line
 Drawings Presented at Fast and Slow Rates

		Verbal <i>Common Real Words</i>	Nonverbal <i>Line Drawings</i>
Slow Rate*	$\bar{X}$	100.00	99.31
	SD	0.00	1.97
	N	8	8
Fast Rate	$\bar{X}$	94.44	96.53
	SD	6.64	7.82
	N	8	8

Fast rate: 250 msec exposure
 1550 msec interstimulus interval
 1800 msec onset to onset

Slow rate*: 500 msec exposure
 4500 msec interstimulus interval
 5000 msec onset to onset

*Reported in Experiment II

No significant difference was found ($t < 1$).² To further explore the relationship between the performance of verbal and nonverbal memory, imagery and meaningfulness values, correlations were carried out and are presented in Table 8. The correlations were nonsignificant (excluding those having a ceiling effect) except between scores for fast and slow rates. Recognition performance did not correlate highly with either imagery or meaningfulness values in each set of items.

In order to examine the effects of presentation rates, a two group analysis of variance was carried out, by collapsing the data across the verbal-nonverbal effect. It was found that presentation rate was a significant effect [$F(1,14) = 5.32, p < .03, \eta^2 = 15.06$] as in the earlier analysis.²

Discussion

The findings of this study did not support the widely accepted notion that picture memory is superior to verbal memory. In Experiment II, when the performance for the nonverbal items, i.e. checkerboard patterns, was compared to the performance for the verbal items, i.e. pseudowords, the difference between verbal and nonverbal memory was not found. This may be attributed to the fact that both sets of items were rated low in imagery and meaningfulness, and more important, they were similar in their ratings. In Experiment III, the ceiling effects found in Experiment II between the recognition performances for line drawings and real words, were further explored. The ceiling was lowered when a

²Median test (Fisher exact tests) found words and line drawings were not significantly different from each other ($p = .25$).

TABLE 8 .

Correlations between Performance (% Correct), Imagery (*I*),
and Meaningfulness (*m*) for Real Words and Line Drawings

Presented at Slow and Fast Rates

	<i>I</i>	<i>m</i>	% Correct (Slow Rate)
<i>Common Real Words</i>			
<i>m</i>	0.09		
% Correct (Slow Rate)	1.00*	1.00*	
% Correct (Fast Rate)	-0.02	-0.01	1.00*
<i>Line Drawings</i>			
<i>m</i>	-0.03		
% Correct (Slow Rate)	0.31	0.12	
% Correct (Fast Rate)	0.03	0.02	0.39**

* $p < .001$

** $p < .10$

faster presentation rate was used. Recognition for the line drawings was again found to be very similar to the performance for common real words. This replicated the findings reported in Experiment II. The question is: Why is the usual picture (line drawings)--words difference in recognition memory not found? Compared with the present study, Paivio and Csapo (1969) were using a faster presentation rate (exposure duration of 62.5 msec, and interstimulus interval of 300 msec) as their "slow" rate, and they found a picture-word recognition difference. They attributed the lack of difference between picture and word memory under the fast rate (exposure duration of 62.5 msec, interstimulus interval of 125 msec) to the inability to activate the verbal code of pictures and visual code for words at this fast rate. But at a slower rate, both of these codes would be activated, and since the visual coding for the pictures is a more potent variable that facilitates recognition, pictures were better recognized. However, in the present experiment, the fast rate was 250 msec exposure time, and the interstimulus interval 1550 msec, much longer than Paivio and Csapo's slow rate; yet, the picture-word difference was not found.

The lack of support for picture and word recognition differences can be attributed to the homogeneity of stimuli generated in Experiment I. The line drawings were selected because of their high meaningfulness and imagery value. A similar procedure was used to select the words. These two sets of items were selected intentionally to be matched in their imagery and meaningfulness values. The usual procedure, used by previous studies, of selecting pictures for a memory study was not used. This study has selected highly homogeneous sets of items as stimulus material.

The pictures were not *assumed* to be high in imagery and meaningfulness, they were carefully scaled, and found to be high in imagery and meaningfulness values, using the same scaling procedure for words. Owing to the fact that the imagery and meaningfulness values were similar between the two sets of items used, the recognition performance of the line drawings and that of words were found to be not significantly different from each other, even at a slow rate. We can conclude by saying that the difference in recognition performance for pictures and words can be attributed to many factors, but the properties, i.e. imagery and meaningfulness, of the items are most important. If two sets of items used in the comparison are equivalent or approximately equal in their imagery and meaningfulness values, recognition performance would not differ between them.

Presentation rate was found to be an important factor affecting recognition memory. Shorter rates tend to lower recognition scores. This finding was in accordance to findings reported by other researchers (Hulme & Merikle, 1975; Potter, 1976; Potter & Levy, 1969; Rosenblood & Pulton, 1975; Tversky & Sherman, 1975). Even if presentation rates were found to affect the activation of the visual code for words and the verbal code for pictures (Paivio & Csapo, 1969), which in turn would affect the availability of these codes in coding processes, the more important issue is the value of these codes. A set of pictures having similar imagery and meaningfulness values as a set of words would have similar recognition performance.

In sum, it is possible for us to redefine pictures and words in relation to their imagery and meaningfulness values. When they are

rated high in these dimensions, their recognition performance will be good but similar to each other.

CHAPTER V

EXPERIMENT IV: EFFECTS OF VARYING RETRIEVAL METHODS

Aside from the problems of stimulus selection procedure and presentation rates, there is another problem which may also inflate recognition scores in pictorial memory studies. It is the use of the conventional forced choice paradigm as a retrieval method. Is the forced choice procedure in recognition paradigm actually measuring recognition memory?

The traditional method of testing recognition performance usually begins with the presentation of the target sets for the study. To test memory, the subjects are later presented with a list of items, some of which are targets (items presented to them in the study series), and some are distractors (new items). The subjects have to decide whether or not a given test stimulus is a member of the target set or if it is a member of the distractor set. Correct recognition indicates the ability to identify from which set the test stimulus is drawn.

Table 1 (pp. 13-14) presented a summary for the types of stimuli used, presentation rates, retrieval tasks, and recognition scores for some major verbal and nonverbal memory studies. Researchers such as Shepard (1967), Standing, Conezio, and Haber (1970), and Standing (1973) used the forced choice method to obtain recognition scores, and pictorial memory was consistently reported to be not only superior (over 90% correct) to verbal memory, but also to possess a large, if not unlimited

capacity. Discrepant findings, however, can also be found in the literature. Goldstein and Chance (1970) reported that recognition performance for nonverbal stimuli does not have to be superior to verbal stimuli, but varies with the type of nonverbal stimuli. They employed a yes/no procedure instead of the forced choice method to obtain recognition scores and found inferior recognition performance for their nonverbal stimuli. Similar results were reported by Koen (Note 1) who used a multiple choice procedure. It is now clear that recognition scores not only change with the type of stimuli and varying presentation rates, they could very well change with the different retrieval methods.

