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THE EFFECT OF MEMORY SPAN ON CUE PATTERNS IN WORD RECOGNITION.

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KINDERGARTEN CHILDREN WERE USED AS SUBJECTS IN AN ATTEMPT TO DISCOVER WHETHER CHILDREN WITH SHORT AND LONG MEMORY SPANS USE DIFFERENT CUES TO RECOGNIZE WORDS AND WHETHER MEMORY SPAN TESTS ARE EFFECTIVE PREDICTORS OF DIFFICULTY IN LEARNING TO READ. IT WAS HOPED THAT CHILDREN WOULD EXHIBIT A CONSISTENT PATTERN OF CHOICES OVER TRIALS, WHICH MIGHT HAVE IMPLICATIONS FOR TEACHING WORD RECOGNITION AND OTHER READING SKILLS. THE DIGIT SPAN SUBTEST OF THE WECHSLER INTELLIGENCE SCALE FOR CHILDREN, AN AUDITORY TEST, MEASURED MEMORY SPAN AND WAS USED AS THE SCREENING DEVICE. FIVE-LETTER NONSENSE WORDS COMPRISED THE WORD RECOGNITION TASK. CHILDREN WERE REQUIRED TO SELECT FROM A GROUP OF NONSENSE WORDS THE ONE SIMILAR TO THE WORD THAT HAD JUST BEEN SHOWN TO THEM. EACH WORD IN THE RESPONSE GROUP CONTAINED ONE CUE WHICH APPEARED IN THE SAME POSITION AS IN THE STIMULUS WORD WITH THE OTHER CUES HELD CONSTANT. FIVE CUES WERE EXAMINED--POSITIONS 1, 2, 3, 4, AND 5, AND EACH SUBJECT HAD AN EQUAL OPPORTUNITY TO RESPOND TO EACH CUE. ALL GROUPS SHOWED A PREFERENCE FOR CUE 1, AND THERE WAS A TENDENCY TO RESPOND TO CUE 3 AND CUE 5. AN AVOIDANCE EFFECT SEEMED TO BE OPERATING WITH CUE 2 AND CUE 4. THE RESULTS ON FRIEDMAN'S ANALYSIS OF VARIANCE OF RANKS INDICATED THAT RANDOM SELECTION MAY HAVE BEEN OPERATING FOR BOYS AND GIRLS IN THE LOW MEMORY SPAN GROUP. FOR THE MIDDLE AND HIGH MEMORY SPAN BOYS, A PREFERENCE PATTERN WAS NOT LIKELY TO ARISE BY CHANCE TABLES, 24 REFERENCES, AND AN EXAMPLE OF THE FORM FOR RECORDING RESPONSE CHOICES ARE INCLUDED. (AUTHOR)

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RESEARCH AND DEVELOPMENT CENTER FOR LEARNING AND RE-EDUCATION

UNIVERSITATIS WISCONSINENSIS SIGILLUM

RESEARCH CLR DEVELOPMENT

Technical Report No. 16

THE EFFECT OF MEMORY SPAN ON CUE PATTERNS IN WORD RECOGNITION

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Based on a master's paper
under the direction of

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Research and Development Center
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PREFACE

This technical report is based on Roberta R. Weissglass' seminar report, prepared under the direction of Wayne Otto, Associate Professor of Curriculum and Instruction.

The R & D Center for Learning and Re-education has as its primary goal the improvement of cognitive learning in children and youth, commensurate with good personality development. Through synthesizing present knowledge and conducting research to generate new knowledge, we are extending the understanding of human learning and the variables associated with efficiency of school learning. Knowledge is being focused upon the three main problem areas of the Center: developing exemplary instructional systems, refining the science of human behavior and learning as well as the technology of instruction, and inventing new models for school experimentation, development activities, and so on.

Within the broad Center goal of improving cognitive learning in children, the goal of the reading group is to understand causes for reading problems in order to strengthen the reading skills needed for efficient cognitive development in subject matter areas. Reading is conceived as a tool, not as a content area. Mrs. Weissglass designed this study to determine the effect, if any, of memory span upon the cue patterns of young children as they begin to acquire skill in word recognition. If the role of memory span in readiness for word recognition skill can be clarified, then there will be one more basis for making prognostic assessments of children's capacity for learning to read. The present study is a step toward that goal: relevancy of memory span is demonstrated and limitations of the task used in the experiment have implications for improving the task.

Herbert J. Klausmeier
Co-Director for Research

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I wish to express my gratitude to Professor Wayne Otto for his guidance throughout all phases of this study. I also wish to thank Dr. David H. Ford for many comments and suggestions, and Tom Houston and Larry Toothaker for their patient assistance during the many hours spent designing the study and analyzing the data.

Appreciation is expressed, also, to the following personnel in the Sun Prairie, Wisconsin, school system: Mr. Oliver Berge, Superintendent; Mr. Bernard Dunn, Supervising Principal; Mr. Lawrence Danielson, Principal, Northside School; Mr. Martin French, Principal, Southside School; and the kindergarten teachers who so graciously permitted me entrance into their classrooms.

R. R. W.

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ABSTRACT

Kindergarten children were used as subjects in an attempt to discover whether children with short and long memory spans use different cues to recognize words, and whether memory span tests are effective predictors of difficulty in learning to read. It was further hoped that children would exhibit a consistent pattern of choices over trials, which might have implications for teaching word recognition and other reading skills.

The WISC Digit Span Subtest, which measured memory span, was used as the screening device, and 5-letter nonsense words comprised the word recognition task. Children were required to select from a group of nonsense words the one similar to the word that had just been shown to them. Each word in the response group contained one cue which appeared in the same position as in the stimulus word, with the other cues held constant. Five cues were examined—positions 1, 2, 3, 4, and 5—and each subject had an equal opportunity to respond to each cue.

