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ABSTRACT

Two experiments were conducted using nine- through twelve-year-old readers to determine how they differed from adults in their ability to identify meaningful units in a written passage, how they were affected by sentences of increasing difficulty, and whether they would be aided by either shorter sentences or meaningful segmentation of sentences. The first experiment showed an inability of children to parse sentences meaningfully. Younger children made irregular markings while many of the older children limited themselves to units identified by commas. The second experiment determined that shortening or segmenting sentences increased reading time but decreased error rates. An interaction showed that these text manipulations improved only low ability readers' scores. There was also an indication that error rate but not reading time was affected by text characteristics other than sentence length and word length. (Author)

CENTER FOR THE STUDY OF READING

Technical Report No. 92

FACILITATING READING COMPREHENSION THROUGH TEXT STRUCTURE MANIPULATION

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Abstract

Two experiments were conducted using 9-12 year old readers to determine how they differed from adults in their ability to identify meaningful units in a written passage, how they were affected by sentences of increasing difficulty, and whether they would be aided by either shorter sentences or meaningful segmentation of sentences. The first experiment showed an inability of children to parse sentences meaningfully. Younger children made irregular markings while many of the older children limited themselves to units identified by commas. The second experiment determined that shortening or segmenting sentences increased reading time but decreased error rates. An interaction showed that these text manipulations improved only low ability readers' scores. There was also an indication that error rate but not reading time was affected by text characteristics other than sentence length and word length.

Facilitating Reading Comprehension through Text Structure Manipulation

There is evidence that an ability to identify intrasentence units of text is an important aspect of comprehension (Rode, 1974-1975; Weinstein & Rabinovitch, 1971) rather than reading efficiency alone (Colemen & Kim, 1961). In studying this topic, however, no assumptions are made that there are two kinds of poor comprehenders: one group who cannot decode and another who have adequate decoding and vocabulary skills but are unable to interpret text information. That is, the design complaint raised by Calfee, Arnold, and Drum (1976), who argued that the readers in Cromers' study (1970) who could not interpret text may not have been appreciably different from average comprehenders, appears well founded. The focus here is on children's ability to identify meaningful units in texts and to read manipulated text materials without trying to distinguish good and poor decoders from good and poor comprehenders.

A technique for identifying meaningful units in written text was first employed by Johnson (1970) who found a high agreement among skilled readers when they were asked to place slash marks at the points where they would pause when reading a passage aloud. Frase and Schwartz (Note 1) relied on this procedure to show that separation of sentences by intended, meaningful units reduced the length of time needed to locate information. Hartley and Burnhill (1976), Cromer (1970), Coleman and Kim (1961), and North and Jenkins (1951) found that text materials that were separated into phrases reduced errors in finding information, improved comprehension scores for poor readers, or led to faster reading.

In research with children, Buswell (1920) found that good comprehenders had longer eye-voice spans than did poor comprehenders. This was confirmed by Levin and Kaplin (1970). Eagan (Note 2) showed that the number of oral reading pauses decreased from grade 2 to 3 and from poor to good readers even after controlling for decoding skill. These studies indicate that children who are better comprehenders have the longer eye-voice spans, implying an ability to identify and group appropriate intrasentence units.

Based on the eye-voice span research, there is reason to expect age and reading skill differences in an ability to identify intrasentence pausal junctures. The effect would be more meaningful, however, if an improvement in reading comprehension could be obtained from text that was segmented by intrasentence junctures. In particular, poor readers in the upper elementary grades who may have a poor conception of complex syntactic structures should obtain higher reading comprehension scores if the text materials are segmented into meaningful units. This effect could be shown by finding a greater difference between low and high ability readers on the standard text than segmented text, with only low ability readers being helped by the manipulation.

In the first experiment reported here, adults and 9-11 year old children were asked to read and segment into pausal junctures a passage which was graded by paragraph from a grade 1 to a grade 9 level of difficulty. This study was intended to determine whether children could locate intrasentence junctures. In the second study, fourth graders read

a story in a standard or revised format. Children marked the time it took them to read each of four sections of the passage; after reading they answered comprehension questions about the passage. Format effects were measured using children's reading time and comprehension error rate. These effects were then compared with respect to reading ability.

Experiment 1

The purpose was to determine whether children who could recognize most of the words in a text would be able to segment sentences into meaningful units in a manner similar to adults.

