THE UNIVERSITY OF ALBERTA

AN INVESTIGATION OF VISUAL SHORT-TERM MEMORY IN GRADE THREE ACHIEVING AND NON-ACHIEVING READERS

by

© IRIS WOYCHUK

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ABSTRACT

The following investigation was designed to examine the visual memory ability of achieving and non-achieving readers in an attempt to determine if any differences existed in their capacity to recall various types of stimuli. The stimuli (memory tasks) consisted of geometric forms, digits, letters, and words. The interrelationships of these memory tasks within each achievement group was also investigated.

Twenty-five achieving and twenty-three non-achieving readers in the grade three level were selected from three schools within the Edmonton Public School System. The subjects were chosen on the basis of achievement or non-achievement in reading as measured by the <u>Gates-MacGinitie Reading Test</u>. The selection of students was also based on intelligence quotients, visual acuity, and visual discriminative ability. Visual short-term memory was measured using the <u>Memory for Forms Test</u>, <u>Digit Span Test</u>, <u>Letter Memory Test</u>, <u>and Word Memory Test</u>.

Findings indicated that there were significant differences between the achieving and non-achieving readers in visual memory span ability. The subsequent partialling out of I.Q. had no notable effect on the difference in retention abilities between the two groups. Further analysis revealed that significant correlations were found between the various memory tasks for achieving readers. However, no significant correlations were exhibited between the various memory tasks for non-achieving readers.

For the total sample, significant correlations were found between the memory tasks and reading scores. However, within each achievement group little correlation was displayed between the memory tasks and reading scores. Exceptions were the significant correlation of the <u>Digit Span Test</u> to reading scores for the non-achievers and the significant relationship of the <u>Letter Memory Test</u> to reading scores for the achievers.

Results of the study would appear to indicate that ability in visual short-term memory is fundamental to success in reading.

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CHAPTER I

INTRODUCTION AND PROBLEM

Numerous educators have hypothesized that visual memory is an important factor in the reading process. Smith (1971) postulates that three aspects of memory must be involved in the reading act: a sensory store, short-term memory, and long-term memory. Visual information is gathered from the printed page and held for less than a second in a sensory store. A considerable amount of the information in the sensory store must necessarily be lost, but some is transferred to short-term memory, where it can be held for a few seconds. The amount of information that is admitted into short-term memory depends on the form. "Short-term memory may contain only four or five elements at any time, but each of these elements may be a single letter or a single word or possibly a meaning extracted from several words." (Smith, 1971, p. 78). The processed elements in short-term memory must then be disposed of - either lost altogether or transferred to long-term memory. Smith (1971) maintains that a good reader is the individual who can ensure that the information lost in the perceptual process is that which is least important.

Goodman (1967) describes the reading process as a 'psycholinguistic guessing game' in which there is constant use of short and long-term memory. He feels that phonological, syntactic, and semantic information is stored in long-term memory and used as a basis for making a tentative choice for the symbol on the page. This choice is stored in short-term memory until it is either accepted or rejected. If the tentative choice is not acceptable semantically or syntactically, the reader regresses to gather more cues from the printed message. If the choice is acceptable, decoding is extended and meaning is assimilated. This meaning is stored in short-term memory as the reader proceeds.

Spache (1966) further indicates that memory is necessary for the successful comprehension of sentences and paragraphs. "Comprehension of a sentence involves holding the successive thoughts in mind until the sentence is finished" (Spache, 1966, p. 69). That is, in order to relate the parts into a meaningful whole it is necessary to hold the initial elements of a sentence in memory until the end of the sentence is reached. Spache (1966) also states, "To comprehend a paragraph the reader must be able to keep in mind the ideas contributed by the successive sentences until the end of the passage" (p. 70).

Several researchers who were aware of the importance of visual memory in the reading process have directed their studies to the relation of visual memory to reading achievement. To determine this relationship several different avenues have been utilized. Numerous studies used visual memory for designs as an avenue to predicting reading achievement (Walters, [illegible]; Weiner, Wepman, and Morency, 1965; Lyle, 1968; Froehlich, 1970; [illegible]hrie and Goldberg, 1972; Carroll, 1972; Noelker and Schumsky, 1973). Other studies employed digits as the stimuli material (Katz and Deutsch, 1963; Murray and Roberts, 1968; Dornbush and Basow, 1970). However, the above studies involved non-verbal tasks (designs and digits) which, at least superficially, did not resemble the reading process per se. It may be that such tasks which contain no verbal material could distort correlations reported between visual memory and reading achievement.

Only a few studies employed visual tasks seemingly related to the reading process. Rizzo (1939), Stauffer (1947), and Raymond (1952) administered memory tests utilizing letters as visual stimuli. Also, a paucity of research concerning visual memory for verbal material such as words, syllables, and sentences is evident. Hence, conclusions on the relationships of visual memory span to acquisition of reading ability have been made without adequate attention to the types of material. Moreover, implications were drawn in most cases on the basis of one test. As early as 1938, Blankenship concluded that experimental results indicate that a person who recalls one material well may or may not recall another material well. This may partially explain why results of the foregoing studies are equivocal.

Thus, this study will attempt to establish the relationship of visual memory span to reading achievement by focusing on various types of material.

I. PURPOSE

The purpose of this study is to examine the student's visual memory span in an attempt to determine if any difference exists between grade three achieving and non-achieving readers to recall various types of visual stimuli.

Secondly, an attempt will be made to ascertain the relationships between the various visual memory tasks in achieving and non-achieving readers. More specifically, by including visual memory

memory tasks seemingly related to the reading process and tasks seemingly unrelated to the reading process, an investigation of the interrelationships between memory tasks in achieving and non-achieving readers will be made.

II. DEFINITION OF TERMS

Visual Memory Span. Visual memory span refers to the ability of an individual to reproduce immediately after one visual presentation, a series of discrete stimuli in their original order.

Achieving Readers. Achieving readers are those students in third grade who obtained a score that was one standard deviation or more above the mean score on the Gates-MacGinitie Reading Test.

Non-Achieving Readers. Non-achieving readers are those students in third grade who obtained a score that was one standard deviation or more below the mean score on the Gates-MacGinitie Reading Test.

Memory for Forms Test.* Adopted from the Benton Visual Retention Test, this test consists of ten designs upon which one or more figures have been drawn. The test was utilized to measure the student's capacity to reproduce geometric designs immediately following presentation.

Digit Span Test.* This examiner-constructed test consists of eight sets of digits with two trials in each set. The sets increase in length from two to nine digits. The test was designed to measure the student's ability to recall digits immediately following presentation.

Letter Memory Test.* This test, adapted from the Visual Attention Span for Letters Subtest of the Detroit Tests of Learning Aptitude, consists of eight sets of letters with two trials in each set. The sets increase in length from two to nine letters. The test was designed to measure the student's capacity to recall letters immediately following presentation.

Word Memory Test.* This examiner-constructed test consists of eight sets of monosyllabic words with two trials in each set. The sets increase in length from two to nine words. The test was designed to measure the student's ability to recall words immediately following presentation.

Non-Verbal Memory Tasks. Non-verbal memory tasks refer to the tasks seemingly unrelated to the reading process and are ascribed in this study to the Memory for Forms Test and the Digit Span Test.

Verbal Memory Tasks. Verbal memory tasks refer to the tasks seemingly related to the reading process and are ascribed in this study to the Letter Memory Test and the Word Memory Test.

III. HYPOTHESES

Null Hypothesis 1

There is no significant difference between the scores obtained by achieving and non-achieving readers on the:

(a) Memory for Forms Test
(b) Digit Span Test
(c) Letter Memory Test
(d) Word Memory Test

*The tests are described in Chapter III and copies are found in Appendices B and C.

Null Hypothesis 2

There is no significant correlation between scores on the non-verbal visual memory tasks and scores on the verbal visual memory tasks for the achieving readers.

Null Hypothesis 3

There is no significant correlation between scores on the non-verbal visual memory tasks and scores on the verbal visual memory tasks for non-achieving readers.

Null Hypothesis 4

There is no significant correlation between scores on the Gates-MacGinitie Reading Test and scores on the:

(a) Memory for Forms Test
(b) Digit Span Test
(c) Letter Memory Test
(d) Word Memory Test

IV. LIMITATIONS

The generalizability of the findings of this study are limited in accordance with the following considerations:

(1) The number of pupils involved in each achievement group was relatively small. Only students who obtained scores on the Gates-MacGinitie Reading Test that were one standard deviation or more below and above the mean score were selected. This criteria for determining achievement or non-achievement in reading required a larger population from which to draw an adequate sample of achieving and non-achieving readers.

(2) The mode of presentation in this study is limited to the visual and thus may affect the recall ability of any pupil whose modality preference is auditory.

V. SIGNIFICANCE OF THE STUDY

The role of visual short-term memory in the reading process has been discussed in the introduction of this chapter. Should the study demonstrate a difference between achieving and non-achieving readers in the various memory tasks this would suggest that the ability to retain visual stimuli is an essential factor to be considered for reading success.

The study may also help to determine which type of material (forms, digits, letters or words) for examining visual memory ability is most closely related to success in reading at the third grade level. Such an instrument could then provide an efficient method for identifying children experiencing difficulties in visual short-term memory. Hence, once children with visual memory deficits are identified, methods could be utilized that account for their short visual memory spans.

VI. OVERVIEW OF THE INVESTIGATION

In Chapter II the writer will delineate the theoretical framework under which this study was conducted and review the empirical research pertinent to the problem. Chapter III will contain the research design of the study with descriptions of the sample, the examiner-constructed and standardized tests used, and the collection and methods of analyzing the data. The results of the test data will be analyzed and explained in Chapter IV. The final chapter will present the summary, conclusion, implications, and suggestions for further research.

CHAPTER II

REVIEW OF SELECTED RESEARCH

Although visual memory appears to be an important component in the reading process, areas that appear to be pertinent to the present study and require further examination include: 1. the relation of visual memory to reading achievement, 2. the relative merits of various measures of visual memory to reading, and 3. the capacity of short-term memory.

In this chapter selected research reports that relate to the above areas will be discussed. To aid in focusing on these objectives only those studies which measure 'short-term' memory are included. In addition, only investigations concerning subjects of normal and above intelligence will be considered, thus eliminating the numerous studies on visual memory conducted with children of mental deficiency.

I. RELATION OF VISUAL MEMORY TO READING ACHIEVEMENT

In several studies, visual memory abilities have been associated with reading achievement. Kluever (1968) assessed short-term memory in thirty normal and thirty disabled readers in the fourth grade, using Guilford's Structure of the Intellect Model which includes figural, symbolic, and semantic factors. All the subjects had normal vision and hearing and no significant emotional disturbances. Intelligence was controlled, and the average WISC I.Q. was 102 for the normal and 100 for the disabled group. The investigation revealed that nine of the twelve visual memory tests as defined by Guilford's model differentiated significantly between normal and retarded readers. According to Kluever, the non-significance of the other three tests may have been due to their difficulty level. Kluever recommended further study on a variety of ages to clarify the impact of memory deficits on reading difficulties.

Katz and Deutsch (1963) studied the relationship between reading achievement and visual and auditory memory span for digits and verbal material. In all the grade levels tested - first, third, and fifth - Katz and Deutsch found that poor readers were able to recall sequentially presented material less efficiently in both modalities than the more skillful readers.

Visual sequential memory was also found to be related to reading achievement in a study by Battin and Kraft (1968). In the evaluations of fifty children who had reading problems, they found that all but two of the subjects were depressed in the Visual Sequential Memory Subtest of the Illinois Test of Psycholinguistic Abilities. The range of depression for the individuals was -2 to -76 months with a mean depression of -31.58 months. The poor readers averaged about two years below their age level in visual sequential memory. Hence, the above three studies suggest that good readers have considerably less difficulty in recalling visual stimuli than do poor readers. The foregoing studies further indicate that visual memory is related to the pupil's ability to read.

Although the above studies indicated a significantly high correlation between visual memory and reading, other investigations did not report this. Rizzo (1939) investigated the relationship of reading ability to memory span as measured by: 1. tachistoscopic visual span, 2. auditory span, and 3. temporal visual span. Children representing eight grade levels and numbering some three hundred and ten were presented with stimuli consisting of nine letters of the alphabet in nonsense order. The general finding of the study was that there is a significant but low correlation between memory span scores and reading test scores. Most of the correlations were positive but few were highly significant. When the comparison between good and poor readers was made in terms of group mean scores on the memory span tests, the scores of the former for all measures exceeded the scores obtained for the latter. However, this study included tachistoscopic presentation of stimuli with exposure times of .1 second. It is likely that the stimuli could not be accurately perceived by disabled readers in the short time period since the perceptual speed of disabled readers is known to be slower than that of normal readers (McGrady & Olson, 1970).