All groups showed a preference for Cue 1 and there was a tendency to respond to Cue 3 and Cue 5. An avoidance effect seemed to be operating with Cue 2 and Cue 4. Results on Friedman's Analysis of Variance of Ranks indicated that random selection may have been operating for boys and girls in the low memory span group, while for the middle and high memory span boys a preference pattern was not likely to arise by chance.

I

RATIONALE FOR THE STUDY

The general purpose of this study was to discover whether children with short and long memory spans use different cues to recognize words, and whether or not their pattern of choices is consistent over trials. Furthermore, it was hoped that insights might be gained regarding the effectiveness of using memory span tests to predict difficulty in learning to read.

The study was based upon a recent study by Marchbanks and Levin (1965), which was concerned with cuing patterns of children. In their report, Marchbanks and Levin reviewed a number of studies concerned with the cues by which words are recognized: "It has been suggested that children recognize words as wholes (Cattell, 1896; Smith, 1928); by geometric shape, outline, or configuration (Bell, 1939; Tinker and Paterson, 1940); by familiarity with grapheme-phoneme correspondence (Gibson, 1962; Gibson, Gibson, Danielson, Osser, and Hammond, 1962); by dominant letters such as ascending or descending letters (Wilson and Fleming, 1938); by initial and terminal letters (Wiley, 1928; Levin and Watson, 1963; Woodward, 1962; Levin, Watson, and Feldman, 1964); or by some combination of these cues (Davidson, 1931; Gates, and Boekker, 1923; Shotty, 1912)." However, many of these studies used adult subjects; therefore, extrapolation to children who lack familiarity with the written language is not clear.

The effect of memory span upon the cue patterns of children was also considered, for Dominowski (1965) has stated short-term memory plays an important role in concept attainment. Jensen (1965) agrees that many of the processes basic to learning may be involved in conceptual learning and that some of these processes may be the same as those involved in short-term memory. Earlier, Burks & Bruce (1965) hypothesized that "poor readers approach learning situations in a more concrete manner as a result of an inability to handle abstractions. Since the reading process... consists of abstractions strongly depending on memory functions, these children are handicapped" and Anderson (1939) concluded that verbal ability is partly dependent on memory span.

The Digit Span subtest of the Wechsler Intelligence Scale for Children (WISC), an auditory test, was the instrument chosen to examine memory span. Other workers, concerned with children already disabled in reading, have examined the relationship of digit span and reading ability. Hawkins (1956) found, as did Baumeister, Smith, and Rose (1965), that Digit Span had validity for predicting short-term memory. Graham (1952), Burks and Bruce (1955), and Robeck (1960) found that unsuccessful readers were significantly low on Digit Span, and on the other subtests requiring memory. On the other hand, Altus' (1956) study of WISC patterns showed Digit Span to be significantly higher than other subtest scores.

According to Rizzo's (1939, p. 208) survey, the concept of memory span can be traced to the work of Jacobs (1887) who devised a "memory span test to determine the maximal number of related or unrelated elements which a testee can reproduce immediately after a single presentation." Warren (1934) used "logical memory" to designate the capacity to retain meaningful material as compared with the term "memory span" which indicated memory for meaningless material. English (1934), Crosland (1929), and Tinker (1929) used the terms "memory span," "range of attention," and "visual apprehension," respectively, to denote the same behavior, showing that in general there was agreement on what memory span is.

Yet, despite this agreement, the results of many of the studies are not comparable because researchers used different kinds of materials, diverse methods of testing and scoring, different groups of subjects, and because studies tended to lack careful controls. In the present investigation, then, memory span is defined specifically as the number of digits which can be repeated orally immediately after a single presentation.

Recent investigations into the area of memory have been concerned with memory as it relates to personality and learning theories, but very few researchers have attempted to relate memory span to reading ability. Perhaps one of the earliest discussions of memory span and reading was an article (Saunders, 1925) in which the author concluded that children with short auditory memory spans showed the following traits: 1) slowness in acquiring facility with language; 2) difficulty in learning to read; 3) difficulty using phonics; 4) difficulty learning rote material orally. Saunders also felt that while all reading disabilities are not allied with poor memory spans, "yet it can be stated with certainty that all poor memory spans are allied with difficulty in reading and spelling." According to Rose (1958), Bond likewise concluded that auditory memory ability" . . . is probably of importance as a factor in learning to read by the look-and-say method, but is apparently of little advantage in the phonetic type of instruction," and Rizzo (1939) found that the relationship between memory span and reading ability was more marked in the lower grades (Grades 2, 3, and 4) than in the upper grades.

Others who have since investigated the relationship of auditory memory span to reading have come to similar conclusions, that is, that auditory memory span correlates significantly with various silent reading test scores (Reynolds, 1953) that tests for auditory memory span are difficult for children who have reading difficulties (Rose, 1958) and that the relationship between auditory memory span and the development of adequate word recognition is statistically significant (Poling, 1953). Yet, it should be clear that poor auditory memory span is not necessarily a cause for reading difficulty. It may be that poor auditory memory is merely a symptom of some other difficulty and, as such, is just one factor contributing to reading difficulty.

By grouping children according to WISC memory span scores, the intent was to examine possible relationships between cue patterns and memory span. This procedure required that some assumptions be made regarding the validity of comparing a number task with a letter task. Blankenship (1938) and Brener (1940) reviewed experiments which indicated that the type of material does affect memory span scores, but there was no agreement on the order of difficulty of various materials. In general, however, nonsense syllables were found to be harder to remember than digits. This is not entirely relevant here for the word identification task employed did not require children to remember the nonsense words.