Method

Twenty-two college students and 60 children aged 9, 10, and 11 read a nine-paragraph passage. The passage had been normed as an oral reading task; the first paragraph was at a grade 1 level of difficulty and each succeeding paragraph increased in difficulty up to grade 9. Adults and children were asked to place slash marks where they would pause if they were to read the passage aloud; children were also asked to circle words they could not pronounce and stop reading if they circled five or more words in a paragraph. The tasks were carried out in classroom settings. Eight children's responses were omitted from the analysis because they did not complete the task. Of the remaining children, 8 were 9 years old, 21 were 10, and 23 were 11.

Only three of the nine paragraphs were analyzed--those approximating the difficulty levels of grades 4, 5, and 6. The easier passages were

not analyzed because adults determined that these sentences contained very few breaks (only 3 in the 21 sentences). The more difficult passages were not analyzed because fewer children completed them and those who did tended to restrict themselves to marking commas. In the three analyzed paragraphs there were 22 intrasentence junctures that were agreed upon by half or more of the college students. These junctures were compared with those produced by the children in terms of hits (slash marks that agreed with adults), misses (slash marks that disagreed with adults), and proportion of responders who parsed only punctuation marks.

Results

Large differences between adults' and children's judgments were found, particularly in the location of slash marks. Children marked only six to nine of the junctures that at least half of the adults had located. Smaller differences appeared in the number of misses primarily because some children relied almost entirely on comma junctures for placement of slashes. Forty-two and 43% of the 10 and 11 year olds but none of the 9 year olds and adults marked only commas. The 9 year olds, instead, made idiosyncratic judgments, ignoring most commas as well as other appropriate junctures; 10 and 11 year olds were quite cautious in their judgments; and adults, while agreeing on the essential pausal breaks, tended in addition to mark lesser pause breaks (see Table 1 for summary).

Insert Table 1 about here

Discussion

The results indicate that children cannot readily identify meaningful units in text, although the ability to do so improves with age. Nine year olds showed little use of any rule or pattern in making pause breaks which suggests that the task was not well understood by them. Given the restrained but relatively accurate responses of older children, however, attention to comma markers seems to be an early step in deciding where to mark pausal breaks. Overall, then, the results indicate that younger, less skilled readers have some difficulty in identifying intrasentence units and that children in general do more poorly at the task than do adults.

It should be noted that the low agreement between adults and children was characteristic of children who indicated they could read all the words. Thus, given that the self-reports are reliable, differences in the hit rate suggest that an ability to identify meaningful intrasentence units may be separate from decoding skill.

Experiment 2

As the first experiment indicates, the inability of upper elementary school children to separate sentences into meaningful units might be related to their text comprehension. In other words understanding of text that contains complex sentences is hypothesized to be affected by an ability to locate intrasentence junctures. Inappropriate parsing by a reader ought to interfere with comprehension and possibly also slow reading rate. However, if a reader does not notice syntactically disjointed phrases, only comprehension should be affected. As a result, manipulations of

the text format to make intrasentence units more apparent should improve comprehension and, perhaps, increase reading rate.

Method

Subjects. Ninety-eight fourth grade students in Halifax, Nova Scotia public schools who had not been used in the first experiment were tested. Schools were selected on the basis of overall reading achievement test score averages which were at or near the 50th percentile. Most of the intact fourth grade classes in the selected schools were tested.

Materials. The three paragraphs that were analyzed in Experiment 1 served as a content base for the construction of systematically varied materials. The paragraphs were divided into four levels of difficulty by creating five sentences each that contained 18, 22, 26, or 30 syllables per sentence. Five multiple-choice comprehension questions were constructed for each of these four levels. Next, two formats of the four difficulty-level sections were put together. In one, sentences were separated on successive lines of the page into pausal units. In the other, four short sentences reflecting these units replaced each complex sentence. The resulting structure is summarized in Table 2. An example of the format variations and a question is shown below.

Standard

Dick will be in Grade Five and though he enjoys math he likes art class best.

Parsed

Dick will be in Grade Five
and though he enjoys math
he likes art class best.

Short sentence

Dick will be in Grade Five. He enjoys math. He enjoys art. He likes art class best.

Question

What is Dick's best subject?