Goins (1958) found no significant correlation between memory span and first-grade reading achievement. Memory was tested with one hundred and twenty children by projecting forty pictures successively on a screen for an interval of twelve seconds each. After all exposures, the test booklet was presented and the subjects selected from groups of four similar pictures the one they saw on the screen. The fact that this test did not show any significant correlations with reading scores may indicate that visual memory for pictures is not an important component of reading.

Weiner, Wepman, and Morency (1965), using a recognition procedure, found that the <u>Bender Gestalt Test</u> on designs did not differentiate between twenty-eight good and twenty-eight poor readers at the fourth grade level. These results could be due to the low reliability of the immediate memory task (r = .35) or to the fact that visual memory for abstract forms is no longer an important component of fourth grade reading, although it might be essential in first grade reading.

Dornbush and Basow (1970) also found a lack of significant difference in recall performance between good and poor readers. Their study included seventy-two subjects in four grades: first, third, fifth, and ninth. Intelligence was held constant. Subjects in each grade were subdivided according to reading ability (good and poor). They found that performance on memory tasks was not affected by reading level. It should be noted, however, that Dornbush and Basow used a bisensory simultaneous task whereby different materials were presented simultaneously to each modality (auditory and visual). For example, a subject might hear 76095 and see, at the same time, 28143. The subject was then required to recall both the visual materials and the auditory materials in the order specified by the examiner.

It is also possible that the tasks Dornbush and Basow employed (auditory and visual short-term memory with digits) are not related to reading achievement. Digits may represent a relatively simple task for subjects, even for poor or retarded readers. In fact recall of numbers has previously been shown to represent a considerably easier task than do letters (Dornbush, 1968). Letters, singly or in word form, on the other hand, may yield differential results with regard to reading level inasmuch as they are the actual items with which subjects deal and on which basic reading tests are constructed. Thus, any difference in performance as a function of reading level might be related more to the nature of the task and as such would be obtained with different materials.

In summary, it appears that the foregoing studies lack consensus on the association of visual memory to reading achievement. Perhaps a major cause of the discrepancies in the results include differences in the tests used to determine retention ability. This prompted the writer to assess achieving and non-achieving readers' visual memory abilities with major consideration given to the various types of visual stimuli that can be used for diagnoses. It thus became apparent that additional literature on the relation of various types of material to reading success needed to be examined.

II. THE RELATION OF VARIOUS TYPES OF GRAPHIC MATERIAL TO READING ACHIEVEMENT

Phrases, sentences, geometric designs, digits, pictures, paragraphs, diagrams, letters, words, and syllables are types of material that have been used to test visual memory. It appears that geometric designs have been used most frequently. Table I illustrates this point.

An extensive study that considers visual memory for designs as an avenue to predicting reading achievement was conducted by Froehlich (1970). Short-term memory was examined in relation to word recognition and comprehension in first grade children. The <u>Memory-For-Designs Test</u>

TABLE 1

SUMMARY OF MAJOR STUDIES ON VISUAL SHORT-TERM MEMORY

AUTHOR	SUBJECTS	MODE OF PRESENTATION	MODE OF RESPONSE	STIMULUS-MATERIALS
Rizzo (1939)	(310) Grade 1-8	visual and auditory	recognition	letters
Brener (1940)	(40) University	visual and auditory	oral reproduction	digits, consonants, designs, colors, nonsense syllables, concrete words, abstract words, paired associates, memory for commissions, simple sentences
Stauffer (1947)	(51) Age 9-0 to 11-0	visual	oral reproduction	Detroit Tests of Learning Aptitude - objects, letters
Raymond (1952)	(50) Age 9-0 to 11-0	visual	oral reproduction	Detroit Tests of Learning Aptitude - objects, letters

TABLE 1 Cont'd.

AUTHOR	SUBJECTS	MODE OF PRESENTATION	MODE OF RESPONSE	STIMULUS-MATERIALS
Goins (1958)	(120) First Grade	visual	recognition	pictures
Walters (1961)	(35) Second Grade	visual	reproduction	Graham-Kendall Memory-For-Designs Test
Katz & Deutsch (1963)	(72) First, Third, Fifth Grade	visual and auditory	oral reproduction	digits, verbal material (pictures with words)
Weiner, Wepman & Morency (1965)	(56) Fourth Grade	visual	recognition	Bender Visual Motor Gestalt Test (geometric designs)
Kluever (1968)	(60) Fourth Grade	visual and auditory	recognition	figural (designs)
			recognition	symbolic (nonsense) words)
			reproduction	semantic (pictures, analogies, homonyms)
Battin & Kraft (1968)	(50) Age 5-6 to 13-1	visual	recognition	Illinois Test of Psycholinguistic Abilities (designs)
Murray & Roberts (1968)	(96) Age 7-0 to 10-0	visual and auditory	reproduction	digits
Lyle (1968)	(108) Ages 6-5 to 12-5	visual	reproduction	Memory-For-Designs Test

TABLE 1 Cont'd

AUTHOR	SUBJECTS	MODE OF PRESENTATION	MODE OF RESPONSE	STIMULUS-MATERIALS
Froehlich (1970)	(128) First Grade	visual	recognition	Memory-For-Designs Test
Dornbush & Basow (1970)	(72) First, Third, Fifth, Ninth Grade	visual and auditory	reproduction	digits
Carroll (1972)	(198) kindergarten & first grade	visual	recognition	geometric designs
Guthrie & Goldberg (1972)	(124) Normals-average age of 8-5. Disabled-average age of 10-3	visual	reproduction reproduction recognition	Knox Cube Test Benton Visual Retention Test (designs) Illinois Test of Psycholinguistic Abilities (designs)
Sister Ruth Eagan (1973)	(72) Second & Third Grade	visual	oral reproduction	Detroit Tests of Learning Aptitude - letters
Noelker & Schumsky (1973)	(48) Ages 9-0 to 9-8	visual	recognition	geometric designs

was constructed and refined, through pilot studies to measure the ability to form and retain visual images of designs for recognition in multiple-choice items. The results indicated that short-term memory for designs, having components of form, orientation, and sequence, was significantly related to both word recognition and comprehension. When intelligence was held constant, all these relationships retained significance. Froehlich indicates that the types of errors made in the retention of designs might generalize to letters. For example, a given tranformation such as rotation or reversal has generality to reading and is not specific to a given design.

Other design tests purporting to measure visual memory include the Benton Visual Retention Test, the Knox Cube Test and the Visual Sequential Memory Subtest of the Illinois Test of Psycholinguistic Abilities (hereafter referred to as the ITPA). The Benton Visual Retention Test and the ITPA are similar measures of visual memory ability although not identical. They both include the presentation of a series of geometric forms, the removal of the forms, and the requirement that the subject remember the forms. The response mode of the two tests is different. In the Benton Visual Retention Test, the subject is required to reproduce on paper the correct form(s). However, in the ITPA all stimulus elements in the form of chips are present for the child to manipulate throughout the time period allotted for him to reproduce the configuration. The Knox Cube Test also requires the child to reproduce motorically a series of stimuli presented visually. However, the test consists of a row of four stationary blocks mounted on a board, which the tester taps with another block in a specified sequence; the child is then given the block and asked to reproduce this sequence successively. The Benton Visual Retention Test differs from the Knox Cube Test and the ITPA in that not only does it require the subject to remember the order of a series of presented stimuli but it also requires the subject to remember the form and the attitude (orientation) simultaneously. However, such a test as the Benton Visual Retention Test obviously measures perceptual and motor functions as well as memory. "At present since the most widely used tests of visual memory require the subject to reproduce from memory various complex geometric designs with paper and pencil, these tests are appropriate only for subjects who are developmentally capable of drawing the stimulus designs (8 years of age and older)" (Carroll, 1972, p. 153).

A study by Guthrie and Goldberg (1972) utilized the foregoing tests to substantiate Froehlich's (1970) findings of the relationship of visual retention for designs (having components of form, orientation, and sequence) to the reading process. In the study, eighty-one normal readers and forty-three retarded readers who had normal intelligence and a mean reading grade of 2.5 were examined. The mean chronological age of the normals was 8.5 and the mean of the disabled was 10.3. Partial correlations between the three tests of visual sequential memory and reading were computed. Significant, positive correlations were identified between visual memory and paragraph comprehension, oral reading, and word recognition. The Benton Visual Retention Test showed more partial correlations with reading than the Knox Cube Test and the ITPA.

Since Guthrie and Goldberg found the Benton Visual Retention Test correlates more with reading than the other two measures, it is probable that reading also requires the simultaneous demand of memory for form, attitude, and sequence. For example, the skill of word recognition requires the retention of the specific letters contained in the word (memory for form), the attitude of the letters (rotations such as 'd' for 'p'), and the sequence of the letters ('lap' for 'pal'). Thus the results suggest that reading disability may derive from the lack of coordination among three different visual memory functions which are required for reading.

Carroll (1972) developed his own test of immediate visual memory that eliminates the output difficulties of visual motor integration and fine motor control. The designs used were similar to those found in the Memory-For-Designs Test and the Benton Visual Retention Test. However, the recognition rather than the reproduction method was used. The general administration procedure was to expose the stimulus designs one at a time for five seconds. After the five second exposure the design was withdrawn and the subject was presented with the multiple-choice retention plate. Each multiple-choice retention plate consisted of the correct design and three incorrect designs (i.e. variations of the correct stimulus but rotated, inverted, or incomplete).

Carroll used this memory scale to measure short-term memory in five and six year old children. A significant relationship between reading readiness in first grade pupils and visual memory of designs was noted. Also, as in Froehlich's study, a significant relationship between reading achievement in first grade pupils and short-term visual memory was found. Neither I.Q. nor sex differences were affecting significantly the subjects' performances on the memory test.

Utilizing designs but with a population of fourth graders, Noelker and Schumsky (1973) administered three memory tasks (sequencing, memory for form, and memory for position) to two groups of twenty-four subjects identified as normal and retarded readers. The groups were matched for I.Q. and chronological age. All tasks discriminated between normal and retarded readers. The position task was the single best discriminator. Serial position data from the position memory task showed a greater percentage of errors for the retarded readers at all positions. The form memory task, although distinguishing significantly between the groups of children, contributed the least discriminating power between the two groups. As possible reasons, Noelker and Schumsky stated that: 1. reading retardation is largely due to deficits in position memory and not memory for form, 2. the form task used in the present study was not difficult enough and therefore did not discriminate well, and 3. reading retardates may be characterized by deficiences in form or position memory and the present sample is heavily loaded on the latter (p. 25).

Further information related to the importance of visual memory for designs to reading achievement was provided by Walters (1961) and Lyle (1968). Each of these studies used the Memory-For-Designs Test. Their findings revealed that the retarded reader performed significantly less well than the normal readers. This discrimination was maintained even after adjustments for intelligence differences were made. Here, as

Guthrie's and Goldberg's study, Lyle and Walters employed the reproduction mode of response whereby the visual-motor integration and fine muscle coordination may have contributed to a decrement in overall functioning. This is plausible as some very young children were involved in the investigations.

A study employing digits as the stimulus material was conducted by Murray and Roberts (1968). Lists of six digits were presented either auditorially or visually at rates of one, two, or three digits per second to groups of seven, eight, nine, and ten year old girls. It was found that immediate recall improved with age under all conditions. No correlation was made to retarded and achieving readers. Instead, the study used age as a determiner of reading ability. That is, Murray and Roberts assumed older subjects would be more fluent in reading than younger subjects.

Another investigation suggesting that visual memory is developmental in nature was conducted by Eagan (1973). Unlike the previous studies mentioned, the Visual Memory Span for Letters Subtest from the Detroit Test of Learning Aptitude was utilized in part of her study. Eagan measured the visual memory spans of seventy-two pupils (twelve above-average, twelve average, and twelve below-average) in grades two and three. The findings were related to oral and silent reading comprehension scores, grade, and sex. Data indicated that grade three children had slightly longer visual memory spans than grade two children. A slight relationship between visual memory span for letters and 'silent' reading comprehension scores is indicated but it is not strong enough to differentiate between above-average and below-average pupils. Visual memory spans for letters, however, did differentiate between 'oral' reading groups, but differences were significant only between the above-average and average groups of oral readers, and only at the grade three level.

Stauffer (1947), in a much earlier study, also used the memory span battery of the Detroit Tests of Learning Aptitude in part of his investigation with fifty-one severely retarded male readers. In addition to the Visual Attention Span for Letters Subtest, the Visual Attention Span for Objects (pictures) was also utilized. It was found that retarded readers achieved significantly higher scores with non-verbal (objects) than with verbal (letters) measures of visual memory span.

Raymond (1952) used the same measures of memory span as Stauffer in her subsequent study with fifty reading achievers. The population consisted of boys each of whom had an average reading score on a standardized test at least two years higher than his mental age expectancy. Raymond found that achieving readers did not do better with non-verbal materials than with verbal materials when both types were used as visual stimuli. Data from Stauffer's and Raymond's studies indicated that different characteristics emerged between retarded and achieving readers when interrelationships between the various visual memory tasks were considered.