Pertinent here are areas which have not been fully investigated: the reliability of tests of memory span and the relationship between auditory and visual span. Attempts made in these directions cannot adequately be evaluated, not only because of the varying conditions under which experiments have been conducted, but also because methods of presentation and scoring have lacked constancy. Rose (1958) found that the visual memory test on the Stanford-Binet was not as difficult for children with reading difficulties as the auditory memory span tests. She speculated that this may have been due to the design of the tests. The digit test did not present a "pattern or unified whole" as did the visual memory test. The question raised in this regard was whether the child is better able to remember a unified whole than details.

The word-recognition task used in the present study did not require words or letters to be repeated or reproduced; rather it required recognition. Whether or not this more nearly equalized the two tasks is difficult to determine, particularly since a delay interval in the word task added a variable not present in the digit task. Here, the relevant literature is again inconclusive: Baumeister, Smith, and Rose (1965), using objects in a picture, and Borkowski (1965), using trigrams, found that responses can be delayed for 12 seconds and 15 seconds, respectively, but that beyond these intervals performance begins to deteriorate. This is inconsistent with Griffith's findings, as pointed out by Baumeister et al. Griffith found "no reliable effect due to the delay interval" even when retardates' responses were delayed for 120 seconds.

Kindergarten children served in the study because they were considered reasonably naive subjects, having had no formal instruction in reading. This was felt to offer two advantages. First, because the children had not been taught the left-to-right sequence required in reading, it could be assumed they would cue to the position most natural for them. Thus, a frequently recurring pattern for either group might have implications for teaching word recognition and other reading skills. Second, as nonreaders, they would not be able to utilize letter blending and other similar knowledge to facilitate their remembering the word; rather, they would either concentrate on the individual letters or develop their own strategy, and the effects of learning would be minimized.

The present study, although not specifically concerned with the relationship between memory span and intelligence, nevertheless took into account a possible correlation between the two. This was done because: 1) when many children, during the initial screening task, were unable to understand what was expected of them in the digits backward task, it seemed that an intelligence factor might be causing the problem, and 2) previous studies have indicated a relationship between memory span and intelligence. Because the results of the existing studies are so varied, making it difficult to determine the true correlation between memory span and intelligence, two groups, whose scores on the WISC did not include the digits backward task, were added to this study.

It is obvious at this point that measuring memory span is an elusive task, not only because previous research is largely inconclusive, but also because of the many factors that may affect memory span. In addition, the relationship of memory span to reading ability and to intelligence is not clear. Yet, three conclusions seem warranted. First, because memory plays an important role in certain types of concept attainment and because reading requires utilization of many concepts, success in reading depends upon certain memory functions. Second, limited auditory memory is a factor contributing to reading difficulty. This conclusion is supported by evidence which indicates that good readers tend to have longer auditory memory spans than poor readers, although the relationship is more marked in the lower grades than in the upper grades. Third, Digit Span appears to provide a valid basis for predicting short-term memory even though memory span varies with the materials used.

II
METHOD

SELECTION OF SUBJECTS

Subjects were chosen from among 168 kindergarten children in Sun Prairie, Wisconsin, on the basis of an individual screening procedure designed to identify those children having the shortest and longest memory spans. The Digit Span subtest of the Wechsler Intelligence Scale for Children was used for the screening. This subtest, which is given orally, yields three scores—a forward score, a backward score, and a total score which is a combination of the forward and backward scores.

Each child was asked first to listen to the examiner, who read digits at one-second intervals, and then to repeat what he had heard. The examiner began with three digits, increasing the number of digits by one each time the child repeated the digits perfectly. The maximum number of digits, as well as the maximum possible score on the digits-forward section was 9. After the child had reached his maximum, he was given the digits-backward test. This time, instead of repeating what he had heard, the child was asked to say the numbers backwards. The highest possible score for digits backward was 8; a perfect total score was 17.

Children whose total scores contained a score of zero in either the digits forward or backward task were eliminated after the random selection of children with the shortest memory spans had been made, because too many children had scores of zero. Had all of them remained as subjects the five groups, into which the subjects were divided, would not have been comparable in size. Thus, of the original 168 children screened, 96 subjects remained and were subsequently presented with the word-recognition test.

MATERIALS

The task comprised 26 groups of five-letter nonsense words; each word was typed, using a primary typewriter, on a separate 4 x 6 card in lower case letters. In order to examine all of the positions, and to give each subject an equal opportunity to respond to each cue, it was necessary that each cue appear in combination with every other cue an equal number of times over the 26 groups of cards (hereafter called "trials"). In other words, the positions were combined as follows: 1 and 2, 1 and 3, 1 and 4, 1 and 5, 2 and 3, 2 and 4, etc. This grouping of cues resulted in some trials having four response cards and others having five or six. Each trial, therefore, contained one stimulus card and four to six response cards, the latter being numbered on the back to facilitate scoring.

The response cards were designed to contain all possible responses the subject might make. That is, each card contained a cue (letter) which appeared in the same position as in the original word on the stimulus card. Five cues were examined—Positions 1, 2, 3, 4, and 5. For example, the stimulus card "moged" was followed by the response cards "mythi" (Cue 1 present), "borsu" (Cue 2 present), "pagle" (Cue 3 present), "fimet" (Cue 4 present), and "jukad" (Cue 5 present) randomly arranged.