(a) math (b) reading (c) art (d) science

Insert Table 2 about here

Procedure. In group testing, children read the passage in one of three format conditions: (1) standard text, (2) each sentence broken into four short sentences, and (3) each sentence divided by meaningful units onto separate indented lines. When they finished each of the four difficulty level sections, they wrote down the time that was displayed on the blackboard (the time was changed every 15 seconds). When they finished the passage, they responded to the vocabulary and comprehension questions which followed. They were instructed to answer the questions without rereading the story and were given as much time as they needed to read and to answer the questions.

Results

Before running an analysis of variance, scores from a school-administered reading comprehension test, given within three months of this study, were used to divide the sample into three groups by reading ability. Then, passage format and reading ability were between subjects variables while passage difficulty was a within subjects variable. This design was analyzed three times using comprehension error, reading time, and the ratio of reading time over the number of syllables per standard sentence as dependent variables. Mean scores from these analyses appear in Table 3.

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Insert Table 3 about here

Comprehension error. With an average error rate of 28%, significant effects were obtained of reading ability, $F(2,87) = 15.0$, $p < .001$, passage difficulty, $F(3,261) = 23.0$, $p < .001$, and a borderline interaction between reading ability and passage format, $F(4,87) = 2.4$, $p < .06$. However, since low ability readers had been predicted to be helped by the experimental format, t test comparisons of the format conditions for low ability students were obtained. Significant differences appeared between the standard and short sentence formats, $t(87) = 4.29$, $p < .01$, and between the standard and parsed sentence formats, $t(87) = 2.0$, $p < .05$. No significant t test differences were found for middle or high ability students. The interaction is shown in Figure 1.

Insert Figure 1 about here

Since the principal hypothesis was that error rate would be affected by reading ability and passage format alterations, this interaction was explored further by graphing it in relationship to the three easier levels of passage difficulty (the fourth level of difficulty was omitted because of discrepant comprehension scores; this will be discussed later). The passage difficulty by format interaction for low and high ability levels, displayed in Figure 2, shows that for the second and third most difficult passage sections, the low ability readers had the lowest error rates on the experimental formats and the highest rates on the standard format. In contrast, the format effect was similar at all three difficulty levels for the high ability readers.

Insert Figure 2 about here

Reading time. The reading time analysis showed significant effects of reading ability, $F(2,87) = 7.1$, $p < .001$, passage difficulty, $F(2,87) = 33.9$, $p < .001$, passage format, $F(2,87) = 3.6$, $p < .03$, and a passage format by passage difficulty interacti[illegible] 1) = 3.0, $p < .01$. The easiest passage section took an average of 32 seconds to read, the hardest took 56 seconds. Passage difficulty of each of the formats was correlated with reading time ($r = .34$ for the segmented format, $p < .01$; $r = .24$ for the other two formats, $p < .02$).

The reading ability effect indicated that high ability readers were the fastest readers while low ability readers were the slowest. However, ability was correlated significantly with only the two experimental formats (see Table 4) so the interaction between these variables was plotted (Figure 1). This showed that low ability readers read more slowly under the experimental formats only. Newman-Keuls tests were made to evaluate the differences between reading times of the high and low ability readers under the two experimental formats. While none was significant, the differences between means were in the predicted direction.

Insert Table 4 about here

The format main effect determined that the experimental formats increased reading time with the short sentence taking the longest time. The interaction between passage format and passage difficulty showed that as the number of syllables was increased, more time was spent reading. This was particularly true for the two experimental formats.

In a third analysis using a ratio of time over syllable number, there were neither significant format differences nor a significant interaction

with passage difficulty. This indicates that format differences were caused by the short sentence format which contained fewer words per sentence. The passage difficulty effect was still significant, $F(3,261) = 5.6$, $p < .001$, in the ratio analysis as was reading ability, $F(2,87) = 6.7$, $p < .002$.

Frase and Schwartz (Note 2) found that appropriately parsed and indented sentences reduced reading time. In this study, parsing did not reduce reading time. This is probably due to the task differences. Frase and Schwartz had people read until information was found rather than read to understand and remember information. Also, the amount of text read was longer in the former study. If children had been given a longer passage to read, their reading speed might have been lower under parsed format conditions than under the standard format.