Focusing attention on types of memory tasks, Blankenship, in reviewing literature previous to 1938, presents evidence to prove that the absolute size of the span varies from material to material. He concluded that the most difficult material to reproduce is nonsense syllables, then letters, then digits, sentences, and related words.

Brener's (1940) study, on the other hand, proved digits easiest to handle and sentences most difficult. "The listing of materials in terms of increasing difficulty is as follows: Digits, Consonants and Colors (the latter two of about equal difficulty), Concrete Words, Geometrical Designs, and Abstract Words (the latter three of about equal difficulty), Paired Associates, Nonsense Syllables, Memory for Commissions, and Sentences" (p. 481). Since Brener's study consists of university students, it is somewhat insignificant to the literature being reviewed in the context of this chapter. Nevertheless, it is interesting to note that findings on the matter of memory capacity as related to the types of material is at variance. It appears that 'certain factors' associated with the types of material may make for easier recall. The factors that appear to increase the capacity of memory will be discussed in the following section.

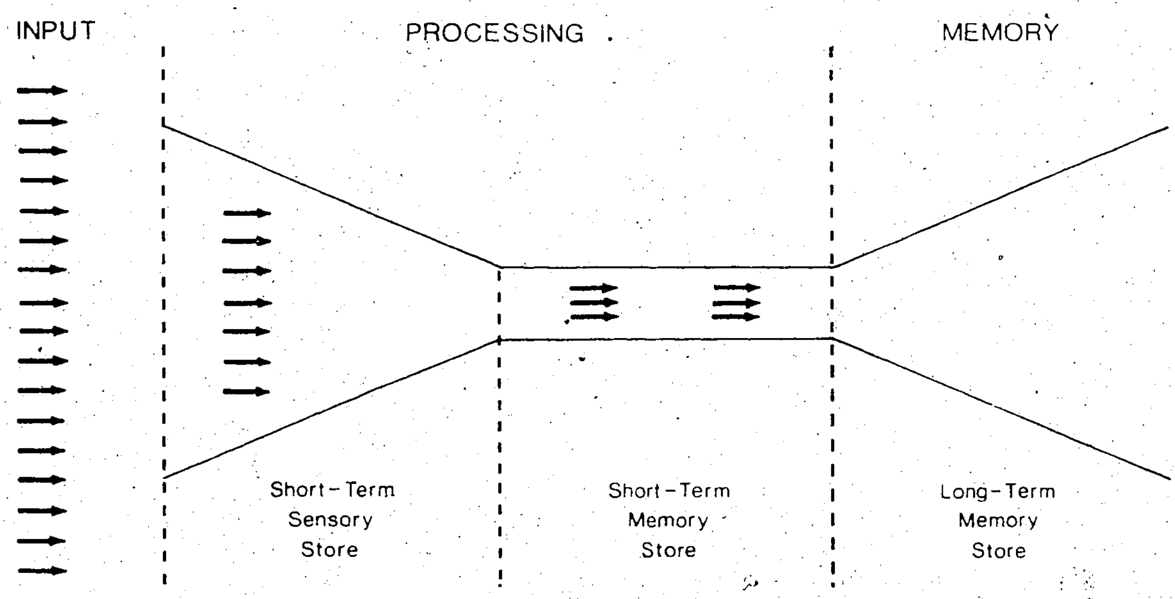
III. CAPACITY OF SHORT-TERM MEMORY

It was Miller's famous paper of 1956 which illustrated that organization of material largely determines the capacity for immediate memory. Miller points out that there is a finite span of immediate memory and that for a lot of different kinds of test materials this span is limited to the magical number seven plus or minus two. His classic article reviewed studies conducted in many different situations which consistently showed that our memory span was limited to seven plus or minus two items. However, it seems obvious that we are able to deal with more information. This is indeed the case and the key to the puzzle lies in the definition of the items that are processed. As Miller described it, our memory span is equivalent to having a purse that will hold seven coins, but it does not matter whether the coins are pennies or silver dollars. People group or 'chunk' information and then process the 'chunks' as an item.

"In order to speak more precisely, therefore, we must recognize the importance of grouping and organizing the input sequence into units or chunks. Since the memory span is a fixed number of chunks, we can increase the number of bits of information that it contains simply by building larger and larger chunks, each chunk containing more information than before" (Miller, 1956, p. 93). In other words, we cannot increase the number of chunks, but we can increase their capacity. It follows that the way material is organized into chunks largely determines the capacity for immediate memory. Miller terms the process by which it becomes possible to process larger and larger units or chunks, recoding. As an example of recoding he cites an experiment by S. Smith (1954). Using himself as a subject, Smith was able eventually to increase his memory span for binary digits up to forty, recoding every five digits into a single unit. He was not remembering forty single items, but was using his recoding capacity to reduce the number of chunks from forty to eight, a quantity within his memorizing capacity. "By organizing the stimulus input simultaneously into several dimensions and successively into a sequence of chunks, we manage to break (or at least stretch) this informational bottleneck" (Miller, p. 95). The informational bottleneck is illustrated below in the schema by Bartz (1968).

FIGURE I

THE FLOW OF INFORMATION IN THE STORAGE PROCESS



In the diagram above, short-term memory is the bottleneck in the storage process; processing is limited to seven plus or minus two items of information. This bottleneck places a premium on the ability to code and group information so that more information may be processed. The limits of short-term memory make it necessary that rules, formulae, strategies, and decision processes be adopted which reduce or summarize the immense array of information that is potentially available.

Miller's (1956) article has had a great effect upon the approaches of investigators in subsequent research. Many investigators concentrated on the importance of organizing activities for memory performance. Material which is well organized is better remembered, and recall performances by subjects in various studies demonstrate an organization similar to that in the original material. Furth, 1963; Vaughan, 1968; Calfee, 1970; Bower et al, 1969).

The general implication of the results of Rosenberg's (1968) study is that, in recalling a sentence, the words are recoded for storage into the largest chunks possible, based upon the syntactic and associative-semantic structure of the sentence. Such a strategy would reduce the number of memory units (chunks) to be stored while increasing the amount of information per unit (chunk).

Vanevery and Rosenberg (1970) further state that, contrary to expectation, the effect of semantic integration on recall performance was not limited to the older subjects. It appears that the semantic competence reflected in adult associative sentence norms develops as early as first grade. However, age tends to increase chunking and thus recall performance.

In the absence of appropriate organization of the material to be remembered, subjects will impose their own organization (Miller, 1956; Tulving, 1962; Smith, 1971). A long series of letters can be more easily held in the short-term memory, for instance, if they are made into an acronym or a word. In this case the word rather than the individual letters is remembered.

In conclusion, it does not appear to matter how much information enters the visual system. The reader can get only about five items through the processing bottleneck of short-term memory, but the items in short-term memory need not be individual letters, or even individual words; they can be larger units of meaning. It is only by reading in these larger units, that the limited capacity of the system can be overcome. It is probable that a skilled reader is more able than a poor reader to attend to cues in the related material, reorganize the material on the basis of these cues, and thus be able to process larger units or chunks for better retention.

SUMMARY

Research findings have been equivocal since the results of a number of studies reveal a significant correlation between visual memory and reading while others question the extent to which visual memory is related to reading achievement. From the review of the literature it appears that the type of material presented may have some bearing on the results secured for retarded and achieving readers. Furthermore, a consensus on the pattern of relative achievement in memory span for various types of material is difficult since experiments varied in factors such as: the ages of the subjects, the length of time of exposure of the material, the method of stimuli presentation - whether simultaneous or successive, and the mode of response - whether recognition or reproduction. For instance, information that cannot be 'recalled' can often be identified in a 'recognition' task. "A complication is that choice of a recall or recognition test as a measure of memory may affect not only the absolute performance levels but also the distribution of results between experimental conditions" (Howe, 1970, pp. 48-49).

In numerous studies (Brener, 1940; Katz & Deutsch, 1963; Dornbush & Basow, 1970; Carroll, 1972; Noelker & Schumsky, 1973) the reliabilities of the visual memory tests are not given and therefore, the magnitude of the correlation between any memory tasks and reading achievement cannot be interpreted.

Apparently, in many of the individual studies implications were drawn on the basis of one memory test. However, a person who recalls one type of material well may or may not recall another type of material well. In conclusion, it appears that there has been little, if any, attempt to interrelate various visual memory tasks and explore their relationship to achieving and non-achieving readers. The design for such a study will be described in the following chapter.

CHAPTER III

THE RESEARCH DESIGN

The purpose of this chapter is to describe the test population, the various screening and testing instruments, the pilot study, and the collection and analysis of data.

I. SAMPLE SELECTION

The sample for this study was selected from a grade three population attending three different schools within the Edmonton Public School System. The children were distributed over six different classrooms. To minimize the effects of differences in socio-economic background, the three schools chosen for the experiment were originally designated by the officials of the Edmonton Public School System as largely of a mid-socioeconomic area.

A grade three population was selected for it is important that a child be diagnosed early in his school years in order that appropriate teaching techniques be utilized. A younger population would be unsuitable since the nature of the study demands that the child have a basic sight vocabulary and a knowledge of numbers and letters.

Reading Assessment

In order to obtain a sample of achieving and non-achieving readers the Gates-MacGinitie Reading Test, Primary C, Form 1 was administered to a total of one hundred thirty-three subjects in six third grade classrooms. All those subjects receiving reading scores of one standard deviation or more above the mean were designated as achieving readers and all those subjects receiving reading scores of one standard deviation or more below the mean were designated as non-achieving readers. The possible research sample at this point consisted of twenty-five achieving readers and twenty-eight non-achieving readers.

Intelligence Quotient Screening

To avoid inclusion of children whose reading difficulty was due to mental deficiency, all subjects of below average I.Q. were excluded. The Canadian Lorge-Thorndike Intelligence Test, Level A, Form 1, which was administered in February by the classroom teachers to the total grade three population of the Edmonton Public School System, was used to determine intelligence quotients. More specifically, scores from the Nonverbal Battery were obtained from the cumulative record files. The Nonverbal Battery "yields an estimate of scholastic aptitude not directly dependent upon ability to read" (Lorge, Thorndike, and Hagen, 1967, p. 3).

Three children whose scores fell more than one standard deviation below the mean, were excluded leaving a sample of twenty-five achieving and twenty-five non-achieving readers. "Lorge-Thorndike intelligence quotients are deviation intelligence quotients, where the average I.Q. for each group has been set at 100 and the standard deviation has been set at 16" (Lorge, Thorndike, and Hagen, 1967, p. 38).

Visual Screening

Assessment of a child's visual acuity and visual discrimination should precede assessment of his visual memory. "Adequate visual sensory efficiency is prerequisite to skill in perceiving printed symbols"

(Goins, 1958, p. 2). Also, in order to retain visual stimuli the child must be able to differentiate similar symbols. Thus, the remaining population of twenty-five achievers and twenty-five non-achievers was administered a visual acuity test employing the Keystone Telebinocular. The children were tested on five of the Keystone Visual Survey Tests - lateral posture, fusion, usable vision with both eyes, usable vision with right eye, and usable vision with left eye, all at near point. These five areas were considered to be essential for unhampered visual functioning while reading. On the basis of this test one child was excluded from the sample of non-achievers and referred for further visual testing.

To test visual discrimination the Huelsman Word Discrimination Test, Form B was adapted for this study. One student had to be excluded from the study on the basis that he could not discriminate similar visual stimuli.

From the original twenty-five achieving and twenty-eight non-achieving readers, five were excluded as a result of I.Q. and visual screening. At this point, twenty-five achieving and twenty-three non-achieving readers remained for purposes of this study and constituted the test sample. Table 2 presents a brief description of the sample in terms of mean chronological age and intelligence quotient.

II. TEST INSTRUMENTS

Standardized Tests

Gates-MacGinitie Reading Test, Primary C, Level 1

The Primary C level of the Gates-MacGinitie Reading Tests is

TABLE 2

MEAN CHRONOLOGICAL AGES AND INTELLIGENCE QUOTIENTS OF THE TEST SAMPLE

	No. of Subjects	Mean C.A. (months)	Mean I.Q. (Nonverbal)
Achieving Readers	25	105.16	123.84
Non-Achieving Readers	23	104.30	99.91
Total Sample	48	104.75	112.38

part of a new series of tests designed to cover grades kindergarten through twelve. This test was chosen as the measure of reading achievement mainly because it is both easily administered and well-standardized. Also, it is presently being utilized within the schools of the Edmonton Public System as a final grade three reading test.

The <u>Gates-MacGinitie Reading Test</u> consists of two subtests - Vocabulary and Comprehension. The Vocabulary Test samples the child's ability to recognize or analyze isolated words. It includes fifty-two exercises, each of which contains a picture or test word followed by four words. The child's task is to choose one of the four words which corresponds or is similar in meaning to the picture or test word. The first exercises are composed of easy and commonly used words. Gradually the words become less common and more difficult.