In addition to the single cues, every cue was presented in combination with every other cue, as explained above. For example, the stimulus card "segof" was followed by the response cards "skgaf," "stgor," "segay," "segip," "slgom," and "shguf." Each of these response cards contains Cue 1 and Cue 3 of the original word. In addition, each word contains one further cue: "skgaf" and "shguf" contain Cue 5; "stgor" and "slgom" contain Cue 4; "segay" and "segip" contain Cue 2.

The purpose of the duplication of cues was to provide for more of a choice than would have been available had the subject been shown just three response cards. It is possible that many children may have refused to choose among only three cards, since it may have been obvious that none looked like the stimulus word. The task was constructed to give each subject an equal opportunity to recognize the word on the basis of any of the five cues.

Both the stimulus and response words were taken from those used by Marchbanks and Levin (1965) in their study with some alterations being made to accommodate the new situation. First, shape was omitted as a cue, since Marchbanks and Levin reported that shape had been the least used cue in both their trigram and pentagram series. This necessitated a second alteration: increasing the number of choices available where the deletion of shape as a cue left too few response words. A third variation was the omission of the trigram task. Marchbanks and Levin had found that strong competition existed between the first and last letters in word recognition. Owing to the possibility that this effect may have been due either to the open-endedness of a short word (i.e., the children might have been cuing to the first and last letters of the trigrams because the complete word was easily seen and there was a great deal of space next to those letters) or to children's ability to remember the complete word, the trigram task was eliminated in favor of a more intensive study of the pentagram task.

Four identical sets of cards were prepared for the four examiners. A form containing the numbers 1-125 (to correspond with the 125 response cards) was prepared for the recording of each child's choices. The stimulus cards appeared in the same order in each of the four sets, but the response cards were randomly arranged within trials.

PROCEDURE

Individual subjects were presented with the word-recognition task by adult examiners. The task was explained as follows: "We are going to play a word game. I will show you a word. After I take it away I will show you several other words. You are to point to the word you just saw or to the one most like it." The subject was then given two sample trigram recognition trials to orient him to the task. The examiner was free to re-explain the task to the subject during this time if necessary. The trigrams were immediately followed by the 26-trial pentagram task without the child's being made aware that the trigrams were to be discarded as practice.

Within each trial the subject was shown a word on a stimulus card and was allowed to look at it for a maximum of 30 seconds. The card was then withdrawn from sight and the response cards for that trial were randomly arranged on the table. The child was again told to point to the word he had just seen or to the one most like it. His response was checked on the scoring form, and the task continued through the 26 trials.

DESIGN AND ANALYSIS

Scores on the Digit Span subtest were arrived at on the basis of the forward and backward tasks as described earlier. During the initial screening task, many children were unable to understand what was expected of them in the digits-backward task. In addition, there were numerous scores of zero, particularly on the digits-backward task. Because level of intelligence might be the cause of both phenomena, it seemed reasonable to select groups in such a way that some would contain no zero scores. There was reason to believe that such grouping might yield useful information. Therefore, three groups were set up according to Total Score, which included both tasks, and two groups were added on the basis of just the Forward Score.

After the completion of the word-recognition task, 18 of the 96 subjects were eliminated owing to mistakes in scoring. Therefore, a total of 78 subjects—41 boys and 37 girls—were included in the analyses. The five groups contained 22 subjects each, 12 boys and 10 girls, with the two Forward Score groups containing several subjects who also appeared in either the short, middle, or long memory span groups.

After the testing was finished, the numbered responses were converted to the cue position which was represented by each word. A tally of responses by cue was made within and between the groups and sexes. The cues were subdivided into primes; that is, instead of Cues 1, 2, 3, 4, and 5 being tallied, Cues 1, 1', 2, 2', 3, 3', etc., were tallied. This was done for three reasons. First, because many response cards within individual trials duplicate a particular cue (as explained earlier), it was reasoned that the primes would assist in differentiating between the two possible choices and hopefully add to the information yield. Using the example previously mentioned, if the stimulus card "segof" has as two of its six response choices "skgaf" and "shguf," both of which contain Cue 5, the immediate question is which of the two words

Table 1

Sample Groups As Divided On The Basis Of WISC Digit Span Subtest

Group	Girls	Boys
Total Score Groups		
I - Short Memory Span (0-4 digits)	N=10	N=12
II - Middle Memory Span[a] (5-6 digits)	N=10	N=12
III - Long Memory Span[a] (8-12 digits)	N=10	N=12
Forward Scores Groups[b]		
IV - Short Memory Span (0-3 digits)	N=10	N=12
V - Long Memory Span (5-7 digits)	N=10	N=12

[a]No zeroes are included in either the Forward or Backward score.

[b]Several subjects in each group appear again in one of each of the Total Score groups.

will the subject choose if he is cuing to position five. Second, it seemed desirable to compare the total times each of the two cues was chosen. Third, it was felt that the data might contain the answer to why one was chosen more often than the other.

The primes were assigned to every second appearance of a cue within a trial. In Trial 5, for example, Cards 17, 18, 19, 20, 21, and 22 contained Cues 5, 4, 3, 3, 4, 5, respectively. Since each cue appeared twice, primes were assigned to Cards 20, 21, and 22 (which marked the second appearance of the cues) so that the chart then read: 5, 4, 3, 3', 4', 5'.

With the cues subdivided in this manner, comparisons were made across cues 1) between all of the boys and all of the girls, 2) among boys in Groups I, II, and III, 3) among girls in Groups I, II, and III, 4) between boys in Groups IV and V, 5) between girls in Groups IV and V, and 6) between boys and girls in each of the five groups taken individually.