Discussion

The error analysis determined that alternative text formats can improve reading comprehension for low ability students. Low ability readers' error rates are reduced under both short sentence and parsed sentence formats. The source of the improvement appears to be explained partially by the amount of time spent on the passage (Figure 1). Low ability readers spend more time than either of the other groups on the nonstandard formatted text. This suggests that with standard formatted text low ability readers do not attend to important propositional or syntactic information. Thus, when text materials contain complex sentences their error rate increases (Figure 2). This supposition is supported by Weinstein and Rabinovitch (1971) who found that, in contrast

to high ability readers, low ability readers do not improve in the number of nonsense words learned when syntactic cues are provided. The supposition is further supported by the effect of the experimental formats. Note the high correlations between reading ability and experimental formats, also the interaction between ability and formats (Table 4 and Figure 1). When major propositions are set out as separate sentences or on separate lines, low ability readers spend more time on the task and obtain comprehension scores that are much more similar to scores obtained by better readers. High ability readers do not spend more time on the experimental formats and are not helped by manipulated text. This suggests that high ability readers have mastered the syntactic structures of text materials used here. Alternatively, text structures that are more complex but parsed could result in an improvement for high ability readers; however, this remains to be shown.

Time spent reading is strongly related to but not completely accounted for by word length and sentence length. The ratio analysis is an adjustment of reading time by the number of syllables which, in the analysis of variance, eliminates the passage format effect but not the passage difficulty effect (refer to Table 2). If one assumes that time on task is a reliable indicator of text difficulty, then this adjustment has accounted for the effect of the short sentence condition but not the passage difficulty effect.

The error rate analysis also shows an effect of variables other than word or sentence length. Since word length was increased systematically

in the standard and parsed formats while holding sentence length constant, a linear fit (of passage difficulty) for error rate was expected. The lack of confirmation is interesting, particularly in the light of assertions that word length and sentence length are sufficient variables to measure text difficulty (according to commonly used readability formulas). However, another text complexity variable is suggested by the error rate decrease on the passage section which contained 30 syllables per sentence. A perusal of each section of the text suggests that there are differences in the grammatical structure (Stein & Glenn, 1977) which could explain the effect. The second and third sections contain poorly related pieces of information (list-like structures) while the last section has a cohesive story-like structure. Assuming the questions for this section are no easier than other items, scores on the multiple choice test seem to be affected by text cohesiveness as well as the tested word and sentence length variables.

Summary

The first experiment demonstrates that children are not able typically to parse sentences into meaningful units, particularly as sentences increase in length and contain longer words. Intrasentence junctures are poorly perceived, even by sixth graders, when compared with adults' judgments.

The second experiment indicates that an inability to mark text breaks does not necessarily identify readers who have poorly developed notions of intrasentence junctures. Only low ability readers' comprehension scores are improved when intrasentence structures are separated. Their reading

rate is slowed by the experimental formatting perhaps because they are now processing the complex information. It is conceivable, then, that separating sentences into parsed structures may help low ability readers learn to cope with the syntactically more complex text materials that prevail from fourth grade onward.

Several questions remain unanswered. Will the effect be stronger: When longer sentences are given? When time constraints are imposed? If longer passages are used? If other measures of reading comprehension are given? Obviously there are a number of studies that should be undertaken before effects on comprehension of segmented sentences are fully understood.

Additionally, the fact that the 9-11 year old children do not agree with adults' conceptions of pausal junctures (Experiment 1) means that they might be trained to locate important intrasentence boundaries. It is possible that this could improve low ability readers' comprehension of complex sentences. This effect needs to be demonstrated by a training study.

Nonconfirmation of a linear fit between comprehension error rate and word length is also important. Text complexity is presently based on only two factors, word length and sentence length. It is apparent that other variables such as story cohesiveness enter into text difficulty. As story grammars are more fully developed, the role of story cohesiveness in understanding and remembering text materials can be more fully explored. This study suggests that text complexity is an important third third variable in measuring text readability.

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Table 1

Tabulation of Hits, Misses, and an Accuracy Ratio

of Intrasentence Pausal Breaks

Age	Average hits	S.D.	Average misses	S.D.	Hits/Total response
9	6.5	3.1	8.1	7.9	.44
10	9.0	4.8	3.4	6.5	.73
11	9.2	4.2	3.0	4.9	.75
College	15.3	5.1	6.6	6.3	.70

Table 2

Description of Format and Intrapassage Differences

Format condition	Passage section			
	First	Second	Third	Fourth
Short sentence				
Number of lines	9	11	14	15
Number of sentences	20	20	20	20
Number of words per sentence	5.35	7.25	9.30	10.15
Number of syllables per sentence	5.85	5.85	6.40	6.55
Parsed				
Number of lines	11	12	11	12
Number of sentences	5	5	5	5
Number of words per sentence	17	17	17	17
Number of syllables per sentence	18	22	26	30
Standard				
Number of lines	8	8	9	9
Number of sentences	5	5	5	5
Number of words per sentence	17	17	17	17
Number of syllables per sentence	18	22	26	30