The Comprehension Test measures the child's ability to read and understand whole sentences and paragraphs. This ability includes many skills not involved in the mere ability to recognize words. The child must grasp the total thought clearly if he is to answer correctly. The test contains twenty-four paragraphs of increasing length and difficulty. Each paragraph is followed by two questions with four alternative answers for each item. The child's task is to choose the best answer for each question.

The norms for the series of tests covering kindergarten through twelve are based on the most recent nationwide standardization and were developed by administering the tests to approximately 40,000 pupils in thirty-eight communities. The main normative testing was carried out in October, 1964. The resultant norms, are expected to reflect more accurately current reading achievement than do those norms on other Gates tests on which the normative procedures were done prior to 1964.

The reliability coefficients were calculated using both alternate form and split-half procedures. The reliability coefficients for Primary C of the Gates-MacGinitie Reading Tests are presented in Table 3. Also, a validity coefficient of .83 is specified for the Primary C level on correlations between the subtests, Vocabulary and Comprehension.

The Canadian Lorge-Thorndike Intelligence Tests, Level A, Form 1

This test provides both a Verbal and a Nonverbal Battery. The Verbal Battery is made up of five subtests which use only verbal items: vocabulary, verbal classification, sentence completion, arithmetic reasoning, and verbal analogy. "... for some - the young, the poorly educated, or the poor reader - printed words may constitute an inadequate basis for appraising an individual's abilities. Consequently, a parallel set of nonverbal tests is provided to accompany the basic verbal series" (Lorge, Thorndike, and Hagen, 1967, p. 3).

The Nonverbal Battery uses items which are either pictorial or numerical in nature. It contains three subtests involving pictorial classification, pictorial analogy, and numerical relationships. Thus, considering the nature of the sample in this study, scores from the Nonverbal Battery were utilized.

The Canadian Lorge-Thorndike Intelligence Tests, originally developed in the United States, were standardized in Canada in October and November of 1966. The standardization sample was selected so as to distribute the pupils across the provinces in the same proportion as the distribution of English-speaking children. A sample of 4,273

TABLE 3

RELIABILITY COEFFICIENTS OF READING SUBTESTS

FOR THE GATES-MACGINITIE READING TEST, PRIMARY C

Subtest Score[1]	Average Raw Score Mean	Average Raw Score Standard Deviation	Alternate Form Reliability	Split Half Reliability
Vocabulary Total Score 52	32.9	8.3	.85	.89
Comprehension Total Score 48	25.0	10.3	.87	.91

[1]The subtest scores and the reliability coefficients given in this table are presented in the Technical Manual for the Gates-MacGinitie Reading Tests (1965b, p.8)

pupils was selected for grade three.

Odd-even reliability data for the test based on representative third-grade samples from the standardization programme are presented in Table 4.

TABLE 4

RELIABILITY COEFFICIENTS OF THE VERBAL AND NONVERBAL BATTERIES OF THE CANADIAN LORGE-THORNDIKE INTELLIGENCE TEST

Level	Grade	N	Verbal Battery			Nonverbal Battery		
			Mean	S.D.	r_{11}	Mean	S.D.	r_{11}
A	3	511	41.75	16.47	.945	41.72	13.51	.931

Intercorrelations between Verbal and Nonverbal Batteries are reported at .681. Validity based on correlations of the Lorge-Thorndike Nonverbal Battery with the Stanford-Binet Intelligence Tests and the Nonverbal scale of the Wechsler Intelligence Scale for Children "have been reported in the high 60's and low 70's" (Lorge, Thorndike, Hagen, 1967, p. 29).

The Keystone Visual Survey Test

This is an individually administered test which involves the use of the Keystone Telebinocular instrument. The instrument contains stereoscopic slides to detect near and far point fusion difficulties, muscular imbalance, binocular efficiency, depth perception, nearsightedness, and farsightedness. The total test consists of fourteen card presentations or subtests, nine of which are placed at the far-point position, equivalent to an actual distance of twenty feet. The remaining five card presentations are placed at the near-point position equivalent to an actual distance of sixteen inches.

As suggested in the Keystone Instructional Manual (1961) a child experiencing difficulties in lateral posture, fusion, and usable vision at near-point would also be hampered in reading at near-point. Thus, these subtests were used to screen out children experiencing visual deficiences in these areas.

Huelsman Word Discrimination Test, Form B

This test is used in the Reading and Language Centre at the University of Alberta and is regarded as a satisfactory test of visual discrimination. It requires the person to distinguish a word from combinations of letters similar in shape and form. Consisting of ninety-six items, the test was modified in that only every second item of the first thirty-five items were used for the present study. Only a few items of the test were required since the researcher was interested solely in whether the subject revealed any difficulty in discriminating visual stimuli rather than determining a pattern of specific types of errors. An adapted version of the test is found in Appendix A.

Benton Visual Retention Test, Form C, Administration A*

This is a clinical and research instrument designed to assess memory, preception, and visuomotor functions. Three equivalent forms (Forms C, D, and E) consist of ten designs each, upon which one or more

*See Appendix B for a complete copy of the test.

figures have been drawn. Various modes of administration of the test are possible.

Lack of data relating to the reliability of the various modes of administration led to the selection of the 'standard' procedure which entails a ten second exposure of one of the forms with immediate reproduction from memory on the part of the subject. Retest reliability for the 'standard' procedure, as estimated by the correlations between equivalent forms, has been found to be approximately .85 (Benton, 1955, p. 1). Also in normal subjects, performance on the Benton Visual Retention Test correlates fairly high with intelligence level, the obtained coefficients between scores on the test and scores on standard intelligence scales being about .7 (Benton, 1955, p. 43).

In the administration of the test, the subject is given blank sheets of paper, the dimensions of which correspond to the dimensions of the stimulus cards (approximately 5.5 in. x 8.5 in.) and a pencil with an eraser. He is shown a series of stimulus cards on which there are one or more designs, he is instructed to study each card for ten seconds and when it is removed he is required to draw what he has seen.

Tests were scored by using Benton's (1955) scoring principles and samples as guides. The scoring samples for each design illustrate correct and incorrect reproductions. The principles underlying the scoring of the designs include omissions, distortions, perseverations, rotations, misplacements and size errors. "In general, the scoring standards are rather lenient because in this scoring system one is interested in the subject's capacity to retain a visual impression and not in his drawing ability. Thus, the size of the reproduction as a whole, as compared with the original design, is not considered in the scoring. However, as the specific principles of scoring show, the relative size of the figures of a single design, as compared with each other is taken into account" (Benton, 1955, p. 5).

Two scoring systems are available for the evaluation of subjects' performances on the drawing forms. One system (Number of Correct Reproductions) provides a measure of general efficiency of performance. The other system (Error Score) takes account of the specific types of errors made by the subject. In the 'Number of Correct Reproductions' scoring system, each design is scored on an all or none basis and is given a credit of one or zero. Therefore, the range of possible scores is zero to ten. This scoring system is used to compare the observed and expected performance levels of children of different ages and intelligence levels as defined by the normative standards. Since this is not the interpretation required, it was necessary to modify the scoring system whereby each figure in a design is scored separately. Thus, the range of possible scores became zero to twenty-six.

The Benton Visual Retention Test, as mentioned previously, is essentially a task which involves the interaction of visuomotor and visual memory factors. Consequently, although the standards of scoring are lenient with respect to the motor-executive aspects of performance, one is sometimes in doubt as to whether a perceptual and retention deficit or a graphomotor disability is responsible when a child does poorly on the test. "...with the scoring standards presented in this manual, it will not be often that graphomotor, rather than perceptual-mnemonic, factors are found to be conditioning performance on the test. The examiner need only have the patient draw one or two designs to evaluate this possibility" (Benton, 1955, p. 59). Accordingly, in the present study the researcher requested the subject to 'copy' a design from Form D of the Benton Visual Retention Test (See Appendix B). According to the manual it was found that the subjects drawings were reasonably accurate under the copying condition. Thus, graphomotor incapacity was excluded as a possible factor for the obtained scores on the memory test.

Tests Constructed for This Study*

Digit Span Test

This test consists of eight series of digits. Each series consists of two trials. The first series begins with a span of two digits. Each consecutive series increases the span by one, until the final and eighth series measures a span of nine digits.

In the construction of the test, the order of digits was determined from a table of random numbers that met the following criteria:

a) no digit appeared more than once in a span,

b) no digits which normally exist in a sequence (ei. 2-3) appeared in any span,

c) no reversed successive digits occurred, and

d) zero (0) was not used in any span.

These constraints were adopted from studies carried out on digit span tests by Jensen (1971) and Keogh and MacMillan (1971).

*See Appendix C for copies of the tests.

The digits were printed with black flow pen on strips of white cardboard, 3½" x 9". The digits were one inch high and evenly spaced so as not to suggest grouping.

In the administration of the test the subject was instructed to report the digits orally, in the order in which they appeared from left to right, immediately after presentation. The exposure time was determined by the length of the span at the rate of one second per digit. In general, only the first trial of the series was administered as long as the child was successful. As soon as the child failed on one of these first trials of a series the second trial was administered. Testing was discontinued when the child failed to repeat correctly three consecutive trials. The child's digit span was determined by the length of the last correct span that he was able to hold in his memory and repeat without error.

Letter Memory Test

The Letter Memory Test was adapted from the Detroit Tests of Learning Aptitude, Visual Attention Span for Letters, Test 16 (hereafter referred to as the Detroit Test).

The Detroit Test consists of six sets of letters with four trials in each set. The sets increase in spans from two letters for each trial in the first set to seven letters for each trial in the sixth set.

For the purposes of this study, the first two trials of the six sets were utilized from the Detroit Test. However, two additional sets were constructed. Thus, the Letter Memory Test was patterned like the Digit Span Test in format and administration. Like the Digit

Span Test, it also consists of eight series of letter spans with two trials in each series. The spans increase in length from two to nine letters. Testing was terminated after three successive failures. It was scored in the same way that the Digit Span Test was scored whereby the largest span repeated correctly in exact order was employed.

The letters were printed with black flow pen on strips of white cardboard, 3½" by 9". The letters were one half to one inch high and evenly spaced so as not to suggest grouping.

Word Memory Test

A review of the related literature indicated that no test was available which measured an individual's ability to recall visually perceived stimuli in the form of words. Thus, a Word Memory Test was constructed identical to the Digit Span and Letter Memory Tests in format and administration. Similarly, the spans increased from two to nine words with all the words in a span presented simultaneously. The exposure time was determined by the length of the span at the rate of one second for each word.

The words were printed with black flow pen on strips of white cardboard. They were evenly spaced so as not to suggest grouping.

The stimulus material consists of monosyllabic words which were selected on the basis of frequency and familiarity. The two criteria were met by the following constraints:

a) each word was selected from the Dolch Basic Sight Vocabulary (Dolch, 1960, p. 255) and rank ordered according to the Kucera-Francis list (Otto and Chester, 1972, p. 437-444) as one of the 200 most frequent words,

b) each word is a 'service' word at or below second grade level. Dolch (1960) defines basic service words as general words; not nouns but the simplest verbs, adverbs, pronouns, adjectives, prepositions, and conjunctions.

Reliability

A test-retest method of achieving a measure of reliability was used for the present study. This procedure indicates how accurate a score is on a test. That is, it elicits the stability of scores over a period of time.

In order to achieve an estimate of the reliability of the test instruments devised by the researcher, the Digit Span Test, the Letter Memory Test, and the Word Memory Test were readministered after an interval of one week. The reliability coefficients for the foregoing tests are reported in Table 5.

TABLE 5

RELIABILITY COEFFICIENTS FOR TESTS CONSTRUCTED FOR THIS STUDY

Tests	Dig pan Test	Letter Memory Test	Word Memory Test
Reliability Coefficients	.67	.89	.92

It should be noted that in the test-retest procedure responses are being correlated to two exposures of the same content. Thus, whatever bias exists in the content of the instrument will be a consistent bias on each exposure to the instrument.

III. PILOT STUDY

A pilot study was conducted using forty randomly selected grade three children who were grouped into high and low reading groups on the basis of teacher judgement. The purpose of the pilot study was:

a) to test whether there was any indication of differing performances on the memory tasks by the high and low readers,

b) to practice the administration and scoring of the memory tasks,

c) to ascertain time requirements for the testing instruments,

d) to determine whether a word recognition test was required as a prerequisite to the Word Memory Test, and

e) to establish norms for the instruments devised by the researcher.