In experiments II and III in this study, recognition scores for line drawings were found to be similar to that of words. This finding differed from those previously reported. Shorter presentation rates reduce recognition performance for both the line drawings and the words, but the scores for line drawings and words remained similar to each other; the performance only decreased as the presentation rate was made briefer.

Hypothesis. It was hypothesized in Experiment IV that, if, by using two sets of highly homogeneous sets: line drawings and words which are similar to each other in their imagery and meaningfulness values, recognition performance for these items would only decrease proportionately as the retrieval task was changed from a forced choice method to a yes/no procedure, but would remain similar to each other, i.e. not significantly different from each other.

Method

Items and apparatus. The items and the apparatus were the same as those used in Experiment III.

Procedure. The organization of the items was identical to that in Experiment III. After the subjects were seated before the projection screen the instructions for a single item, yes/no retrieval task were read aloud to them, prior to the onset of the experiment. The study list was projected onto the screen at a presentation rate of 1800 msec onset to onset, exposure duration was 250 msec, and 1550 msec inter-stimulus interval. Immediately after the presentation of the study list, a test list was presented. The test list was comprised of 36 single items, with 18 target items randomly interspersed with 18 distractor items. The items were presented one at a time with 8 seconds exposure duration for each slide and approximately 1 second between items. The subjects' task was to identify those items which were presented previously during the study trials and to make a response of *yes* or *no* (*yes* meaning they have seen the item before; *no* meaning they have not seen the item before) on the response sheet. (The instruction for this experiment is presented in Appendix A, and the response sheet is presented in Appendix C).

Subjects. Sixteen university students (8 males and 8 females) participated in this experiment. None of these 16 subjects had participated in any earlier part of this study. Their ages ranged from 18 to 23 years, and the mean age was 19.6. They were randomly assigned to two groups, with the restriction that equal numbers of males and females would be present in each group.

Results and Discussion

In order to investigate the effect of varying retrieval tasks, the recognition data for real words and line drawings collected by a forced choice retrieval task reported in Experiment III were included in this part of the analysis. This constituted a 2(retrieval tasks) x 2(verbal-nonverbal mode of stimuli) x 2(sex of subjects) factorial design. A 2 x 2 x 2 analysis of variance on the data was carried out. Sex of subjects as a factor and all interactions involving sex of subjects were found to be nonsignificant and will not be further discussed. Table 9 presents the means and standard deviations for the four conditions (collapsed across the sex of subjects factor). The main effect of retrieval task was found to be significant, $F(1,14) = 5.16$, $p < .03$, percent of variance accounted for = 15.30% and the mode of stimuli effect was nonsignificant ($F < 1$).

The results confirmed the operation of the retrieval task variable as reported by May and Adamowicz (Note 3). The recognition performance for real words and line drawings remained similar to each other, regardless of the type of retrieval task used. The percent of correct responses decreased proportionately as hypothesized for both sets of items. This finding confirmed the conclusions in both Experiments II and III that with homogeneous sets of items, recognition performance for line drawings would be similar to that of real words. This similarity remained as other variables such as presentation rates and retrieval tasks made the recognition task more difficult; and as a consequence of increasing task difficulty, recognition scores decreased for both sets of stimulus items.

Table 9

Means ($\bar{X}$) and Standard Deviations (SD) for Real Words and
Line Drawings in Single Item (Yes/No) or Forced Choice Tasks

		Verbal	Nonverbal
		<i>Common Real Words</i>	<i>Line Drawings</i>
Forced Choice*	$\bar{X}$	94.44	96.53
	SD	6.64	7.82
	N	8	8
Single Item (Yes/No)	$\bar{X}$	89.58	90.97
	SD	6.08	5.09
	N	8	8

*Reported in Experiment III

Nevertheless, the recognition performance for line drawings and real words only decreased proportionately without differing much from each other. Thus, elimination of the ceiling effect observed in Experiment II did not lead to a differential performance in the recognition of real words compared with line drawings.

CHAPTER VI

GENERAL DISCUSSION

This thesis was designed to compare recognition performance between four sets of highly homogeneous items: line drawings, real words (selected from Paivio, Yuille & Madigan, 1968), checkerboard patterns (selected from Adamowicz, 1976) and pseudowords. Three sets of items (line drawings, checkerboard patterns, and pseudowords) were rated, along the parameters of imagery and meaningfulness, to be homogeneous within each set of items, in a scaling study presented in Experiment I. Experiment II found no significant difference between the recognition performance between verbal and nonverbal items. Recognition for line drawings was not found to be superior to real words, and recognition for checkerboard patterns was also not found to be better than pseudowords. This finding was contrary to results reported by Shepard (1967), Standing (1973), Paivio and Csapo (1969) and many others. Experiments III and IV further explored the line drawings and real words memory differences. Again, the performance for line drawings was found to be similar to that of real words. The results reported by Experiments III and IV replicated the conclusions of Experiment II.

The results of the present study supported the conclusions made by Goldstein and Chance (1970, 1974) that recognition memory varies with the type of stimuli used. Standing (1973) commented on the items used by Goldstein and Chance (1970) as "extremely confusable items" (p. 219). Standing also stated that "their findings must be due to common visual

cues rather than common subject matter among the pictures" (p. 74). In order to compare the results reported by Goldstein and Chance (1970) to verbal stimuli,

it would have to be assumed that the verbal stimuli had no special image value or meaning to subjects, that the subjects were unfamiliar with the stimulus class, and that the words were quite similar so that partial learning could not take place. Based on these assumptions, the stimuli of Goldstein and Chance would be better equated with nonsense syllables than with words (Porteous, Note 4).

Recognition memory for nonsense syllables (pseudowords) was compared with checkerboard patterns, and no significant difference was found between them.

The study has produced several findings which are important to a better understanding of the recognition paradigm, especially the memory of individual verbal and nonverbal stimuli. The first major finding was that with a learning series of 18 target items, recognition performance for nonverbal material is not necessarily superior to that of verbal material, when the stimulus properties of imagery and meaningfulness are controlled. This finding was replicated by Experiments III and IV: no significant difference was found between the performance for real words and for line drawings.

The second finding was that the sets of stimuli which were rated to be high in both imagery and meaningfulness (line drawings and real words), were better recognized by subjects than those sets which were rated low in the two attributes (checkerboard patterns and pseudowords). Superiority in recognition performance was more a function of the high-rated versus low-rated variable than of the verbal-nonverbal difference in stimulus items.