Table 3

Error Rates and Reading Time, Under Passage Format and Passage Difficulty Conditions and as a Function of Reading Ability

	Mean		Ratio of Reading time
	Error rate	Reading time in sec.	to Number of syllables
Format			
Standard format	1.51	39.7	.34
Parsed format	1.46	45.3	.38
Short sentence format	1.29	55.5	.34
Passage difficulty			
90 or 117 syllables	1.00	34.2	.35
110 or 145 syllables	1.72	47.1	.39
130 or 186 syllables	1.94	50.3	.34
150 or 203 syllables	1.02	55.6	.33
Reading ability			
High	1.04	38.3	.29
Middle	1.27	42.6	.32
Low	1.95	59.5	.44

Table 4

Reading Time Correlations Between Reading Ability and Text Format

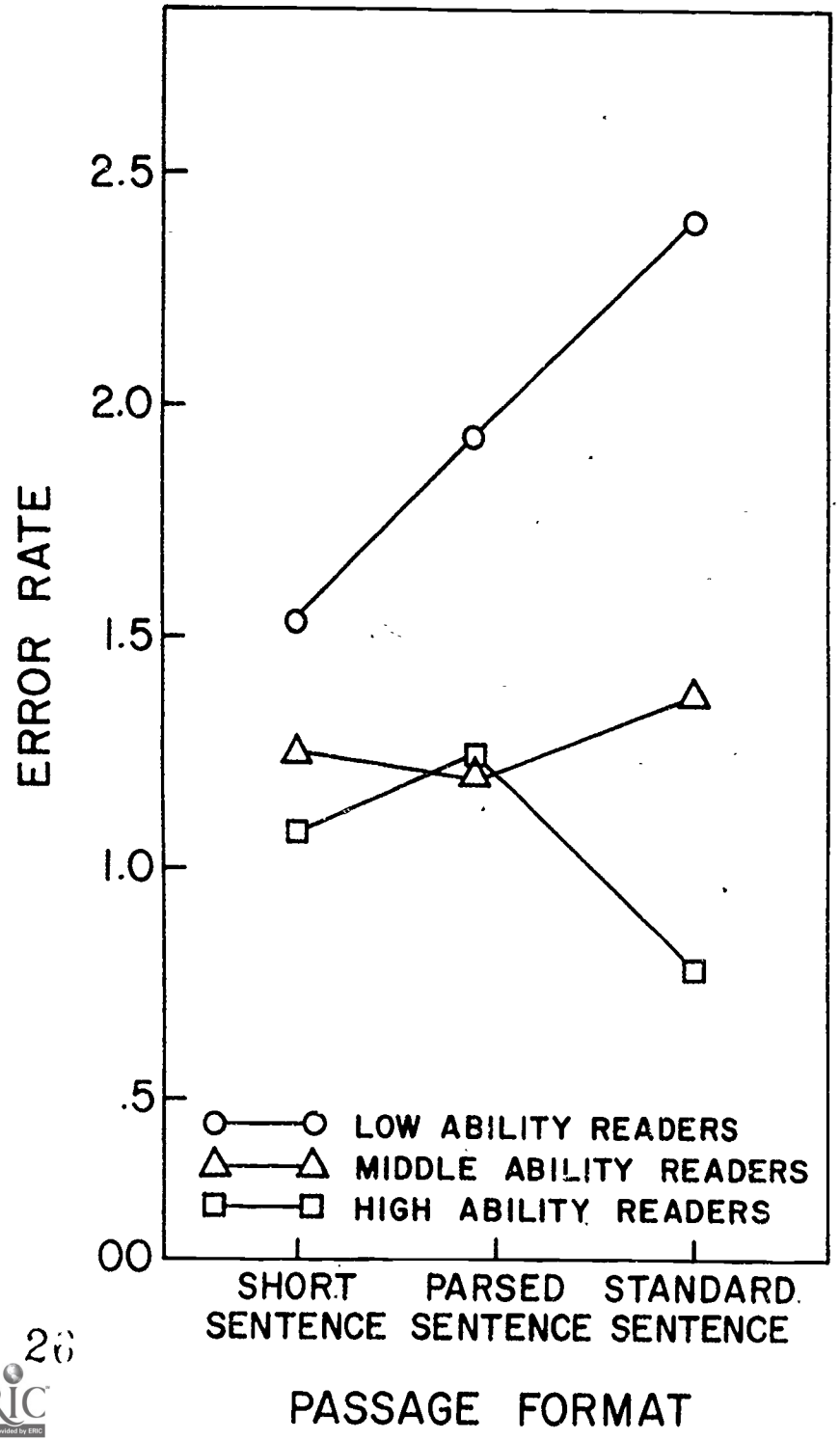
	Comprehension test score	Vocabulary test score
Standard format	-.05	-.17
Parsed format	-.64*	-.59*
Short sentence format	-.60*	-.53*