III
RESULTS

The expectation was that the long memory span group would respond to Cue 1 or Cue 5 more often than to any other cue because it was assumed that in the scanning process beginning and ending letters would dominate. It was further speculated that because none of the response cards replicated the stimulus card the long memory span subjects would start either at the far left or far right when looking for a familiar letter; thus, if no card exactly like the stimulus card were found the tendency would be to choose the card that contained Cue 1 or Cue 5.

For the short memory span group, it was expected that the last letter the subjects saw might be remembered; thus, if they had been scanning from left to right, they would tend to look for Cue 5. If during the task they realized that they could not retain the stimulus information, it was anticipated that they might try to keep just a single letter in mind. Thus the feeling was that these subjects, more than either of the other two groups, would cue randomly.

CHI SQUARE ANALYSIS OF CUE FREQUENCIES

To test the null hypothesis that cues would be chosen with equal frequency, chi square tests were used. Single and combined (prime) cues have been combined for discussion purposes.

Long Memory Span Groups

For the boys, Cue 5 was the second most utilized cue (Figure 1, Table 2) and Cue 4 was the weakest cue. The girls responded somewhat differently, their weakest cue being Cue 2 and the second strongest cue being Cue 4 (Figure 1; Table 2). Both boys and girls with long memory spans responded to Cue 1 significantly more often than to any other cue (Table 3). Listing the cues in the order of frequency of choice, starting with the most frequently chosen cue, we have these patterns: Boys—1, 5, 3, 2, 4; Girls—1, 4, 3, 5, 2.

Table 2

Cue Preference Frequencies

Sex	Cue	Memory Span: High	Middle	Low	Total
Boys	1	103	95	82	280
	2	51	49	60	160
	3	54	60	60	174
	4	44	57	52	153
	5	60	51	58	169
Girls	1	85	72	67	224
	2	39	47	45	131
	3	45	42	61	148
	4	49	40	37	126
	5	42	59	50	151
Total	1	188	167	149	504
	2	90	96	105	291
	3	99	102	121	322
	4	93	97	89	279
	5	102	110	108	320

Middle Memory Span Groups

The subjects in the middle memory span group were considered comparable to those with long memory spans, since the digit span scores of both of these groups contained no zeroes. In other words, their Total Scores did not include a zero in either the digits forward or backward task. Considering that the groups were similar, finding that Cue 1 was the most utilized cue was not unexpected. For the boys, significance beyond the .05 level was calculated (Table 3). The order of cue preference for boys was 1, 3, 4, 5, 2. For the girls, there was no statistically significant

Table 3

Chi Square Values for Cue Preference Frequencies

Sex	Cue	Memory Span High	Memory Span Middle	Memory Span Low	Total
	1	26.416*	17.031	6.669	46.003**
	2	2.082	5.755	.092	3.952
Boys	3	.565	.092	.092	.930
	4	5.425	.467	1.733	6.248
	5	.092	2.082	.310	2.566
	1	20.942**	7.692	5.769	29.641**
	2	3.250	.480	.942	4.006
Girls	3	.942	1.923	1.557	.410
	4	.171	2.769	5.769	5.769
	5	1.923	.942	.076	.160
	1	47.351**	24.184	10.464*	75.339**
	2	5.204	2.959	.772	7.939
Total	3	2.073	1.344	.380	1.309
	4	4.003	2.646	5.639	12.009*
	5	1.344	.154	.358	1.568

* = p > .05
** = p > .01
Degrees of freedom = 4
Critical values were: p > .05, 9.488; p > .01, 13.2777
p > .10, 7.779; p > .001, 18.46

preference for any single cue; order of preference was 1,5,2,3,4.

Combining sexes for this group, preference of Cue 1 was highly significant (Table 3), and order of cues was 1,5,3,4,2.

Short Memory Span Groups

As stated earlier, it was thought that the pattern of results for the long and short memory span groups would be dissimilar in terms of the strongest cue. However, a visual survey of the cue choices (see Figure 1) for the latter group reveals that the differences are not large.

For the boys, the chi square test showed no statistically significant preference for any cue (Table 3). The observed order of preference was 1,2-3 (tie), 5,4. For the girls, no cue frequency reached significance, but observed order of cue preference was 1,3,5, 2,4.

For the low group as a whole, Cue 1 was chosen significantly more frequently than other cues, and order of preference was 1,3, 5,2,4. (Tables 1 and 2)

Sex Across Memory Span

The three groups of boys were combined and the total choices per cue were tested using chi square. Cue 1, of course, had a frequency significantly different from chance; and Cue 4 was utilized with infrequency (Table 2). The order of cue preference was 1,3,5,2,4.

The girls' choices were similarly compared. They, too, responded significantly to Cue 1, and again Cue 4 was utilized least frequently. Girls' order of cue preference was 1,5,3,2,4.

Comparing across sexes and memory span, the pattern of cue preferences was 1,3,5,2,4, Cue 1 being utilized significantly more than chance (p .001), and Cue 4 being used significantly less than chance (p > .05, Table 3). The competition between Cue 3 and Cue 5 for second most utilized cue which was evident with the low memory groups (Tables 2 and 3) was again operating here.

Since Cue 1 was definitely preferred by all groups, a comparison was made of the other cue choices for those trials where Cue 1 was not available as a possible choice. In making this comparison for all boys, the following dominance pattern appeared: 1 > 2 > 3 > 5 > 4; and for the girls: 1 > 2 > 3 > 5 > 4. From these results, we can conclude that both boys and girls exhibited the same dominance pattern of cuing. This does not mean that boys and girls showed the same frequency of choices, but that, when they were forced to choose between certain cues, the same ones dominated for both sexes.