Another finding was that presentation rate is an important factor which may either increase or decrease recognition scores. At a slow rate, recognition for real words and line drawings had reached a ceiling effect; at a fast rate, the performance for the same two sets of stimuli was found to be significantly lower than in the slow rate.

Finally, the type of retrieval task was also found to be a significant factor that affects recognition performance. Scores obtained by using a single item, yes/no procedure, were significantly lower than those obtained by using a forced choice method.

The results of the present study are presented in Table 10. Figure 2 compares results in Experiments II, III, and IV. It is clear that by controlling confounding variables, such as stimulus properties, presentation rates, and retrieval tasks, recognition memory for different types of stimuli varied, and results contrary to the accepted notion of picture superiority were found. Many studies which found picture superiority used labels of the pictures as word stimuli; however, the properties (imagery and meaningfulness) of the pictures and words were not controlled. As a result, the sample of picture stimuli may have higher imagery and meaningfulness values than their verbal counterparts, thus, the recognition performance for pictures was often found to be superior to the words.

In conclusion, a word of caution for researchers in the area of verbal and nonverbal memory: When designing a study to compare recognition performance for verbal and nonverbal items, the sample of stimuli must be first equated on certain common grounds. Imagery and meaningfulness have been found to be usable parameters for matching stimulus

TABLE 10

Summary of Results in the Present Study

Study	Type of Stimuli	Exposure Time	Retrieval Tasks	% Correct
Experiment II	Common words	500 msec	Forced Choice	100.00
	Pseudowords	500 msec	Forced Choice	59.02
	Line drawings	500 msec	Forced Choice	99.31
	Checkerboard patterns	500 msec	Forced Choice	63.19
Experiment III	Common words	250 msec	Forced Choice	94.44
	Line drawings	250 msec	Forced Choice	96.53
Experiment IV	Common words	250 msec	Yes/No	89.58
	Line drawings	250 msec	Yes/No	90.97

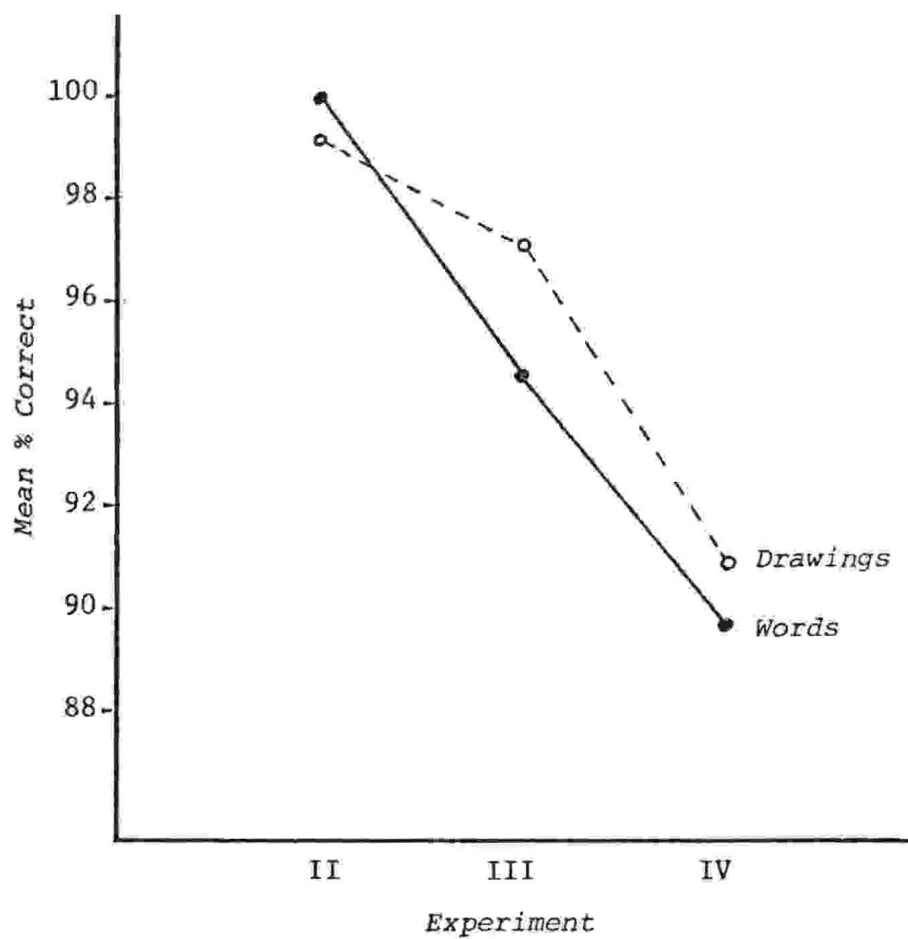


FIGURE 2. Recognition Performance for Common Words and Line Drawings in Experiments II, III, and IV.

materials, but future research will need to further investigate the validity of these two attributes.

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APPENDIX A

INSTRUCTIONS FOR EXPERIMENTS I, II, III, IV

INSTRUCTIONS FOR RATING IMAGERY

Items, whether they are letters put together, patterns, or pictures, differ in their capacity to arouse mental images of things or events. Some items arouse a sensory experience, such as a mental picture or sound, very quickly and easily whereas others may do so only with difficulty (i.e. after a long delay) or not at all. The purpose of this experiment is to rate a list of items as to the ease or difficulty with which they arouse mental images. Any items which, in your estimation, arouse a mental image (i.e. a mental picture, or sound, or other sensory experience) very quickly and easily should be given a high imagery rating; any item that arouses a mental image with difficulty or not at all should be given a low imagery rating. Think, for example, of the words "apple" or "fact." Apple would probably arouse an image relatively easily and would be rated as high imagery. Since items tend to make you think of other items as associates, it is important that you note only the ease of getting a mental image of an object or an event to the item.

Your ratings will be made on a 7-point scale, where one is the low imagery end of the scale and seven is the high imagery end of the scale. Make your ratings by putting a circle around the number from 1 to 7 that best indicates your judgment of the ease or difficulty with which the item arouses imagery. The items that arouse mental images most readily for you should be given a rating of 7; items that arouse images with the greatest difficulty or not at all should be rated 1; items that are intermediate in ease or difficulty of imagery, of course, should be

rated 1; items that are intermediate in ease or difficulty of imagery, of course, should be rated appropriately between the two extremes. Feel free to use the entire range of numbers, from 1 to 7; at the same time, don't be concerned about how often you use a particular number as long as it is your true judgment.