On the basis of the results of the pilot study, the following observations and decisions were made:

a) There appeared to be differences between the high and low groups on their performances in the memory tasks.

b) The instructions given to the stud[illegible]ts in the pilot study appeared to be satisfactory. A[illegible] a result, they were utilized in the major study. The standard i[illegible]ructions are reproduced in Appendices B and C. Scoring techniques for the instruments devised by the researcher appeared to be satisfactory. The system involved giving credit to the highest span repeated correctly in the exact order. The scoring system established for the Benton Visual Retention Test appeared satisfactory as well, whereby each figure was scored separately, giving a possible score of twenty-six.

c) The total time involved in the administration of the four memory tasks was approximately fifteen minutes, which did not appear to cause the children any undue strain.

d) It appeared that stimulus material in the Word Memory Test presented little or no difficulty to the subjects, even the low achievers. Thus, a word recognition test which would select only those students who correctly identify all words contained in the Word Memory Test was not necessary. In cases where there was doubt as to whether the subject's poor memory span score was the result of word recognition difficulty or memory per se, a decision was made that upon termination of the Word Memory Test the subject would be asked to identify the words in the spans in which he received three successive failures.

e) Norms could not be established on the instruments devised by the researcher on the basis of only forty subjects.

IV. COLLECTION OF DATA

Testing for the main study was carried out in the first three weeks of May. All tests, with the exception of the Canadian Lorge-Thorndike Intelligence Tests, were administered and scored by the researcher.

The Gates MacGinitie Reading Test was administered to each grade three class as a total group within their respective classrooms. Separate testing periods were scheduled for the Vocabulary and Comprehension subtests.

The visual screening tests and the memory tests were administered individually to each subject. If the child displayed difficulty in the Keystone Visual Survey Test or the Visual Discrimination Test testing was discontinued at that point. The total mean time involved for the visual screening and memory tests was approximately twenty minutes per child. Private rooms were made available for the individual testing sessions.

To establish test-retest reliability, the four memory tasks were readministered one week subsequent to the initial testing. Practice and fatigue effects, which may arise from the presentation of the memory tasks in the same order to all subjects, were eliminated by splitting the forty-eight subjects into presentation-order groups, A, B, C, and D. The presentation scheme employed in the test and retest sessions follows:

Group A - digits, forms, letters, words.

Group B - forms, letters, words, digits.

Group C - letters, words, digits, forms.

Group D - words, digits, forms, letters.

For example, Group A consisted of twelve subjects who commenced with the Digit Span Test and proceeded to the Benton Visual Retention Test, then the Letter Memory Test, and lastly, to the Word Memory Test.

Data on chronological age and intelligence quotients were collected from the school cumulative record files.

V. STATISTICAL ANALYSIS OF DATA

The data were analyzed using computer programs set up by the Division of Educational Research Services of the University of Alberta. The following analyses were used:

(1) Pearson Product Moment Correlation (DEST 02)

Using this program, correlation matrices were computed for the memory and reading variables for each of the achievement groups and for the total sample.

(2) Partial Correlation (APL STP2)

The effect of the I.Q. variable was partialled out from reading and memory correlations using this APL function.

(3) One Way Analysis of Variance (ANOV 10)

This analysis was used to determine whether differences existed between the reading groups on the various memory tasks.

(4) One Way Analysis of Covariance (ANOCV 10)

An analysis of covariance was used to determine whether the differences in memory tasks between the two groups were maintained when I.Q. was covaried out.

(5) Uncorrelated t-Tests (ANOV 10)

t-tests were used to assess the significance of the difference between the mean performances of the achieving and non-achieving readers in the various memory tasks.

(6) Stepwise Discriminant Function (MULR06)

A stepwise discriminant function using a multiple regression analysis identified the relative contribution of the various memory tasks as predictors of the reading group.

CHAPTER IV

ANALYSIS AND INTERPRETATION OF DATA

In this chapter the following aspects of the data obtained for the study will be examined:

(1) Performance on Tests of Reading Achievement

(2) Relationship Between Achieving and Non-Achieving Readers on Various Memory Tasks

(3) Relationship Between Memory Tasks for Achieving Readers

(4) Relationship Between Memory Tasks for Non-Achieving Readers

(5) Relationship Between Memory Tasks and Reading Scores

(6) Additional Findings

In reporting the results of statistical analyses a level of significance at the .05 level was accepted, as it was considered to be sufficiently rigorous for the present study. Relationships which were beyond the .01 level of significance were noted.

PERFORMANCE ON TESTS OF READING ACHIEVEMENT

Data on the reading ability of the pupils was obtained from administration of the Gates-MacGinitie Reading Test, Primary C, Form 1. A measure of the total reading competence was acquired by totaling the raw scores of the two subtests, Vocabulary and Comprehension. The mean scores and standard deviations of reading achievement for both achieving and non-achieving readers are presented in Table 6. The mean score for each group of readers reflects the design that was built into the sample. The standard deviations indicate a wider range

TABLE 6

MEANS AND STANDARD DEVIATIONS FOR READING ACHIEVEMENT OF ACHIEVING AND NON-ACHIEVING READERS

		READING	ACHIEVEMENT
	N	$\overline{X}$	S.D.
Achievers	25	91.720	2.55
Non-Achievers	23	46.48	6.19

of scores for the non-achievers than for the achievers. Nevertheless, the reading scores within each group are rather homogeneous.

To obtain some indication of the performances of each of the groups on the standardized reading test relative to the population upon which the norms for the test were based the mean scores of the Vocabulary and Comprehension subtests were converted to grade equivalents (Table 7). The grade equivalents corresponding to the mean scores for the achievers on Vocabulary and Comprehension were 6.1 and 6.6, respectively. The grade equivalents corresponding to the mean scores for non-achievers on Vocabulary and Comprehension were 2.9 and 2.7, respectively.

Since the subjects were approaching the ninth month in grade three at the time of the administration of the tests, it appears that the performance of the achieving readers on the Gates-MacGinitie Reading Tests was considerably above the mean grade level equivalent for the population upon which the test was standardized. For the non-achievers, the grade equivalents fell below the grade 3.9 level.

An analysis of variance and an analysis of covariance were undertaken (Table 8 and Table 9) to determine whether the two groups differed significantly in reading achievement when I.Q. was held constant. Examination of the tables indicate that subsequent to partialling out I.Q. discrimination between the groups was still maintained at the .01 level of significance.

TABLE 7

PERFORMANCE OF ACHIEVERS AND NON-ACHIEVERS
RELATIVE TO GATES-MACGINITIE NORMS

	READING ACHIEVEMENT MEASURE[1]			
	Vocabulary		Comprehension	
	Mean	Grade Score[1]	Mean	Grade Score
Achieving Readers	47	6.1	45	6.6
Non-Achieving Readers	26	2.9	20	2.7

[1]The grade scores are derived from the teacher's manual of the Gates-MacGinitie Reading Tests, Primary C, Form 1.

TABLE 8

SUMMARY OF ANALYSIS OF VARIANCE BETWEEN THE GROUPS FOR READING ACHIEVEMENT

Test	Source of Variance	df	MS	F
Gates-MacGinitie Reading Test	Between groups	1	24519.12	1081.58**

**Significant at the .01 level.

TABLE 9

SUMMARY OF ANALYSIS OF COVARIANCE BETWEEN THE GROUPS FOR READING ACHIEVEMENT WITH I.Q. SCORES PARTIALLED OUT

Test	Source of Variance	df	MS	Adj.F
Gates-MacGinitie Reading Test	Between groups	1	11113.70	480.17**

**Significant at the .01 level

II. RELATIONSHIP BETWEEN ACHIEVING AND NON-ACHIEVING READERS ON MEMORY TASKS

To ascertain the ability of achieving and non-achieving readers to retain visual stimuli, the mean scores in the various memory tasks were analyzed. Results in Table 10 indicate the mean number of items recalled correctly by the total sample and by each group for the Benton Visual Retention Test (hereafter referred to as the Memory for Forms Test), the Digit Span Test, the Letter Memory Test, and the Word Memory Test.

The results in Table 10 further indicate that the achieving readers attained higher mean scores than the non-achievers on all of the memory tasks. A hierarchial pattern appears to have been established in retaining visual stimuli that is more pronounced in the non-achievers than in the achievers. Within each achievement group, the children generally found digits easier to retain than letters and words. However, no difference exists between the achieving readers to visually retain letters and words, whereas; within the non-achieving group mean differences were found between each of these memory tasks.

An uncorrelated t-test was undertaken to examine the possibility of significant differences between the two groups for the four different types of memory tasks. The 't' values calculated between achieving and non-achieving readers yielded probabilities beyond the .01 level of significance (Table 11). Hence, there were significant differences between the achievers' and non-achievers' mean performances on all the memory tasks. In particular, highly significant differences existed between achievers and non-achievers in ability to retain lett-

TABLE 10

MEANS AND STANDARD DEVIATIONS OF MEMORY TESTS FOR
ACHIEVING AND NON-ACHIEVING READERS

	MEMORY TESTS									
	Forms Total = 26		Digits Total = 9		Letters Total = 9		Words Total = 9		Total Total = 44	
Achieving Readers	$\overline{X}$	21.20	$\overline{X}$	6.64	$\overline{X}$	5.64	$\overline{X}$	5.64	$\overline{X}$	39.12
	S.D.	2.56	S.D.	1.16	S.D.	.79	S.D.	1.22	S.D.	4.55
Non-Achieving Readers	$\overline{X}$	18.09	$\overline{X}$	5.52	$\overline{X}$	4.17	$\overline{X}$	3.70	$\overline{X}$	31.48
	S.D.	3.12	S.D.	.83	S.D.	.70	S.D.	.80	S.D.	3.81
Total Group	$\overline{X}$	19.71	$\overline{X}$	6.10	$\overline{X}$	4.94	$\overline{X}$	4.71	$\overline{X}$	35.46
	S.D.	3.24	S.D.	1.16	S.D.	1.05	S.D.	1.43	S.D.	5.68

TABLE 11

UNCORRELATED t-TESTS - DIFFERENCE BETWEEN MEANS OF ACHIEVERS AND NON-ACHIEVERS

	D.F.	t-values	P-Two Tail
Forms	46	3.71**	.00056
Digits	46	3.73**	.00052
Letters	46	6.62**	.00000
Words	46	6.29**	.00000
Total	46	6.15**	.00000

**Significant at the .01 level for a two-tailed test of significance ers and words.

Since the differences in the results of the memory tasks for the two groups may be attributed to differences in intelligence, an analysis of variance and an analysis of covariance were carried out. A comparison between Table 12 and Table 13 indicates the performance of achievers and non-achievers on memory tasks before and after intelligence quotient scores were partialled out. The comparative results show that discrimination between the two groups was maintained even after adjustments for I.Q. were made. With the exception of memory for forms ($p < .05$), the differences remained beyond the .01 level of significance. These results suggest that the difference in short-term retention between achieving and non-achieving readers does not appear to be merely a function of general intelligence.

III. RELATIONSHIP BETWEEN MEMORY TASKS FOR ACHIEVING READERS

The Pearson product-moment correlation was used to determine the relationship between the memory tasks. As mentioned in Chapter I, the Memory for Forms Test and the Digit Span Test are classified as non-verbal tasks, whereas the Letter Memory Test and the Word Memory Test are classified as verbal tasks.

The results in Table 14 indicate the correlation between the total non-verbal score and the total verbal score reached a high level of significance ($p < .01$) for achieving readers revealing that their performance on non-verbal tasks is similar to their performance on the verbal tasks. However, it is interesting to note that the Memory for Forms Test has not been found to correlate as highly with the total

TABLE 12

SUMMARY OF ANALYSIS OF VARIANCE BETWEEN THE GROUPS ON THE MEMORY TASKS

Memory Tasks	Source of Variance	df	MS	F
Non-Verbal	Between groups	1	214.47	18.51**
1. Forms	Between groups	1	116.09	13.77**
2. Digits	Between groups	1	14.98	13.92**
Verbal	Between groups	1	139.32	55.42**
1. Letters	Between groups	1	25.75	43.76**
2. Words	Between groups	1	45.29	39.58**

**Significant at the .01 level

TABLE 13

SUMMARY OF ANALYSIS OF COVARIANCE BETWEEN THE GROUPS ON THE MEMORY TASKS WITH I.Q. SCORES PARTIALLED OUT

Memory Tasks	Source of Variance	df	MS	Adj.F.
Non-Verbal	Between the groups	1	123.06	10.44**
1. Forms	Between the groups	1	47.45	5.51*
2. Digits	Between the groups	1	17.68	17.73**
Verbal	Between the groups	1	98.24	40.58**
1. Letters	Between the groups	1	20.08	36.04**
2. Words	Between the groups	1	29.49	25.90**

**Significant at the .01 level

*Significant at the .05 level

TABLE 14

CORRELATION COEFFICIENTS BETWEEN NON-VERBAL AND VERBAL MEMORY TASKS FOR ACHIEVING READERS

		VERBAL MEMORY TASKS		
		Letters	Words	Total
NON-VERBAL MEMORY TASKS	Forms	.33	.48*	.47*
	Digits	.51**	.58**	.61**
	Total	.45*	.59**	.59**

**Significant at the .01 level

*Significant at the .05 level

verbal memory tasks as does the Digit Span Test.