Note that since the possible range of frequencies for a given cue was 0 to 15n, rather than 0 to 26n (where n is the number of subjects), the theoretical variance under the null hypothesis is smaller than that assumed for the chi square distribution; thus, the critical values required for significance are somewhat conservative.

Forward Memory Span Groups

Of the boys in Forward 0-3 and 5-7, seven in each group were also in Groups 0-4 or 8-12. Of the ten girls in each of the forward groups, five appeared again in Group 0-4, and another seven appeared in Group 8-12. Because there was considerable overlap of subjects, comparisons of the forward groups with other groups would have been difficult to interpret, and so shall not be pursued further.

ANALYSIS OF CUE PREFERENCE RANKINGS

Because of the conservative bias of the chi square test with regard to these data, frequencies of cue preferences were obtained for each individual, summed, and converted to ranks.

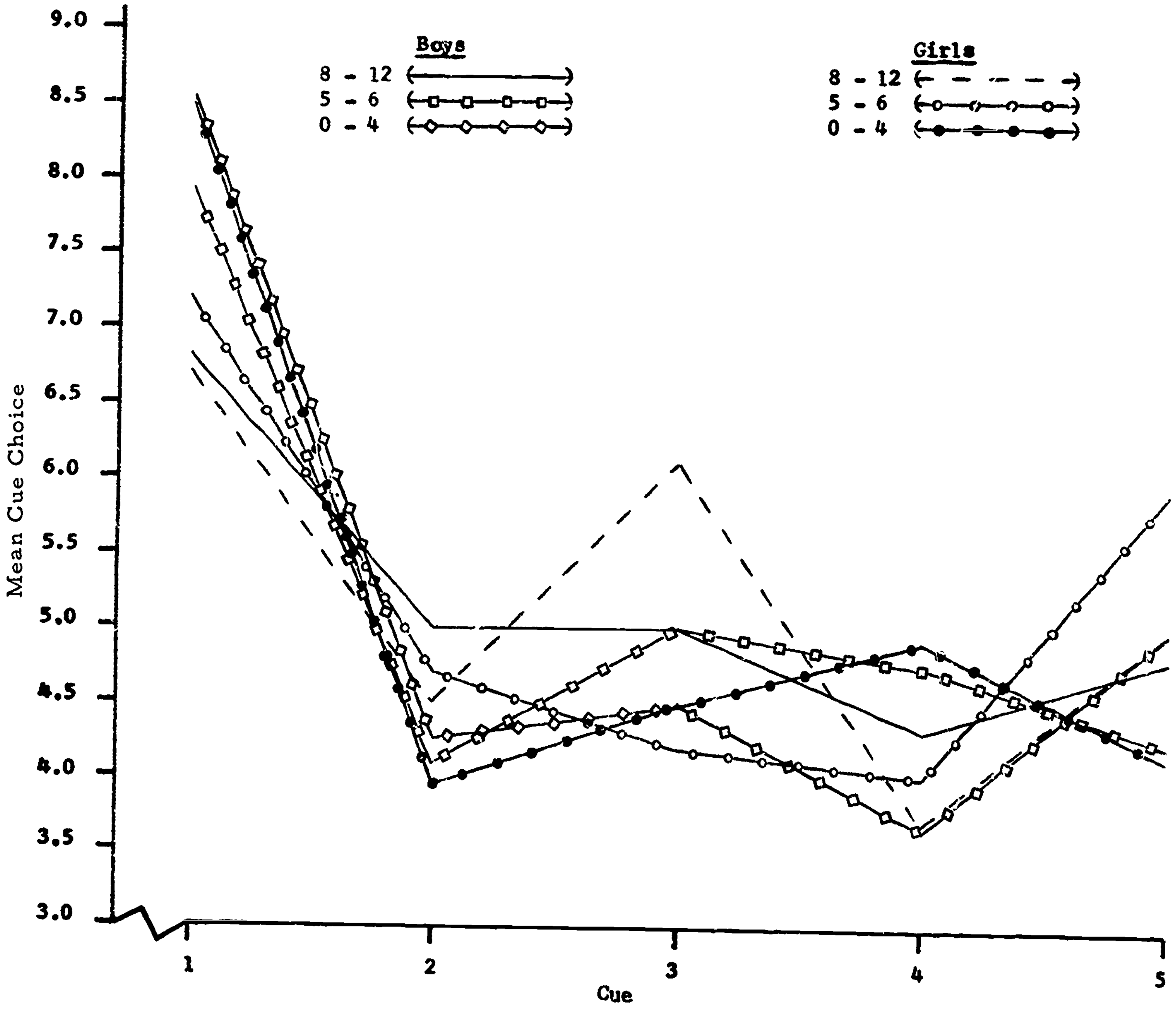

Fig. 1. Mean cue frequencies across memory span groups.

Friedman's Analysis of Variance of Ranks (Ferguson, 1959) was performed on the resulting ordinal data in order to determine whether a cue preference pattern could arise by chance. If the null hypothesis that conditions did not differ among the population were true, then the distribution of ranks would be expected to appear in all columns with about equal frequency. If the subjects' scores were dependent on some condition (that is, if the null hypothesis were false), then the rank totals would vary.

Results were significant for the high and middle memory span boys (Table 4), indicating the improbability of a pattern's arising by chance. Results for both boys and girls in the low memory span group were not significant, indicating that random selection may have been operating.