You should look at the item, then turn the page. You should find a 7-point scale at the back of the page. At the top of the page, there is an instruction indicating that you should count backwards from one number to another number, by tens. For example, if the instruction indicates that you should count from 100 to 50, you should count as follows: 100, 90, 80, 70, 60, 50. After counting backwards, you then circle your judgment about the ease or difficulty to image the item.

The first four items are for your practice. Indicate the ease of getting an image by circling the appropriate number.

If necessary, refer back to these instructions when rating the items on the following pages. If there are any questions, ask them now, otherwise turn the page and begin.

INSTRUCTIONS FOR RATING MEANINGFULNESS

This is a test to see how many words you can think of and write down in a short period of time. The purpose of the study is to evaluate a list of items in terms of their meaningfulness. (Your word associations will be used as a measure of meaning.) You will be given a key item (whether it is a set of letters, pictures, or patterns) and you are to write down as many words which the key item brings to mind as you can. These words which you write down may be things, places, ideas, events, or whatever you happen to think of when you see the key item. Remember to look back at the key item every time you make an association.

You will be given 30 seconds to make word associations for each item. You will turn the page to work on a new item when given a signal.

There are 4 training items at the beginning of each set of items.

If you have any questions, ask now or we shall begin.

INSTRUCTIONS FOR FORCED CHOICE RECOGNITION TASK

This is an experiment on recognition memory and is divided into two parts.

In the first part of the experiment, you will be presented a series of items at very brief exposure durations. They will be presented one at a time, and your task is to study and remember them as precisely as you can.

In the second part, you will be presented a series of paired items. In each pair, one item will be an old item (one which you have seen before in part I of the experiment) and the other will be a new item (one which you have not seen before in part I of the experiment). Your task will be to identify which one of the pair is an old item. If the left one of the pair of items is an old item, you would then circle the letter (L), and if the right one is an old item, you would then circle the letter (R).

Are there any questions?

INSTRUCTIONS FOR SINGLE ITEM, YES/NO RECOGNITION TASK

This is an experiment on recognition memory and is divided into two parts.

In the first part of the experiment, you will be presented a series of items at very brief exposure durations. They will be presented one at a time, and your task is to study and remember them as precisely as you can.

In the second part, you will be presented a series of items, also one at a time. In this series, there are old items (items which you have seen before in part I of the experiment) and new items (items which you have not seen before in part I of the experiment). Your task will be to identify which are the old items among the new ones. If the item presented is an old item, you would then circle the word (YES), meaning that item is an old item; and if the item presented is a new item, you would then circle the word (NO), meaning that item is not an old item.

Are there any questions?

APPENDIX B

DETAILED RESULTS OF EXPERIMENT I RATINGS

TABLE 11

Means ($\bar{X}$) and Standard Deviations (SD) of Imagery (I) and Meaningfulness (m)
for Fifty-two Pseudowords Ranked (R) by Imagery Values

Item	R	#	I		m		Item	R	#	I		m	
			$\bar{X}$	SD	$\bar{X}$	SD				$\bar{X}$	SD	$\bar{X}$	SD
*WXQCXH	1.50	39	1.60	1.26	5.40	2.17	*QWXHG	25.5	29	3.00	2.10	6.20	3.25
*XMZFLV	1.50	21	1.60	1.07	6.00	2.82	*BTVNZ	28.5	13	3.10	2.46	5.80	2.48
*PFCDVQ	3.00	25	1.70	1.49	6.00	2.66	*VFWHBG	28.5	35	3.10	2.18	6.00	3.01
GCZLBWQ	4.00	T1	1.77	1.20	2.60	2.50	*BFCJQM	31.5	14	3.20	2.39	5.10	3.14
*QXFWGW	5.00	42	2.00	1.11	6.00	2.66	*QSSXZ	31.5	30	3.20	2.61	5.80	2.78
*XZFJN	6.00	24	2.10	2.02	5.00	1.63	*SBCSDS	31.5	46	3.20	2.29	6.00	3.01
*DNGQGC	7.50	9	2.20	1.87	5.50	2.59	*VGWQGH	31.5	37	3.20	2.04	6.20	3.45
RPFVVX	7.50	44	2.20	1.87	6.40	2.41	SBCCW	35.0	43	3.30	2.00	6.40	3.77
*ZRQSHM	10.5	23	2.30	1.63	5.60	3.43	SNDJL	35.0	47	3.30	2.45	6.60	3.13
*KQZFPT	10.5	1	2.30	1.82	6.00	2.66	HBCNJ	35.0	3	3.30	2.45	7.20	3.79
*GDWFCT	10.5	5	2.30	1.94	6.10	2.76	*CJZQZB	37.5	11	3.40	2.54	4.70	2.75
HLZZM	10.5	4	2.30	1.56	6.90	2.07	*GGVFS	37.5	6	3.40	2.11	5.90	2.46
SVGFT	13.0	31	2.31	1.80	6.30	2.58	*VBGSW	39.0	36	3.44	2.60	5.60	2.41
*VGWJS	14.5	38	2.40	2.27	6.10	3.92	*LKDCPZ	40.5	15	3.50	2.22	5.90	3.44
FBBRZ	14.5	8	2.40	2.01	6.50	3.71	TKLLG	40.5	33	3.50	2.50	6.80	2.69
*NNLBVM	16.0	19	2.60	2.41	6.10	2.96	*RNTWNB	43.0	41	3.60	2.63	4.90	3.28
*MZPRL	18.5	17	2.70	2.21	5.10	3.14	*SJJZK	43.0	T4	3.60	2.06	5.20	3.25
*DTTZH	18.5	7	2.70	1.56	5.50	2.06	SWMPBF	43.0	34	3.60	2.41	6.50	2.32
*SKFWFX	18.5	48	2.70	1.70	6.00	2.10	*XKPHNZ	45.0	22	3.70	2.31	5.50	2.63
*DTBVS	18.5	10	2.70	2.16	6.20	2.85	*QQLRL	46.0	T3	3.77	2.58	6.00	3.01
*CVCCKQ	22.0	12	2.90	2.28	5.60	2.01	PNWNMN	47.0	27	3.90	2.18	6.30	2.54
*VKBDPP	22.0	40	2.90	2.13	5.80	3.04	LMZRW	48.0	18	4.00	2.49	6.30	3.59
*NLRVFB	22.0	20	2.90	1.66	6.00	2.16	KLCXR	49.0	2	4.40	2.27	5.90	2.87
*SRQXVFV	25.5	32	3.00	2.21	4.80	2.48	LGSGB	50.5	16	5.00	2.30	7.50	3.40
*PDSWVC	25.5	26	3.00	1.94	5.30	3.43	SSSTW	50.5	T2	5.00	1.93	5.50	3.89
*SDLGZX	25.5	45	3.00	2.21	6.10	2.76	PNKWC	52.0	28	5.10	2.07	5.90	3.28