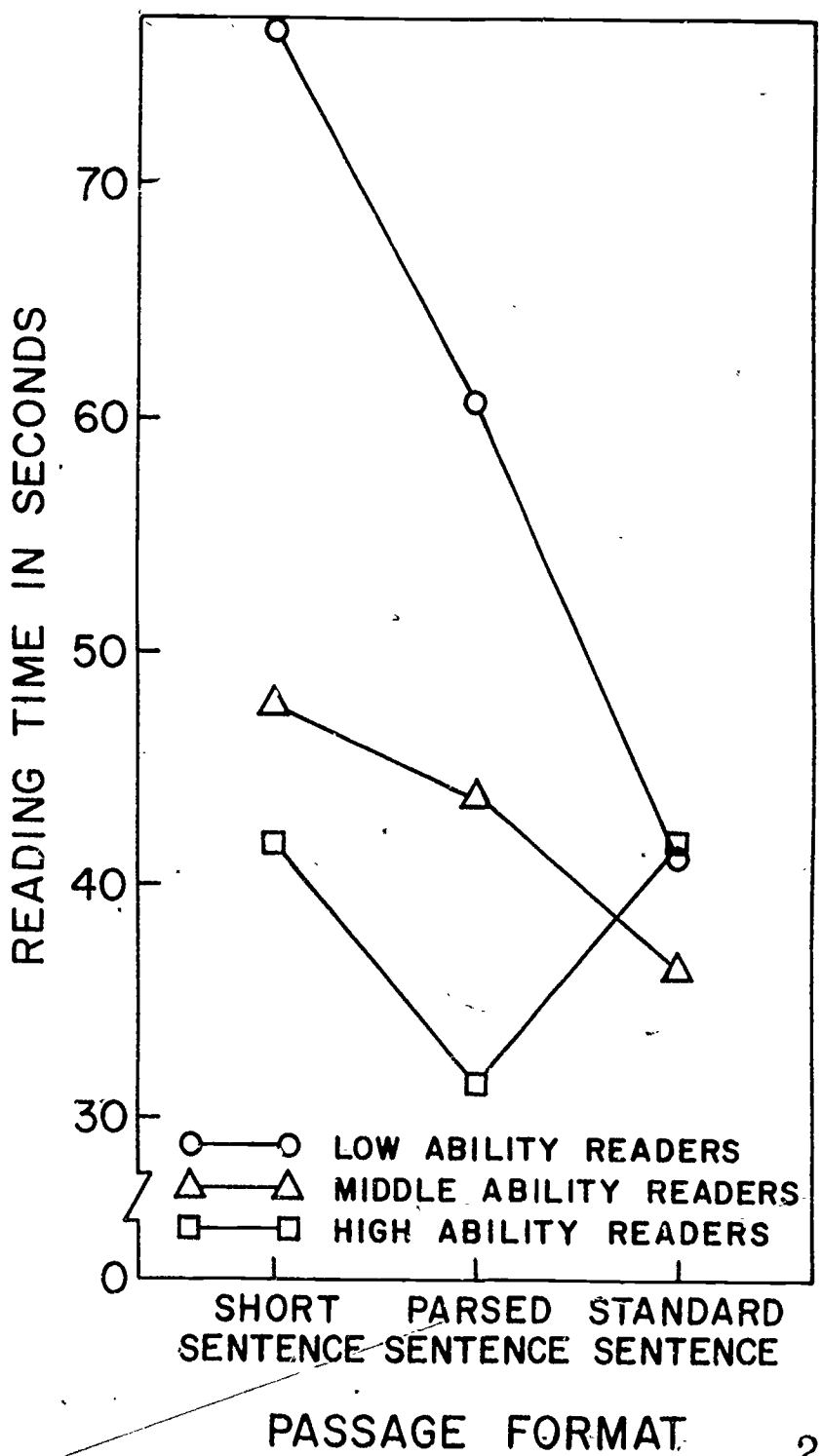
*$p < .01$

Figure Captions

Figure 1. Interactions between reading ability and passage format for error rate and reading time.