Table 4

Friedman's Analysis of Variance on Cue Preference Ranks

	Memory Span			
Sex	High	Middle	Low	Total
Boys	10.45*	11.82*	2.65	24.57**
Girls	6.74	4.16	6.08	11.32*
Total	14.63**	21.61**	6.991	29.45**

* = $p < .05$
** = $p < .01$
Degrees of freedom = 4
Chi square values were: $p < .05$, 9.488
$p < .01$, 13.277
$p < .10$, 7.779
$p < .001$, 18.46

Using the chi square test for the two groups combined, that is, sexes and memory span, significance was reached for the high and middle groups. This would indicate that something other than random selection was operating.

As stated earlier, a comparison across sexes and memory span revealed a pattern of cue preferences 1,3,5,2,4. The W-shaped trends (Figure 1) in the totals of the groups' choices seem to imply the existence of significant differences between cues. To test the strength of individual cues and groups of cues the sign test (Freund, 1960) was performed on the raw data for individual subjects' total choices per cue. Since there was a tendency for the most frequent choices to be Cues 1, 3, and 5 and for the least preferred choices to be Cues 2 and 4, they were combined into two groups for the analysis—Cues 1, 3, 5 and Cues 2, 4. Results were significant for all subjects ($p < .001$, Table 5) indicating a greater preference for the extreme and medial cues versus Cues 2 and 4 than can be assigned to chance.

Both short and long memory span groups chose Cues 1, 3, and 5 significantly ($p < .01$) more often than Cues 2 and 4, while the significance level reached by the average memory span group and the Forward 5-7 group was $p < .05$. Results were not significant for the Forward 0-3 group.

Individual subjects' total choices for Cue 1 versus Cue 5 were compared next. Results were significant for all subjects ($p < .001$) and within the three memory span groups in favor of Cue 1.

Since Cue 1 was preferred by all groups, the above results, which included Cue 1 in the analysis, were not unexpected. It seemed logical, therefore, to compare Cues 3 and 5 with Cues 2 and 4 to see if either of them, in addition to Cue 1, was contributing significantly to the differences. Results were just short of significance at the .01 level, indicating that Cue 1 was the only cue chosen with any great significance. Here the low power of the sign test may be unfortunate.

Table 5

Sign Test of Cue Strengths

Boys & Girls	Cues 1,3,5 vs. 2,4	Cues 3,5 vs. 2,4
Long Memory Span	Z = 2.56*	Z = 1.34
Average Memory Span	Z = 2.13**	Z = .89
Short Memory Span	Z = 2.56*	Z = .447
Forward 5-7	Z = 2.13**	
Forward 0-3	Z = .852	
All Subjects	Z = 4.19***	Z = 1.54[a]

* $p < .01$
** $p < .05$
*** $p < .001$

[a]Results do not include the two Forward groups.

IV
DISCUSSION

Observations of the data and subsequent analyses have indicated some emerging patterns among the memory span groups. The strength of these patterns, however, cannot be determined from this study because of unfortunate limitations in the task. A particularly pertinent area to pursue concerns the various conditions which may have been operating during the task to affect response choices.

The letters appearing in the duplicate-cue response cards, for example, might have influenced subjects' choices. In fact, individual letters may have been a major influence throughout the task, since many children chose a card after saying to the examiner, "That letter is in my name." The factor of familiarity or unfamiliarity with different letters for individual subjects may have influenced their choices in a variety of ways. They may have chosen a card not on the basis of the five stimulus cues, as assumed in the tabulations made of responses, but rather on the basis of familiarity with a particular letter which they happened to recognize immediately.

If this possibility were to be ignored, since it was not always detectable and certainly could not be assessed objectively, it still would not be possible to evaluate the choice made between duplicate-cue response cards. Such an evaluation would involve a comparison of the two words which contained duplicate cues to see if, over trials, a pattern evolved showing that children tended to choose the word of each pair which contained certain letters. This, unfortunately, could not be done since in Marchbanks and Levin's pentagram list letters did not appear equally over trials.

There was, in addition, reason to expect that incomplete learning, and considerable forgetting, of the stimulus pentagrams would occur. Since subjects were nonreaders and, for the most part analphabetic, phonetic encoding of stimuli into nonsense sounds was unlikely. Instead, subjects had to retain five visual "bits" of information, whose correct sequencing (critical to the study) probably went beyond the limit of the subjects' information-processing capabilities. Furthermore, since response pentagrams necessarily resembled the stimuli, considerable proactive interference would be expected, so that subjects might cue on similarities of response to alternative response, rather than response to the stimulus. Since on items for which cues were held constant (96% of the items) such response preferences would tend to be based on unkeyed cues, the recorded cues would be uncorrelated with the "true" cues in these cases. In other words, where response choices began with the same letter, for example, subjects might forget about the stimulus card and choose between those two response cards, thus making a choice on the basis of something other than one of the five stimulus cues. The result of responding in this manner would be an invalidation of the data. Fortunately, giving irrelevant cues in random fashion would not bias the study by favoring one cue over the others, but would raise the error of measurement.

Kendall's coefficient of concordance (symbolized W) is a measure of agreement within a group of raters. In this case, the raters would be the memory span groups. Because there is no reason to suppose that the different sexes or digit span groups have different proportions of the various scanning patterns among their members, they should all have the same value of W if all things were equal. The results of the computation follow:

0-4 boys	W = .055	0-4 (both sexes)	
0-4 girls	W = .152		W = .079
5-6 boys	W = .246	5-6 (both sexes)	
5-6 girls	W = .104		W = .127
8-12 boys	W = .218	8-12 (both sexes)	
8-12 girls	W = .169		W = .163

These values of W are quite low, representing poor agreement. The suggestion is that either different strategies are being employed or there is much nonretention of stimuli. The values do reflect more agreement in patterns of cue preference for the long memory span groups than for the short memory span groups, suggesting that all things relating to retention are really not equal and that the low memory span group may be responding to many items for reasons other than cues, since they cannot recall the stimulus anyway. These low values corroborate the results of the Friedman Analysis of Variance (Table 4) where only the short memory span group differed from the other groups.