*Items (a total of 36 items) selected for Experiment II

TABLE 12

Means ($\bar{X}$) and Standard Deviations (SD) of Imagery (I) and Meaningfulness (m) for
Fifty-two Checkerboard Patterns Ranked (R) by Increasing Imagery Values

R	#	I		m		R	#	I		m	
		$\bar{X}$	SD	$\bar{X}$	SD			$\bar{X}$	SD	$\bar{X}$	SD
1.00	36	1.70	1.05	4.60	3.33	27.0	*T4	4.50	2.50	4.70	2.83
2.00	*44	2.40	1.50	6.50	3.83	28.0	*14	4.60	1.83	6.10	3.81
3.00	*37	2.60	1.57	5.50	2.83	29.5	*10	4.80	2.29	5.70	3.46
4.00	*32	2.80	1.87	5.00	2.78	29.5	* 2	4.80	2.14	6.30	3.71
6.00	*T1	2.90	1.91	5.50	3.20	31.0	*19	5.00	2.00	5.70	2.94
6.00	*39	2.90	1.72	5.60	3.23	32.5	*T2	5.10	1.91	5.20	2.85
6.00	*43	2.90	2.02	5.80	3.52	32.5	*26	5.10	1.96	6.30	2.86
8.00	*38	3.10	2.37	5.80	3.11	34.0	*11	5.30	1.76	6.20	2.65
9.00	*35	3.20	2.09	5.20	3.52	35.5	*23	5.40	1.83	6.30	3.09
10.5	*42	3.50	1.95	5.40	3.09	35.5	30	5.40	2.06	6.90	2.96
10.5	*47	3.50	2.27	5.80	3.22	37.0	*27	5.50	1.90	5.30	2.98
13.0	*33	3.60	2.22	4.80	3.48	38.0	*17	5.60	2.01	5.80	2.65
13.0	*45	3.60	2.27	6.10	3.34	39.0	3	5.70	2.26	6.60	3.13
13.0	*46	3.60	2.41	6.30	3.43	40.5	12	5.80	2.09	7.00	2.44
15.5	*40	3.70	1.63	4.90	4.06	40.5	21	5.80	1.87	6.00	3.33
15.5	*28	3.70	2.11	5.70	3.80	42.0	9	5.90	1.44	6.80	2.34
17.0	*T3	3.80	1.87	5.30	2.45	43.0	25	6.10	1.66	5.30	3.05
18.5	*34	3.90	2.02	5.40	3.37	44.0	29	6.30	1.49	5.70	2.94
18.5	*20	3.90	2.18	5.70	3.36	45.5	24	6.40	0.96	5.70	3.02
20.5	* 4	4.00	1.94	5.40	3.59	45.5	7	6.40	1.26	5.80	3.76
20.5	*13	4.00	2.35	6.30	2.00	47.5	31	6.50	1.26	6.30	3.49
22.5	*48	4.10	1.91	5.20	3.29	47.5	15	6.50	1.26	6.70	3.40
22.5	*18	4.10	2.55	5.60	3.40	49.0	6	6.60	0.69	6.60	2.95
24.0	* 1	4.20	2.14	5.70	3.56	50.0	8	6.70	0.94	7.60	2.50
25.0	*41	4.30	2.00	5.30	3.43	51.0	16	6.80	0.63	6.70	2.00
26.0	*22	4.40	2.50	5.90	2.84	52.0	5	7.00	0.00	7.60	2.27

*Items (a total of 36 items) selected for Experiment II

TABLE 13

Means (X) and Standard Deviations (SD) of Imagery (I) and Meaningfulness (m) for
Fifty-two Line Drawings Ranked (R) by Increasing Imagery Values

R	#	I		m		R	#	I		m	
		$\bar{X}$	SD	$\bar{X}$	SD			$\bar{X}$	SD	$\bar{X}$	SD
1.50	27	4.80	1.81	7.70	3.09	28.5	*11	5.80	1.93	7.60	1.50
1.50	18	4.80	2.20	8.80	1.87	28.5	* 7	5.80	2.09	8.20	1.98
3.00	25	4.90	2.02	7.70	3.16	28.5	*37	5.80	1.93	8.30	2.66
4.00	1	5.00	1.88	9.80	2.29	28.5	*23	5.80	1.98	8.40	2.01
5.50	15	5.20	2.14	8.10	1.37	28.5	*46	5.80	1.54	8.40	1.77
5.50	31	5.20	1.93	9.50	1.58	32.5	*T4	5.90	1.37	6.90	3.57
8.00	48	5.30	1.82	7.00	1.88	32.5	*19	5.90	1.79	8.40	1.95
8.00	36	5.30	2.00	7.70	3.16	34.0	*28	6.00	1.33	8.60	1.42
8.00	44	5.30	2.11	7.70	1.88	37.0	* 5	6.10	1.44	7.00	2.66
12.5	41	5.40	2.01	7.30	2.58	37.0	* 4	6.10	0.87	7.90	2.80
12.5	35	5.40	1.83	7.50	2.59	37.0	*21	6.10	1.59	7.90	2.13
12.5	38	5.40	2.11	7.60	1.64	37.0	*39	6.10	1.85	8.30	1.82
12.5	42	5.40	2.06	7.60	1.83	37.0	*32	6.10	1.28	10.1	2.18
12.5	26	5.40	2.41	8.50	1.71	41.0	*40	6.20	1.61	8.00	1.49
12.5	14	5.40	2.31	9.10	1.96	41.0	* 8	6.20	1.47	8.20	1.87
18.5	*16	5.50	1.71	7.30	2.83	41.0	*29	6.20	1.87	8.50	2.01
18.5	*20	5.50	1.64	7.70	1.25	43.5	*33	6.30	1.05	8.20	1.39
18.5	*34	5.50	1.58	7.70	2.00	43.5	*10	6.30	1.56	8.90	1.96
18.5	* 3	5.50	1.90	8.10	1.96	45.0	*13	6.40	1.57	8.80	2.39
18.5	*24	5.50	2.06	8.40	1.71	46.5	T1	6.50	1.08	5.40	2.17
18.5	*22	5.50	1.71	8.50	2.17	46.5	* 2	6.50	0.70	9.00	2.05
22.5	* 9	5.60	1.95	7.70	1.76	48.0	*T3	6.60	0.69	7.60	3.09
22.5	*47	5.60	1.57	7.90	2.07	49.5	*45	6.70	0.48	6.80	1.87
24.5	*12	5.70	1.63	8.50	1.65	49.5	*T2	6.70	0.67	6.90	3.10
24.5	*30	5.70	1.33	9.00	2.16	51.5	*17	6.80	0.63	8.30	2.45
28.5	* 6	5.80	1.87	6.80	1.81	51.5	*43	6.80	0.63	8.70	1.70