In further support of the concept that an achieving readers' performance generally appears to be similar for each of the memory tasks, correlations between the verbal tasks were performed. A correlation of r=.61 was reported between the Letter Memory Test and the Word Memory Test revealing a level of significance beyond the .01 level. Moreover, correlation between the non-verbal tasks, Digit Span Test and Memory for Forms, was reported as r=.41 indicating that the relationship had reached the .05 level of confidence. Thus, the achieving readers tend to display a related ability in all the memory tasks.

IV. RELATIONSHIP BETWEEN MEMORY TASKS FOR NON-ACHIEVING READERS

Correlations between the total non-verbal and the total verbal are low and insignificant for non-achievers revealing that a non-achiever's performance on each of the tasks varies with the nature of the task (Table 15). For instance, a non-achiever scoring low on verbal memory tasks does not necessarily score as low in non-verbal tasks. This disparity is especially evident when correlating performance on the Word Memory Test with Memory for Forms Test

To further reveal that a non-achiever's performance differed according to the task, correlations between the non-verbal tasks, Memory for Forms Test and Digit Span Test, were performed. A low, insignificant correlation coefficient of r=.29 was reported. Similarly, a low, insignificant correlation of r=.25 was found between the verbal tasks, Letter Memory Test and Word Memory Test. Thus, the non-achiev-

TABLE 15

CORRELATION COEFFICIENTS BETWEEN NON-VERBAL AND VERBAL MEMORY TASKS FOR NON-ACHIEVING READERS

		VERBAL MEMORY TASKS		
		Letters	Words	Total
NON-VERBAL MEMORY TASKS	Forms	.25	-.06	.11
	Digits	.07	.24	.20
	Total	.24	.00	.15

ers' performances tend to differ not only between non-verbal and verbal tasks but also between tasks within the non-verbal or verbal.

V. RELATIONSHIP BETWEEN MEMORY TASKS AND READING SCORES

The relationship between the results of the memory tasks and those on the Gates-MacGinitie Reading Test was analysed by means of the Pearson product-moment technique. Inspection of Table 16 reveals that all the memory tests reached significance beyond the .01 level in their correlation with the reading scores for the total sample.

When the I.Q. factor was subsequently partialled out from the foregoing correlations by means of the partial correlation technique, all memory tasks maintained the significant relation with reading scores ($p < .01$) (Table 17). Also, the Letter Memory Test appears to exhibit the highest correlation coefficient with reading achievement. The Word Memory Test similarly displays a comparatively high relationship to reading scores.

However, an analysis of the correlations between memory tasks and reading scores for the separate reading groups (Table 18) indicated that only one correlation coefficient reached the level of significance. A correlation of $r=.43$ on the Digit Span Test was found for the non-achievers at a $p < .05$ level of confidence. When I.Q. was partialled out the correlation was still maintained at the same level of significance (Table 19). Also, the Letter Memory Test for the achieving readers reached significance beyond the .05 level when the I.Q. factor was partialled out.

TABLE 16

CORRELATIONS BETWEEN MEMORY TESTS AND READING SCORES

	MEMORY TESTS						
	Forms	Digit	Total Non-Verbal	Letters	Words	Total Verbal	Total
Reading Scores	.51**	.51**	.57**	.72**	.69**	.75**	.70**

**Significant at the .01 level

*Significant at the .05 level

TABLE 17

CORRELATIONS BETWEEN MEMORY TESTS AND READING SCORES WITH I.Q. SCORES PARTIALLED OUT

	MEMORY TESTS						
	Forms	Digit	Total Non-Verbal	Letters	Words	Total Verbal	Total
Reading Scores	.38**	.57**	.49**	.70**	.61**	.71**	.63**

**Significant at the .01 level

TABLE 18

CORRELATIONS BETWEEN MEMORY TESTS AND READING SCORES IN ACHIEVING AND NON-ACHIEVING READERS

	MEMORY TESTS						
	Forms	Digits	Total Non-Verbal	Letters	Words	Total Verbal	Total
Achieving Readers	.26	.03	.21	.36	.10	.21	.24
Non-Achieving Readers	.23	.43*	.31	.24	.20	.27	.36

*Significant at the .05 level

TABLE 19

CORRELATIONS BETWEEN MEMORY TESTS AND READING SCORES IN ACHIEVING AND NON-ACHIEVING READERS WITH I.Q. PARTIALLED OUT

	MEMORY TESTS						
	Forms	Digits	Total Non-Verbal	Letters	Words	Total Verbal	Total
Achieving Readers	.29	.10	.27	.46*	.10	.25	.30
Non-Achieving Readers	.23	.44*	.31	.24	.21	.28	.36

*Significant at the .05 level

VI. ADDITIONAL FINDINGS

A stepwise discriminant function using a multiple regression analysis identified the rank order of the memory tasks as predictors of the reading group (Table 20). The findings of this analysis indicates that the Letter Memory Test was the most able predictor of whether a student is likely to be an achieving or non-achieving reader. Scores on this task accounted for 48.75 percent of the variance and reached a significance beyond the .01 level of confidence. The inclusion of the Word Memory Test raised the proportion to 55.13 percent. The two remaining measures of recall did not add significantly to the percentage of variance accounted for by the Letter Memory Test and Word Memory Test. The results in Table 16 similarly indicate that the verbal tasks, Letter Memory and Word Memory Tests, correlate most highly with reading achievement.

VII. SUMMARY

The major findings resulting from the interpretation of the data are summarized below:

(1) Results obtained on all the memory tasks indicate that achieving readers are better able to retain visual stimuli than are non-achieving readers.

(2) Within the achieving group significant correlations emerged between the scores of the various memory tasks.

(3) Within the non-achieving group insignificant correlations existed between the scores of the various memory tasks.

TABLE 20

STEPWISE REGRESSION ANALYSIS OF MEMORY VARIABLES ON READING ACHIEVEMENT GROUPS

	Variable Entering	F Value	Probability Level	Total Variance
Step 1	Letters	43.763	.000**	43.762
Step 2	Words	6.394	.015**	55.130
Step 3	Forms	.913	.344	56.043
Step 4	Digits	.012	.913	56.055

**Significant at the .01 level.

(4) The ability to retain visual stimuli in terms of forms, digits, letters, and words appeared to be significantly related to the reading scores of the total sample.

(5) Within the achieving group, only the Letter Memory Test correlated significantly with the Gates-MacGinitie Reading Test.

(6) Within the non-achieving group, the Digit Span Test correlated significantly with the Gates-MacGinitie Reading Test.

(7) In terms of short-term retention ability, the Letter Memory Test is the best predictor of success in reading for this sample of grade three achieving and non-achieving readers.

The following chapter will contain a summary of the purpose and design of the study, a discussion of the hypotheses, possible implications, and suggestions for further research.

CHAPTER V

SUMMARY, CONCLUSIONS, IMPLICATIONS, AND SUGGESTIONS FOR FURTHER RESEARCH

I. SUMMARY

This [illegible]ted to indicate whether there were differences between ach[illegible]nd non-achieving readers in their abilities to retain vari[illegible]es of visual stimuli. Also, the study attempted to indicate the interrelationship of these abilities within each of the achievement groups. The purpose of this research was achieved by utilizing the Memory for Forms Test, Digit Span Test, Letter Memory Test, and Word Memory Test which measured the students' short-term retention abilities.

A sample of twenty-five achieving readers and twenty-three non-achieving readers of average or above intelligence was selected from a population of one hundred thirty-three grade three students on the basis of the Gates-MacGinitie Reading Test and visual screening tests.

II. FINDINGS AND CONCLUSIONS

The null hypotheses outlined in Chapter I are restated below and conclusions concerning their acceptance or rejection are discussed.

Hypothesis One

There is no significant difference between the scores obtained by achieving and non-achieving readers on the:

(a) Memory for Forms Test
(b) Digit Span Test
(c) Letter Memory Test
(d) Word Memory Test

(a) Analysis of the data revealed that a significant difference ($p < .01$) in scores existed between achieving and non-achieving readers in the Memory for Forms Test. When I.Q. was held constant the significant difference in scores was upheld but at a lower level of confidence ($p < .05$). Thus, Hypothesis 1(a) was rejected.

(b) There was a significant difference ($p < .01$) between the scores of achieving and non-achieving readers on the Digit Span Test. The discrimination between the two groups was significantly maintained when I.Q. was partialled out. Hypothesis 1(b) was, therefore, rejected.

(c) The Letter Memory Test significantly ($p < .01$) discriminated between the achievers and non-achievers. This significant difference was upheld when I.Q. was partialled out. Thus, Hypothesis 1(c) was rejected.

(d) Significant differences ($p < .01$) were found between the performances of achievers and non-achievers on the Word Memory Test. This discrimination was significantly retained subsequent to the partialling out of I.Q. Hypothesis 1(d) was, therefore, rejected.

Conclusion

The present data indicate that the ability to retain various types of stimuli differentiate significantly between achieving and non-achieving readers prior to and subsequent to the partialling out of I.Q. However, the Memory for Forms Test was reduced to a lower level of significance upon the partialling out of I.Q. indicating that intelligence plays a somewhat greater role in the retention of forms than in the retention of digits, letters, and words. The results further suggest that the apparent deficiency in visual memory ability displayed by the non-achievers may be a contributing factor to their lack of reading success.

Hypothesis Two

There is no significant correlation between scores on the non-verbal visual memory tasks and scores on the verbal visual memory tasks for the achieving readers.

A significant relationship at the .01 level of confidence was found between the non-verbal memory tasks (Memory for Forms Test and Digit Span Test) and the verbal memory tasks (Letter Memory Test and Word Memory Test) for high achieving readers. Thus, the hypothesis was rejected.

Conclusion

It is interesting to note that retention of forms was somewhat less difficult for achieving readers than the retention of the other memory tasks, particularly letters and words. No differences existed among the achieving readers to visually retain letters and words. Nevertheless, when scores were totalled on the non-verbal and verbal memory tasks, it was found that they were relatively similar (correlated significantly) for the achieving readers. A similar trend was exhibited by Raymond's (1952) study which reported that the high achievers' performances on the retention of non-verbal material (objects) were no better than their performances on the retention of verbal material (letters). Thus, it appears that the achieving readers' performances on the various memory tasks are not differentiated to any great extent by the nature of the material.

Hypothesis Three

There is no significant correlation between scores on the non-verbal visual memory tasks and scores on the verbal visual memory tasks for non-achieving readers.

No significant relationship was found between the non-verbal memory tasks (Memory for Forms Test and Digit Span Test) and the verbal memory tasks (Letter Memory Test and Word Memory Test) for non-achieving readers. This hypothesis was, therefore, accepted.

Conclusion

A hierarchial pattern of retaining visual stimuli has been established within the non-achievement group. Differences were found between each of the memory tasks. The listing of the materials in terms of increasing difficulty were memory for forms, digits, letters, and finally words. More specifically, tasks seemingly unrelated to the reading process (forms and digits) were found to be easier for non-achievers than tasks seemingly related to the reading process (letters and words). Thus, it appears that the non-achievers' performances on the various memory tasks differ with the nature of the task.

Perhaps the lack of correlation among tasks in non-achieving readers suggests inconsistency related to the perceptual process. For instance, it is likely that a series of letters or words cannot be perceived as readily by non-achievers as a series of digits or forms. Further, a non-achieving reader may become so engrossed in the perception of each individual letter or word that he finds it difficult to remember what he read prior to the item he is immediately attending to. Thus, the non-achiever's slow perceptual process and his manner of attending to letters or words may impede his ability to retain such stimuli.

These results are in agreement with those obtained by Dornbush ([illegible]) and Stauffer (1947). Dornbush points out that the recall of numbers has been shown to represent a considerably easier task than the recall of letters. Stauffer's study further reports that poor readers exhibited significantly higher scores with regards to retention of objects than with retention of letters.

Hypothesis Four

There is no significant correlation between scores on the Gates-MacGinitie Reading Test and scores on the:

(a) Memory for Forms Test
(b) Digit Span Test
(c) Letter Memory Test
(d) Word Memory Test

(a) A significant relationship ($p < .01$) was found between reading scores and the Memory for Forms Test for the total sample. Furthermore, when I.Q. was partialled out, the correlation just reached the .01 level of significance.

In terms of achieving and non-achieving reading groups no significant correlation was found between their respective reading scores and the Memory for Forms Test. A lack of a significant correlation also existed subsequent to the partialling out of I.Q. Thus, Hypothesis 4(a) was rejected only in part.

(b) A significant relationship ($p < .01$) emerged between reading scores and the Digit Span Test for the total sample even after I.Q. was held constant.

No significant correlations existed between achieving readers and the Digit Span Test even after I.Q. was partialled out. However, a significant relationship reaching the .05 level of confidence was found between non-achieving readers and the Digit Span Test. This relationship was maintained when I.Q. was partialled out. Thus, Hypothesis 4(b) was rejected only in part.