In testing for significance of cue preference, no significant differences among the noninitial cues were found, perhaps as a result of the long-retention intervals which involved a great deal of interference of additional materials. The W-shaped trends (Figure 1) in the totals of the groups' choices (the tendency for the most frequent choices to be 1, 3, and 5 and for the least preferred choices to be 2 and 4), seem to imply the existence of significant differences between cues; however, the significance level does not bear this out, possibly because of the small numbers of subjects.

The findings of the present study compared favorably with Marchbanks and Levin's findings. It was generally agreed that Cue 1 was the most utilized cue for all groups, and that Cue 4 was one of the least preferred cues. Competition between Cue 1 and Cue 5 for their kindergarten boys, however, seemed to relate closely, in the present study, only to the high memory span boys and to the girls when frequency of choice was combined across memory span. Further differences appeared in in the original study's report that kindergarten boys often based their judgments on Cue 5, utilizing Cue 1 as their second choice. This was not the case in the present study even for the low memory span boys (as we had anticipated), although a few of the boys did prefer Cue 5.

Both studies exhibited W-shaped trends, suggesting an avoidance effect for Cue 2 and Cue 4, both of which are imbedded in the other letters. The present study, unlike the previous one, demonstrated strong competition between Cue 3 and Cue 5. This finding, although it has not been adequately measured, is regarded as potentially significant for word recognition. More subjects, however, and tighter controls would be required if a comparison of cue preference were to be pursued in a meaningful way.

V

SUMMARY, LIMITATIONS, AND IMPLICATIONS

The data indicate that all groups showed a preference for Cue 1; however, the strength of the preference differed from group to group. There was a tendency, too, across memory span groups, for boys and girls to respond to Cue 3 and Cue 5, while there seemed to be an avoidance effect for Cue 2 and Cue 4 (although some individual groups did not show this cue preference). Thus, the W-shaped trends. Why these tendencies occurred is a matter for speculation; but it seems that cuing to 1, 3, and 5 may be the most natural pattern of scanning for untrained children. The ends are open and may be more eye-catching for that reason. The middle cue might have been a frequent choice because from that point subjects could scan in either direction. Cue 2 and Cue 4 are couched within the words, so would tend to be overlooked in favor of other positions.

It appears that scanning itself may have affected subjects' performance and the data more than was anticipated. This scanning applies not only to that done with the stimulus cards, but with the response cards as well. It is difficult to determine why a subject chose a particular card, since there was no instrument set up to record eye movements, for example. Since the examiner could only make subjective judgments regarding the subjects' strategies, this problem cannot be pursued. Although it seemed at times that subjects were picking the first card they saw, there was no way of determining, in this study, whether or not they actually did look at all of the cards. To assess this particular aspect of the problem, it might be better to present the response cards in some controlled pattern, rather than randomly. For example, if the cards were arranged in a row, knowing where in the row each card appeared would throw more light on the subjects' patterns of choice. By varying cue positions within the rows, the experimenter would be able to decide if the child were cuing to the position of the card in the row or to the actual cue positions of the letters.

As mentioned in Chapter IV, it is also difficult to determine to what extent variables such as familiarity with individual letters, the long-retention intervals involving interference of additional materials, or responding to unkeyed cues influenced the entire task. In addition, the task was not set up to distinguish between the effects of primacy and recency.

With the individual memory span groups, randomness of choice seemed to be operating. This was particularly true for the low memory span groups. This randomness may have been the result of subjects' poor retention ability and, possibly, low intelligence. If these groups' problems were just an inability to retain the stimuli, a tendency to make random selections would be expected, for it would not be unreasonable to expect responses to be made for reasons other than cue positions or stimulus letter cues. The Friedman Analysis of Variance of Ranks showed that for the low boys a preference pattern could arise by chance, while for the other boys it was 95% likely not to arise by chance.

It was expected that a comparison could be made of cue preferences between the duplicate-cue response cards. This would have required that the letters appear equally over trials by position. Unfortunately, Marchbanks and Levin's pentagram list was not controlled in this way, so the comparison could not be made. In order to see how individual letters operate in word-recognition an experiment could be designed controlling letter difficulty and frequency of appearance over trials; or the number of letters used in the total task might be limited. Any of these designs might be expected to show which letters contain the most information for children. This could be a valuable aid in the teaching of new words to beginning readers.

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APPENDIX

FORM FOR RECORDING RESPONSE CHOICES

NAME: ______________________ DATE: ______________________

AGE: ______________

1.	26.	51.	76.	101.
2.	27.	52.	77.	102.
3.	28.	53.	78.	103.
4.	29.	54.	79.	104.
5.	30.	55.	80.	105.
6.	31.	56.	81.	106.
7.	32.	57.	82.	107.
8.	33.	58.	83.	108.
9.	34.	59.	84.	109.
10.	35.	60.	85.	110.
11.	36.	61.	86.	111.
12.	37.	62.	87.	112.
13.	38.	63.	88.	113.
14.	39.	64.	89.	114.
15.	40.	65.	90.	115.
16.	41.	66.	91.	116.
17.	42.	67.	92.	117.
18.	43.	68.	93.	118.
19.	44.	69.	94.	119.
20.	45.	70.	95.	120.
21.	46.	71.	95.	121.
22.	47.	72.	96.	122.
23.	48.	73.	97.	123.
24.	49.	74.	98.	124.
25.	50.	75.	99.	125.