*Items (a total of 36 items) selected for Experiment II

TABLE 14

Means ($\bar{X}$) and Standard Deviations (SD) of Imagery (I) and Meaningfulness (m) for Fifty-two Real Words (selected from Paivio, Yuille & Madigan, 1968) Ranked (R) by Increasing Imagery Values

Item	R	#	I		m		Item	R	#	I		m	
			$\bar{X}$	SD	$\bar{X}$	SD				$\bar{X}$	SD	$\bar{X}$	SD
COTTON	1.50	19	6.00	1.27	7.13	2.03	*PLANT	24.5	40	6.50	0.91	8.32	2.36
*SOIL	1.50	47	6.00	1.19	8.00	2.18	*WINTER	28.0	58	6.53	1.04	8.32	2.44
MARKET	3.50	33	6.13	1.36	7.04	2.72	SUGAR	31.5	52	6.57	0.90	7.00	1.83
*TROOPS	3.50	55	6.13	1.07	7.54	2.11	FLOWER	31.5	24	6.57	0.79	7.13	2.46
*PICTURE	6.00	39	6.20	1.20	7.16	1.91	*CAMP	31.5	11	6.57	0.70	7.17	1.99
*TICKET	6.00	54	6.20	1.17	7.21	1.74	*BOTTLE	31.5	7	6.57	0.75	7.24	2.22
*COLLEGE	6.00	18	6.20	1.00	7.28	2.07	*QUEEN	31.5	43	6.57	0.70	7.36	2.16
*PRISON	8.50	42	6.23	0.87	7.21	1.74	STREET	31.5	51	6.57	0.97	7.48	2.80
*STONE	8.50	49	6.23	1.04	7.24	2.15	*WATER	35.5	56	6.60	0.70	7.50	1.98
JUDGE	11.5	30	6.27	0.95	7.04	2.13	*DOOR	35.5	62	6.60	1.03	7.96	2.26
*PARTY	11.5	38	6.27	0.84	7.08	2.24	*CHAIR	40.5	13	6.63	0.74	7.20	2.00
*KING	11.5	31	6.27	0.95	7.50	2.34	CHURCH	40.5	15	6.63	0.74	7.52	2.68
*EARTH	11.5	22	6.27	0.88	7.56	2.27	*RIVER	40.5	44	6.63	0.54	7.52	2.22
PAPER	14.0	37	6.30	1.46	7.68	2.97	*SHOES	40.5	45	6.63	0.82	7.52	2.18
*STEAM	15.0	48	6.37	0.86	7.46	2.00	*GRASS	40.5	26	6.63	0.65	7.54	2.30
*DOCTOR	17.0	20	6.40	1.06	7.32	2.06	*SHORE	40.5	46	6.63	0.47	8.13	1.85
CATTLE	17.0	12	6.40	1.06	7.56	2.68	*MEAT	40.5	63	6.63	0.65	8.32	3.08
*WHEAT	17.0	57	6.40	0.93	7.96	1.74	FOREST	40.5	25	6.63	0.69	9.12	7.15
STORM	19.5	50	6.43	0.83	7.21	2.73	*DIAMOND	46.0	61	6.67	0.59	7.84	2.23
*CITY	19.5	60	6.43	0.70	7.72	1.40	*SHIP	46.0	64	6.67	0.59	7.87	1.94
*CABIN	21.0	10	6.47	0.97	7.20	1.89	LAKE	46.0	32	6.67	0.53	9.22	2.02
CHILD	24.5	14	6.50	0.97	7.04	2.68	*FIRE	48.0	23	6.70	0.68	7.36	2.23
CLOCK	24.5	16	6.50	0.87	7.08	2.58	*COFFEE	49.5	17	6.73	0.56	7.28	1.90
*PALACE	24.5	36	6.50	0.79	7.08	2.12	*APPLE	49.5	2	6.73	0.56	7.67	2.24
*POTATO	24.5	41	6.50	1.10	7.13	1.85	OCEAN	51.0	35	6.77	0.42	8.76	2.30
*TABLE	24.5	53	6.50	1.01	7.60	2.55	HORSE	52.0	28	6.80	0.47	8.67	2.50

*Items (a total of 36 items) selected for Experiment II

APPENDIX C

RECOGNITION RESPONSE SHEETS

IDENTITY NO. _____ SEX: M F AGE: _____

Please circle the old items you have seen in the first part of the experiment. Circle the letter (L) if the left one of the pair is an old item, and circle the letter (R) if the right one of the pair is an old item.

- | | | |
|-----|---|---|
| 1. | L | R |
| 2. | L | R |
| 3. | L | R |
| 4. | L | R |
| 5. | L | R |
| 6. | L | R |
| 7. | L | R |
| 8. | L | R |
| 9. | L | R |
| 10. | L | R |
| 11. | L | R |
| 12. | L | R |
| 13. | L | R |
| 14. | L | R |
| 15. | L | R |
| 16. | L | R |
| 17. | L | R |
| 18. | L | R |
| 19. | L | R |
| 20. | L | R |

IDENTITY NO. _____

SEX: M F

AGE: _____

Please circle the old items (items you have seen in the first part of the experiment). Circle the word (YES) if the item presented is an old item, and circle the word (N) if the item presented is not an old item.

- | | | | | | |
|-----|-----|----|-----|-----|----|
| 1. | YES | NO | 21. | YES | NO |
| 2. | YES | NO | 22. | YES | NO |
| 3. | YES | NO | 23. | YES | NO |
| 4. | YES | NO | 24. | YES | NO |
| 5. | YES | NO | 25. | YES | NO |
| 6. | YES | NO | 26. | YES | NO |
| 7. | YES | NO | 27. | YES | NO |
| 8. | YES | NO | 28. | YES | NO |
| 9. | YES | NO | 29. | YES | NO |
| 10. | YES | NO | 30. | YES | NO |
| 11. | YES | NO | 31. | YES | NO |
| 12. | YES | NO | 32. | YES | NO |
| 13. | YES | NO | 33. | YES | NO |
| 14. | YES | NO | 34. | YES | NO |
| 15. | YES | NO | 35. | YES | NO |
| 16. | YES | NO | 36. | YES | NO |
| 17. | YES | NO | 37. | YES | NO |
| 18. | YES | NO | 38. | YES | NO |
| 19. | YES | NO | 39. | YES | NO |
| 20. | YES | NO | 40. | YES | NO |