(c) A high significant relationship beyond the .01 level of confidence emerged between reading scores and the Letter Memory Test for the total sample. The subsequent partialling out of I.Q. gave further evidence to the significant correlation.

No significant relationship existed between achieving readers' reading scores and the Letter Memory Test. However, subsequent to the partialling out of I.Q., a significant correlation at the .05 level was found. With reference to non-achieving readers, an insignificant relationship emerged between their reading scores and the Letter Memory Test prior to and subsequent to the partialling out of I.Q. Thus, Hypothesis 4(c) was rejected only in part.

(d) A high significant relationship beyond the .01 level existed between reading scores and the Word Memory Test for the total sample. This relationship was sustained subsequent to the partialling out of I.Q.

In terms of achieving and non-achieving readers, no significant correlations were found between their reading scores and the Word Memory Test. The subsequent partialling out of I.Q. gave further evidence to support these low correlations. Hypothesis 4(d) was, therefore, rejected in part.

Conclusion

The test results suggest that all the memory tasks are related significantly to the reading scores for the total sample. This would tend to confirm the conclusion reached in Hypothesis One illustrating that the child's ability to retain various types of stimuli is related to whether he is an achieving or non-achieving reader.

The Letter Memory Test maintained the highest level of correlation with reading achievement scores over the total group. It would seem, therefore, that the child's level of reading achievement is most highly related to his ability to retain visual stimuli in the form of letters. This substantiated the finding that the Letter Memory Test is the most able predictor of all the memory tasks in designating whether a student is likely to be an achieving or non-achieving reader. This suggests that the Letter Memory Test is possibly the best instrument for measuring differences in visual memory abilities with grade three children.

When considering scores within each reading achievement group the memory tasks have little or no relationship to the reading scores. For instance, it appears that an achieving reader who obtained the highest score in the reading test did not necessarily obtain the highest score(s) in the memory task(s). Likewise, the non-achiever who obtained the lowest score in the reading test did not necessarily obtain the lowest score(s) in the memory task(s). An exception is the Digit Span Test which indicates that the non-achievers' scores in digits were relative to their scores in the reading test. A further exception (subsequent to partialling out I.Q.) was the Letter Memory Test for achieving readers. Apparently, if an achieving reader scored extremely well on the reading test he also scored well in the Letter Memory Test.

III. IMPLICATIONS

1. The results of the study indicate that non-achieving readers differ significantly from the achieving readers in ability to recall various types of visual stimuli. This further suggests that the ability to retain visual stimuli is a skill necessary to the efficient performance of the reading act. Thus, the assessment of visual memory is essential in the diagnostic study of any child experiencing difficulty in reading. If an inadequacy is manifested appropriate programs may then be initiated.

2. The present results of the study also reveal that the Letter Memory Test has the highest predictive value for reading achievement. As a result, it could readily be used as a diagnostic instrument by the teacher or reading clinician in identifying a possible antecedent for an individual child's reading problem. However, since the scores used in this study are norms only for a particular group of grade three children, the other tests may prove of diagnostic value in a clinical situation,

For instance, the Memory for Forms Test may be desirable to use with kindergarten or grade one children who have not as yet developed a recognition of letters and words; whereas, the Word Memory Test as well as the Letter Memory Test may be more valuable to assess older children since these tests are more a function of reading.

3. The study further denotes that for non-achievers the ability to perceive and remember stimuli in the order in which they are presented varies significantly with the nature of the task. That is, tasks involving non-verbal material (forms and digits) presented less difficulty than tasks involving verbal material (letters and words). This inability of non-achievers to cope sufficiently with materials that are more a function of reading (letters and words) necessitates training that would enhance visual memory for letters and words. Th s, by capitalizing on new words that the child is confronted with in his daily schoolwork the following procedure may be utilized:

(a) Arrange cardboard letters into a word.

(b) Allow the child to study the word for a few seconds (about 10 seconds).

(c) Have child turn his back while you remove one letter.

(d) Allow child to again inspect the word and tell what letter is missing.

(e) Allow the child to reproduce the word from memory.

The task can be made more difficult by utilizing the following procedures:

(i) Decrease the time the child is allowed to study the word.

(ii) Increase the number of letters that form a word and that are taken away.

(iii) Change the position of letters within a word without removing them. Make the child reproduce the original position and the new position.

(iv) Substitute similar letters for those taken away, to force attention to detail (changes in orientation or form - 'b' for 'd' or 'r' for 'n').

(v) Add letters and rearrange position of the originals.

IV. SUGGESTIONS FOR FURTHER RESEARCH

The findings and conclusions from the study described herein produced the following suggestions for further research.

1. A follow-up study, using the present sample, might be conducted to determine whether the ability to retain visual stimuli is developmental in nature. Such a longitudinal study may further reveal whether difficulties in retaining visual stimuli are overcome during the course of development and whether difficulties in reading persist and/or become more serious in subjects who continue to display difficulty in visual memory.

2. A cross-sectional study of several grade levels may prove useful to note if there is a progression in memory abilities for different types of visual stimuli and if there is a similar complementary progression in the relationship between memory abilities and reading achievement.

3. Since only high and low achieving readers were used in the

present study, a study of the ability to retain visual stimuli in a more heterogeneous group may provide more conclusive evidence on the importance of short-term memory in reading achievement.

4. A further study could involve only low reading achievement groups with a more detailed assessment of their memory abilities. For instance, tasks could be analysed to reveal whether deficiencies were mainly in 'form' or 'position' memory.

5. A study could be done to determine the effectiveness of remedial procedures for children who are not proficient in short-term retention. The variety of instructional materials and methods outlined in this study may be used with subsequent evaluation of their efficacy.

6. There is need for further research on:

(a) the specific relationship between short-term memory and the ability to hold a sequence of words in mind to arrive at the meaning of sentences of different complexity.

(b) the specific relationship between short-term visual memory and the ability to hold a sequence of ideas in mind as part of the process of gaining the total meaning of passages of different length.

7. In view of the possibility of one modality compensating for another in school learning, a comparison of the relationship of visual memory and auditory memory to each other and to reading achievement should be studied.

8. Another problem for future research is the determination of the effect of environment on memory for various stimuli. The relative

influence of socio-economic status on memory for forms, digits, letters, and words, as used in this study, should prove interesting. Subjects from low, middle, and high socio-economic status could be tested to note if the findings hold true for these differing categorizations. Investigators (Robinson & Hansen, 1968) have urged that factors which affect progress in learning to read should be measured with instruments as unbiased for disadvantaged children as for others.

9. It would be desirable to investigate the relationship between spelling and visual memory abilities of students. Spelling depends upon the reproduction of the form, orientation, and sequence of letters. Therefore, the question might be raised as to whether visual memory for these components affects spelling ability.

V. CONCLUDING STATEMENT

The findings of the study have indicated that in every visual memory task the achieving readers performed significantly better than the non-achieving readers. The statistically significant difference between the two achievement groups tends to suggest that the ability to deal with the sequential order of visually-presented stimuli is related to achievement in reading, and that children in the normal range of intelligence who experience more difficulty in retention ability also experience more difficulty with reading. Thus, while it cannot be stated that all reading disabilities are allied with poor visual memory spans, it can be stated with more certainty that poor visual memory spans are allied with difficulty in reading.

There is also evidence that the differences in ability between the various memory tasks are much more pronounced in non-achieving readers than in achieving readers. Thus, it appears that for non-achievers the nature of the memory task has substantial bearing on the results secured.

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APPENDICES

APPENDIX A

VISUAL DISCRIMINATION TEST

Directions: "Look at the first word in the row. Now find exactly the same word among the groups of letters that follow. Put a circle around it. Do the others now."

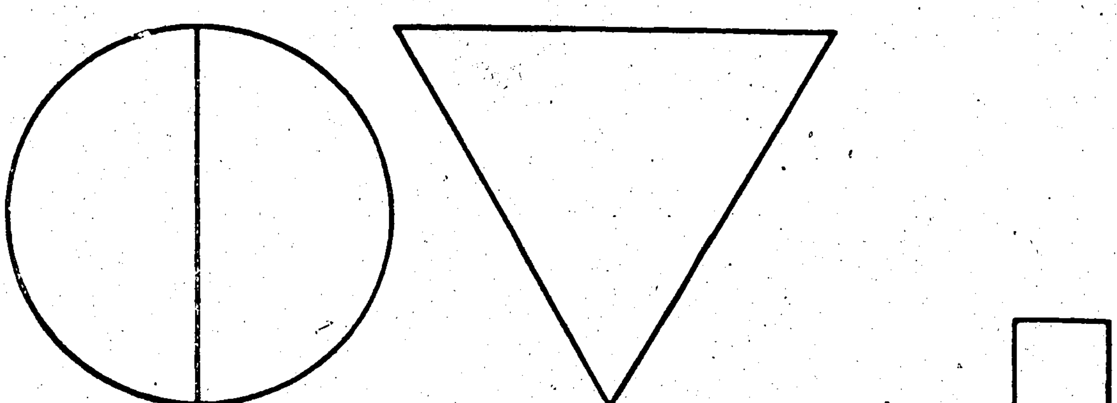
1.	two	lwo	hwo	gwo	two	kwo
2.	boat	boat	boal	boah	boet	baot
3.	make	mafe	melse	make	mame	mako
4.	play	ptay	plav	piay	layp	play
5.	down	bown	domn	down	dcwn	dwon
6.	funny	funnv	fnuuy	funry	lunny	funny
7.	black	lbokc	blax	black	blaek	ckabl
8.	came	ame	came	cam	cawe	emac
9.	soon	sooh	soom	soon	scon	sune
10.	good	gocd	goob	doog	good	gued
11.	rabbit	rabbil	rabbit	rebbit	robbit	bitrab
12.	hen	nem	hon	uey	hen	neh
13.	went	went	wcnt	weht	wenf	ment
14.	white	vhite	wlite	whife	wnite	white
15.	new	nem	wen	new	ncw	uew
16.	farm	tarm	fanm	armf	farm	fram
17.	friends	frienbs	fnierds	frionds	friens	friends

APPENDIX B

BENTON VISUAL RETENTION TEST, FORM D*

Directions: "I am going to show you a card with some designs on it. I want you to look carefully at the designs and draw exactly what you see."

*Sample used to assess visuomotor ability.

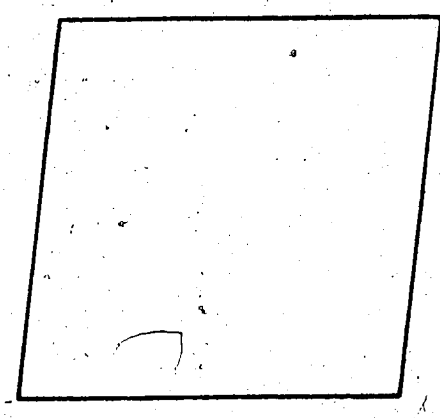


BENTON VISUAL RETENTION TEST, FORM C*

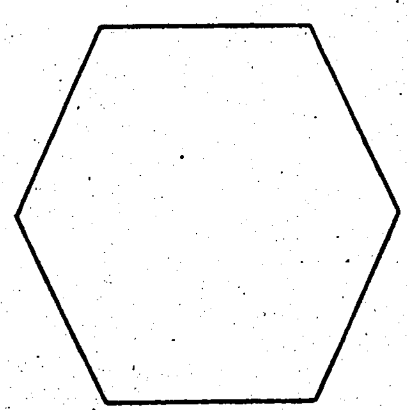
Directions: "I am going to show you a card with one or more designs on it. After I take the card away I want you to draw exactly what you saw on this piece of paper."

*Referred to as the Memory For Forms Test in this study.

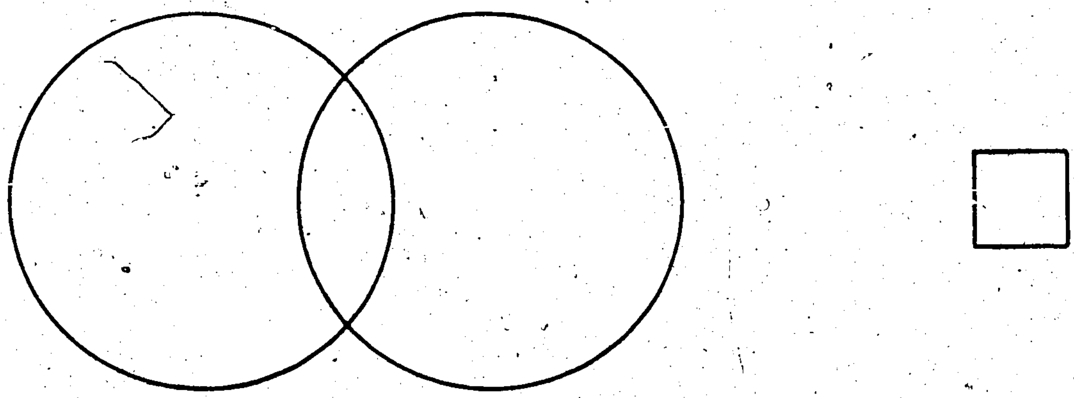
1.