APPENDIX D

DETAILED RESULTS OF EXPERIMENT II

TABLE 15

Recognition Performance of Pseudowords* in Percent Correct (%)
Presented Along with Imagery (I) and Meaningfulness (m) Values

Item No.	I		m		Number Correct	%
	$\bar{X}$	SD	$\bar{X}$	SD		
21	1.60	1.07	6.00	2.82	4	50.0
25	1.70	1.49	6.00	2.66	5	62.5
9	2.20	1.87	5.50	2.59	6	75.0
1	2.30	1.82	6.00	2.66	6	75.0
5	2.30	1.94	6.10	2.76	4	50.0
19	2.60	2.41	6.10	2.96	7	87.5
7	2.70	1.56	5.50	2.06	7	87.5
12	2.90	2.28	5.60	2.01	4	50.0
40	2.90	2.13	5.80	3.04	5	62.5
26	3.00	1.94	5.30	3.43	1	12.5
45	3.00	2.21	6.10	2.76	6	75.0
35	3.10	2.18	6.00	3.01	2	25.0
14	3.20	2.39	5.10	3.14	4	50.0
46	3.20	2.29	6.00	3.01	4	50.0
6	3.40	2.11	5.90	2.46	7	87.5
15	3.50	2.22	5.90	3.44	2	25.0
T4	3.60	2.06	5.20	3.25	5	62.5
T3	3.77	2.58	6.00	3.01	6	75.0
$\bar{X}$	2.83		5.78		4.72	59.02
SD	0.62		0.33		1.77	22.19

*Only 18 target items are presented

TABLE 16

Recognition Performance of Eighteen Target Checkerboard Patterns in
Percent Correct (%) Along with Imagery (I) and Meaningfulness (m) Values

Bits*	Item No.	I		m		Number Correct	%
		$\bar{X}$	SD	$\bar{X}$	SD		
H	37	2.60	1.57	5.50	2.83	3	37.5
H	T1	2.90	1.91	5.50	3.20	4	50.0
H	43	2.90	2.02	5.80	3.52	7	87.5
H	38	3.10	2.37	5.80	3.11	6	75.0
H	47	3.50	2.27	5.80	3.22	7	87.5
H	33	3.60	2.22	4.80	3.48	7	87.5
H	40	3.70	1.63	4.90	4.06	4	50.0
H	28	3.70	2.11	5.70	3.80	3	37.5
H	34	3.90	2.02	5.40	3.37	7	87.5
L	13	4.00	2.35	6.30	2.00	6	75.0
H	18	4.10	2.55	5.60	3.40	4	50.0
H	1	4.20	2.14	5.70	3.56	6	75.0
L	T4	4.50	2.50	4.70	2.83	4	50.0
L	14	4.60	1.83	6.10	3.81	4	50.0
H	19	5.00	2.00	5.70	2.94	4	50.0
L	T2	5.10	1.91	5.20	2.85	7	87.5
L	23	5.40	1.83	6.30	3.09	4	50.0
H	17	5.60	2.01	5.80	2.65	4	50.0
$\bar{X}$		4.02		5.59		5.06	63.19
SD		0.88		0.46		1.51	18.92

*Information Bits: H = 13.7 bits
L = 6.1 bits

TABLE 17

Recognition Performance of Eighteen Target Line Drawings in Percent
Correct (%) Along with Imagery (I) and Meaningfulness (m) Values

Item No.	I		m		Number Correct	%
	$\bar{X}$	SD	$\bar{X}$	SD		
20	5.50	1.64	7.70	1.25	8	100.0
34	5.50	1.58	7.70	2.00	7	87.5
24	5.50	2.06	8.40	1.71	8	100.0
47	5.60	1.57	7.90	2.07	8	100.0
12	5.70	1.63	8.50	1.65	8	100.0
7	5.80	2.09	8.20	1.98	8	100.0
23	5.80	1.98	8.40	2.01	8	100.0
46	5.80	1.54	8.40	1.77	8	100.0
T4	5.90	1.37	6.90	3.57	8	100.0
5	6.10	1.44	7.00	2.66	8	100.0
21	6.10	1.59	7.90	2.13	8	100.0
32	6.10	1.28	10.10	2.18	8	100.0
8	6.20	1.47	8.20	1.87	8	100.0
33	6.30	1.05	8.20	1.39	8	100.0
10	6.30	1.56	8.90	1.96	8	100.0
T3	6.60	0.69	7.60	3.09	8	100.0
45	6.70	0.48	6.80	1.87	8	100.0
43	6.80	0.63	8.70	1.72	8	100.0
$\bar{X}$	6.02		8.08		7.94	99.30
SD	0.41		0.78		0.23	2.95

TABLE 18

Recognition Performance of Eighteen Target Real Words in Percent
Correct (%) Along with Imagery (I) and Meaningfulness (m) Values

Item No.	I		m		Number Correct	%
	$\bar{X}$	SD	$\bar{X}$	SD		
47	6.00	1.19	8.00	2.18	8	100.0
39	6.20	1.20	7.16	1.91	8	100.0
42	6.23	0.87	7.21	1.74	8	100.0
38	6.27	0.84	7.08	2.24	8	100.0
22	6.27	0.88	7.56	2.27	8	100.0
48	6.37	0.86	7.46	2.00	8	100.0
57	6.40	0.93	7.96	1.74	8	100.0
10	6.47	0.97	7.20	1.89	8	100.0
53	6.50	1.01	7.60	2.55	8	100.0
40	6.50	0.91	8.32	2.36	8	100.0
7	6.57	0.75	7.24	2.22	8	100.0
56	6.60	0.70	7.50	1.98	8	100.0
13	6.63	0.74	7.20	2.00	8	100.0
44	6.63	0.54	7.52	2.22	8	100.0
46	6.63	0.47	8.13	1.85	8	100.0
61	6.67	0.59	7.84	2.23	8	100.0
64	6.67	0.59	7.87	1.94	8	100.0
17	6.73	0.56	7.28	1.90	8	100.0
$\bar{X}$	6.46		7.56		8.00	100.0
SD	0.20		0.38		0.00	0.0

APPENDIX E

ANCILLARY ANALYSIS

ANCILLARY ANALYSIS

In Experiment I, the subjects were given homogeneous response booklets (one type of stimuli in one booklet) when they scaled three types of stimuli (pseudowords, checkerboard patterns, and line drawings) for their imagery values. Each subject saw only one type of stimulus and was not exposed to the other two sets of stimuli. In the present analysis, subjects were given a mixed response booklet, i.e. a response booklet which included all three types of stimuli. They were all exposed to all three types of stimuli, and rated the items relative to the total population of stimuli involved. The purpose of this analysis was to examine if imagery values vary with the type of response booklet used.

Items. The three types of items were identical to those used in Experiment I. Identical instructions for the subjects were also read aloud and are presented in Appendix A.

Procedure. The three types of stimuli were presented to a group of subjects in the form of randomly mixed booklets. Here, a mixed booklet meant a response booklet which was comprised of all three kinds of items and were rated in the same way as the homogeneous booklets used in Experiment I. Since rating 156 items by each subject in one session was too lengthy and may cause fatigue, half of the subjects (10) were presented with response booklets consisting of 78 items (26 line drawings, 26 checkerboard patterns, 26 pseudowords), and the remaining 10 subjects were given the remaining 78 items.

Subjects. Twenty university students volunteered to participate in this experiment. None of these students had participated in Exper-

iment I. Their ages ranged from 23 to 41 years, and the mean age was 28.

Results and Discussion

The means, standard deviations, and the empirical ranges for the imagery values scaled in mixed booklets were presented in Table 19. The results showed that imagery values obtained, for the three types of stimuli, by using homogeneous and those by mixed booklets differed from each other significantly ($p < .05$). It was found that the mixed booklets produced higher imagery values for two sets of items, than those produced by homogeneous booklets [line drawings: $t(103) = 11.65$, $p < .001$; pseudowords: $t(103) = 5.78$, $p < .001$]; however, the checker-board patterns were rated lower in T values produced by the mixed booklet [$t(103) = 1.91$, $p < .06$]. This presented a significant problem. Researchers must bear in mind that, when comparing recognition memory between different types of stimuli, the subjects being exposed to all types of stimuli used in the experiment will respond differently to those subjects seeing only one type of stimuli. This is because, the subjects exposed to all types of stimuli will respond to the stimulus in question relative to all other stimuli involved. The results may also mean that in future scaling studies, it is better to have the subjects scale all the stimuli, even if that means more money, time, and energy.

TABLE 19

Ranges, Means ($\bar{X}$), and Standard Deviation (SD) of Imagery (I)

Values of Line Drawings, Checkerboard Patterns, and
Pseudowords Collected in Homogeneous and Mixed Booklets

	Homogeneous	Mixed
<i>PSEUDOWORDS</i>		
Range	1.77-5.10	2.40-5.30
$\bar{X}$	3.02	3.85
SD	0.81	0.64
<i>CHECKERBOARD PATTERNS</i>		
Range	1.70-7.00	2.40-6.40
$\bar{X}$	4.61	4.17
SD	1.33	0.97
<i>LINE DRAWINGS</i>		
Range	4.80-6.80	6.00-7.00
$\bar{X}$	5.79	6.70
SD	0.51	0.22

Homogeneous = Imagery values collected in Experiment I.

Mixed = Imagery values collected in mixed booklets
(consisting of three types of stimuli)

APPENDIX F

RAW DATA FOR EXPERIMENTS II, III, AND IV

TABLE 20

Raw Data for Experiments II, III, and IV

Experiment II High-Rated Items					Experiment II Low-Rated Items					Experiment III High-Rated Items					Experiment IV High-Rated Items				
S	Sex	Age	Correct #	%	S	Sex	Age	Correct #	%	S	Sex	Age	Correct #	%	S	Sex	Age	Correct #	%
27	M	18	18	100.00	1	M	18	10	55.55	43	M	18	18	100.00	51	M	18	35	97.22
V 28	M	18	18	100.00	2	M	18	8	44.44	44	M	22	15	83.33	52	M	18	30	83.33
E 29	M	19	18	100.00	3	M	18	7	38.88	45	M	21	16	88.88	53	M	18	35	97.22
R 30	M	18	18	100.00	4	M	18	11	61.11	46	M	19	18	100.00	54	M	18	29	80.55
B 31	F	19	18	100.00	5	F	19	12	66.66	47	F	19	18	100.00	55	F	22	33	91.66
A 32	F	18	18	100.00	6	F	18	16	88.88	48	F	18	18	100.00	56	F	19	31	86.11
L 33	F	18	18	100.00	7	F	18	10	55.55	49	F	18	16	88.88	57	F	18	31	86.11
34	F	19	18	100.00	8	F	19	11	61.11	50	F	18	17	94.44	58	F	18	33	91.66
N 19	M	19	18	100.00	9	M	18	10	55.55	35	M	24	14	77.77	59	M	18	33	91.66
O 20	M	23	18	100.00	10	M	18	8	44.44	36	M	17	18	100.00	60	M	20	31	86.11
N 21	M	18	18	100.00	11	M	18	11	61.11	37	M	18	18	100.00	61	M	20	30	83.33
V 22	M	23	17	94.44	12	M	17	14	77.77	38	M	26	18	100.00	62	M	22	34	94.44
E 23	F	18	18	100.00	13	F	19	10	55.55	39	F	25	18	100.00	63	F	19	33	91.66
R 24	F	18	18	100.00	14	F	17	16	88.88	40	F	19	17	94.44	64	F	19	33	91.66
B 25	F	19	18	100.00	15	F	19	10	55.55	41	F	17	18	100.00	65	F	23	36	100.00
A 26	F	18	18	100.00	16	F	23	12	66.66	42	F	18	18	100.00	66	F	21	32	88.88
L																			

Experiment II: Presented items at slow rate. Tested by forced choice method.

Experiment III: Presented items at fast rate. Tested by forced choice method.

Experiment IV: Presented items at fast rate. Tested by yes/no method.

Note: Maximum score in Experiments II and III is 18, in Experiment IV it is 36.

VITA

Surname	WONG	Given Names	JESSIE CHI-HAY
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Place of Birth HONG KONG

Date of Birth FEBRUARY 7, 1951

Educational Institutions Attended,
with Dates of Entering and Leaving:

HONG KONG BAPTIST COLLEGE, HONG KONG 1969 to 1973

UNIVERSITY OF VICTORIA, VICTORIA, B.C. 1973 to 1975

UNIVERSITY OF VICTORIA, VICTORIA, B.C. 1975 to 1977

to

Degrees, Diplomas, Etc., Awarded,
with Dates and Names of Institutions:

Diploma of Social Science
(First Class Distinction) 1973 Hong Kong Baptist College

Bachelor of Arts 1975 University of Victoria

Honours and Awards:

University of Victoria Scholarship, 1975-1977

Publications:

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OF EXPERIMENTAL PROCEDURES

Author: _____

Jessie Chi-Hay Wong

Name

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Date