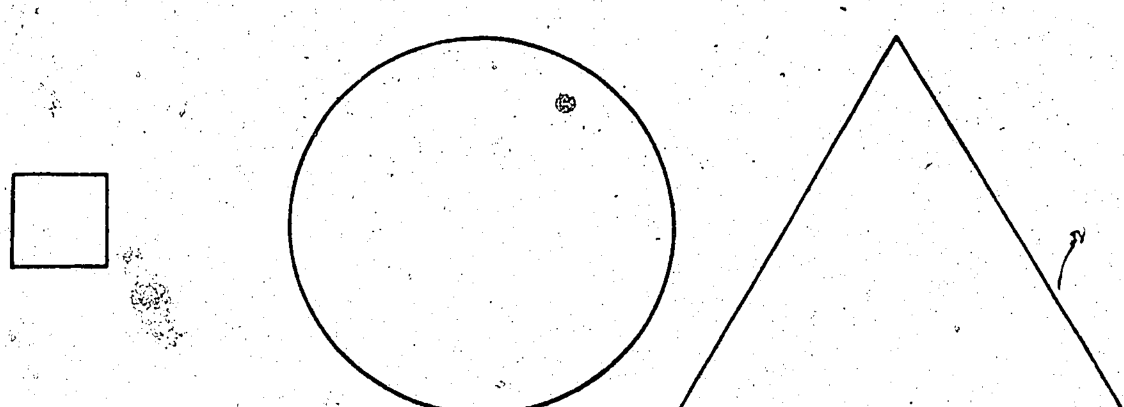
2.



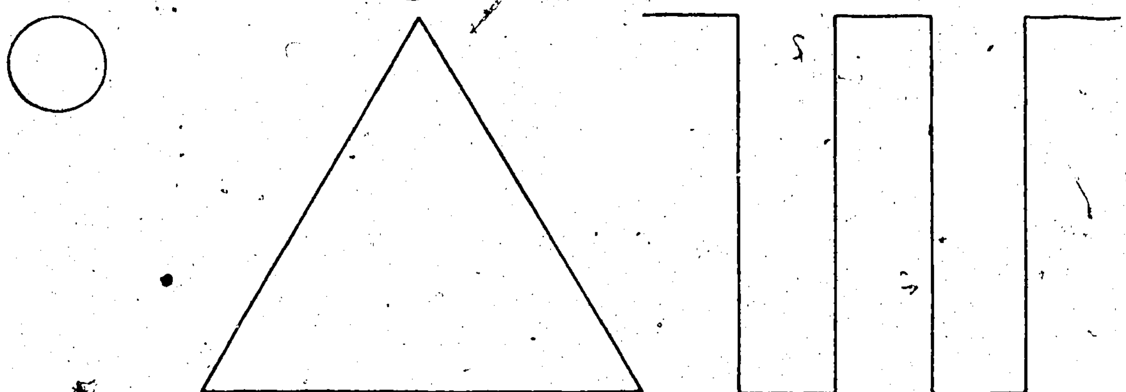
3.



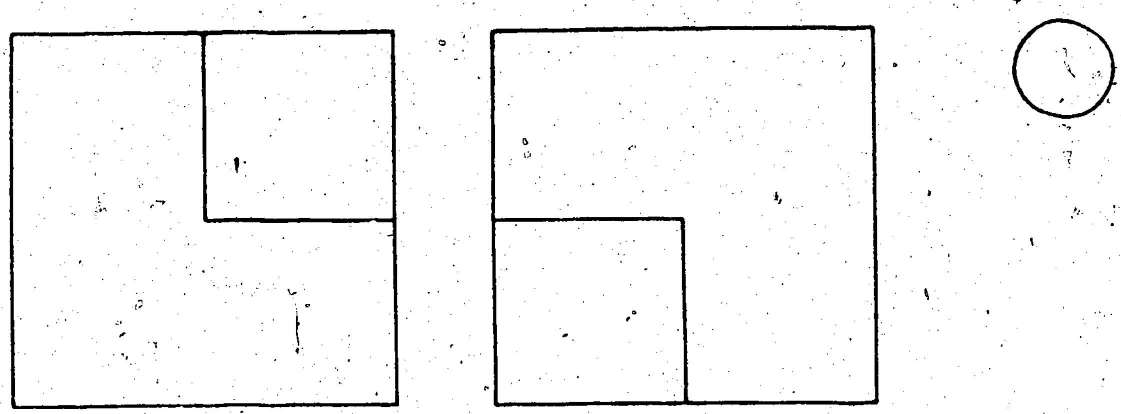
4.



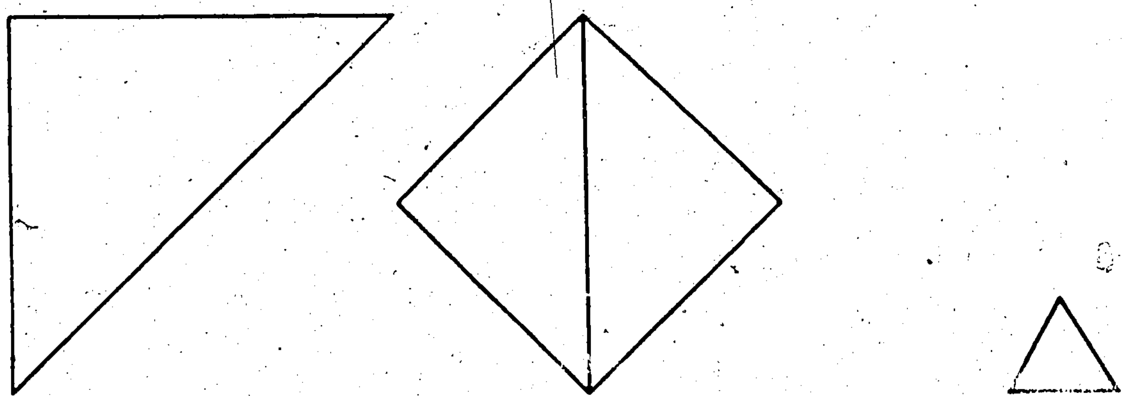
5.



6.



7.



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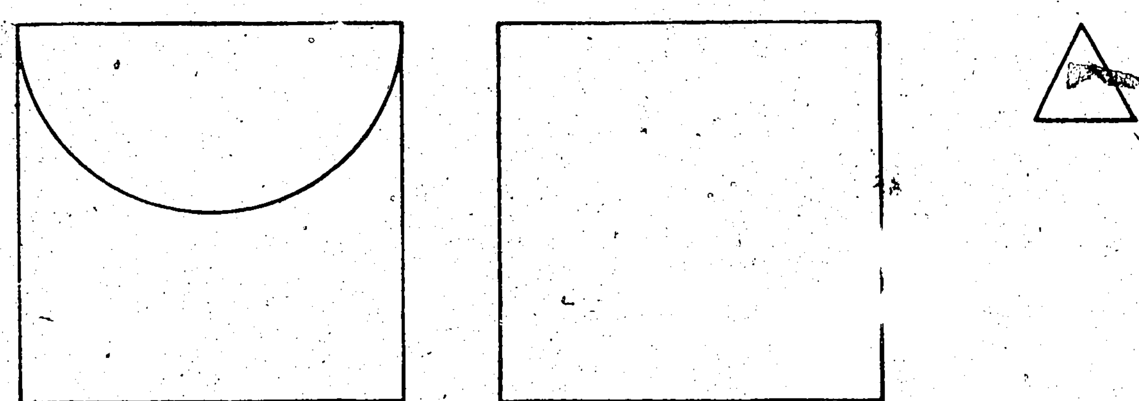
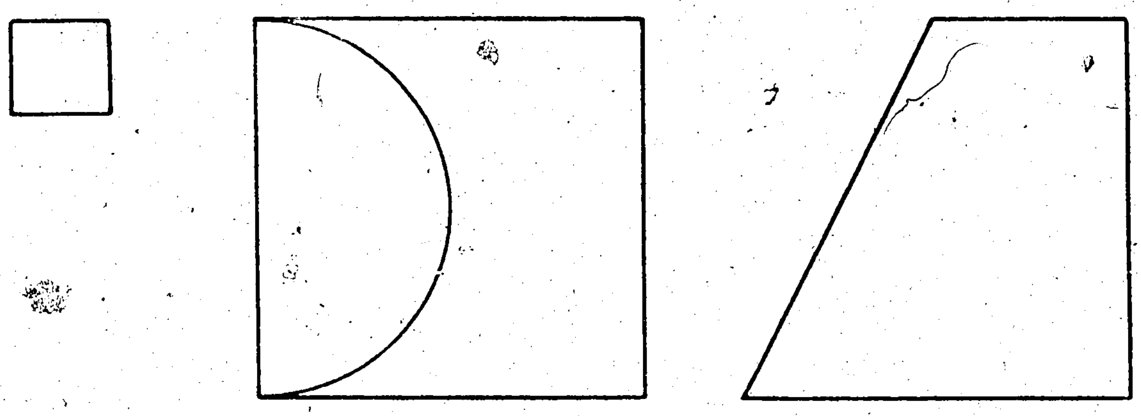
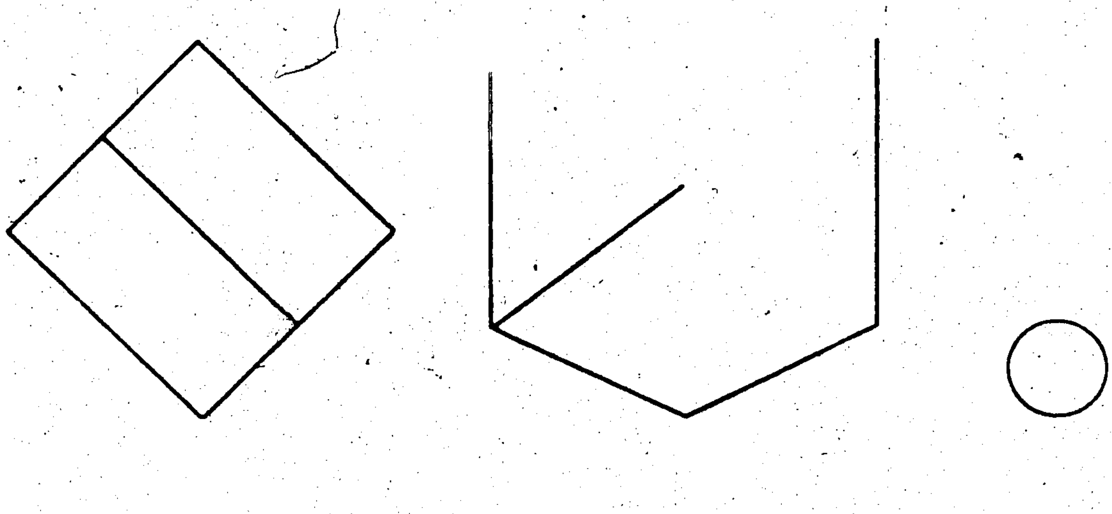


9.



10.



APPENDIX C

TESTS CONSTRUCTED FOR THIS STUDY

Each series was presented separately on 3½" by 9" cards. In this appendix only the scoring sheets will be represented.

Directions for the <u>Digit Span Test</u>:

"I am going to show you a card with numbers on it. After I take the card away, I want you to tell me exactly what numbers are on the card. Tell them to me in the same order if you can."

Directions for the <u>Letter Memory</u> and <u>Word Memory Test</u> were similar except 'letter' and 'word' were substituted for 'number'.

Name:____________________

SCORING SHEET FOR

DIGIT SPAN TEST

SERIES	TRIAL 1	TRIAL 11
2	83	26
3	724	862
4	9748	5793
5	42596	21635
6	153824	286359
7	2937461	4716925
8	38465791	35169748
9	824739516	752684931

Name:_____ ____________

SCORING SHEET FOR
LETTER MEMORY TEST

SERIES	TRIAL 1	TRIAL 11
2	cq	xp
3	bmr	dnv
4	gzfs	jpyc
5	ztbrc	qldnr
6	bvnygb	hxmjwd
7	mzrfbsk	vqsjdch
8	fjwzsbxv	zrfpclsn
9	dbxcshqnyf	tlbdsvkph

Name: ________________

SCORING SHEET FOR
WORD MEMORY TEST

2a	help	and							
b	some	down							
3a	said	have	then						
b	that	come	you						
4a	can	her	now	run					
b	what	put	make	was					
5a	goes	like	work	off	say				
b	look	they	where	these	who				
6a	out	see	has	may	your	just			
b	went	give	here	could	why	came			
7a	this	our	soon	when	the	not	well		
b	were	take	its	those	been	for	must		
8a	find	did	will	but	are	sew	this	use	
b	know	all	how	does	too	them	let	made	
9a	get	would	she	that	his	with	had	there	found
b	their	want	call	buy	which	him	from	live	think