Figure 2. Interaction between passage format and passage difficulty for low and high ability readers as a function of reading comprehension error.


ERROR RATE
2.5
2.0
1.5
1.0
.5
00
LOW ABILITY READERS
MIDDLE ABILITY READERS
HIGH ABILITY READERS
SHORT SENTENCE
PARSED SENTENCE
STANDARD SENTENCE
PASSAGE FORMAT


READING TIME IN SECONDS
70
60
50
40
30
0
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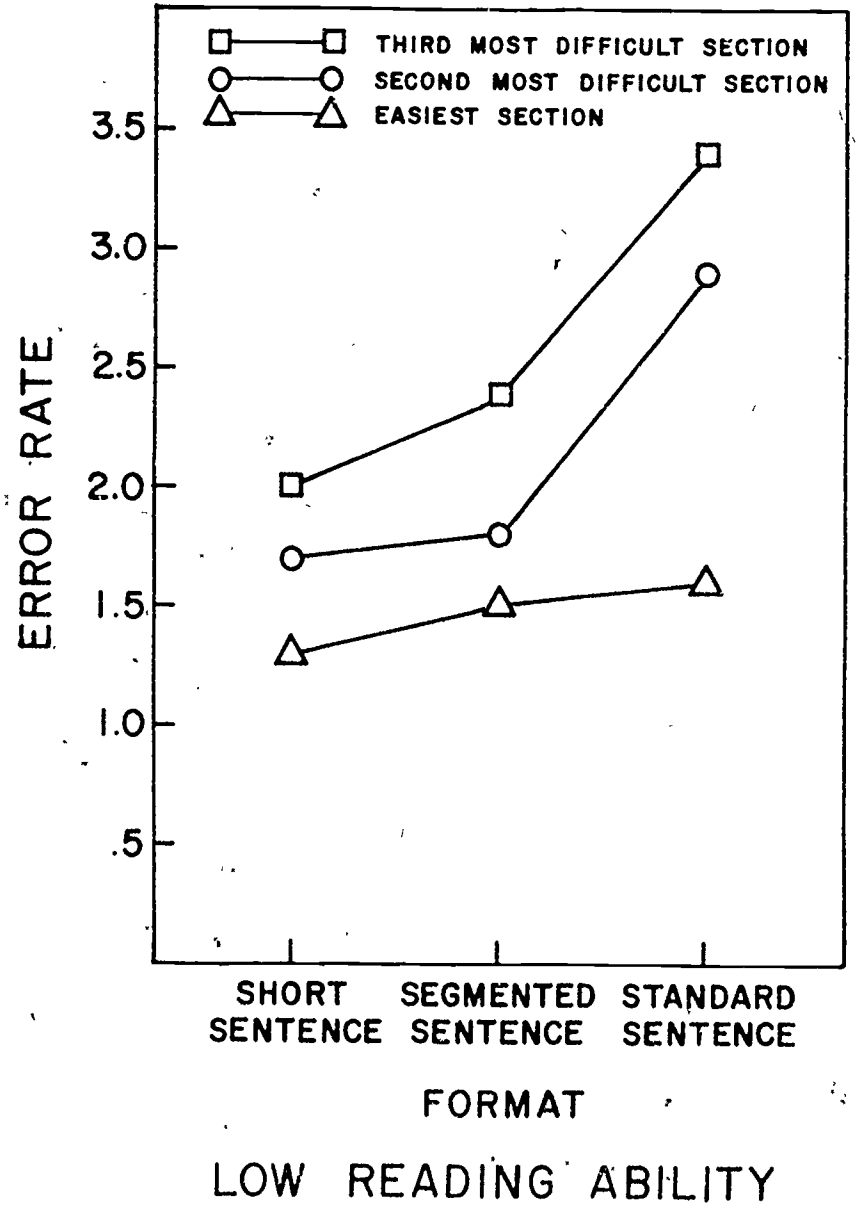
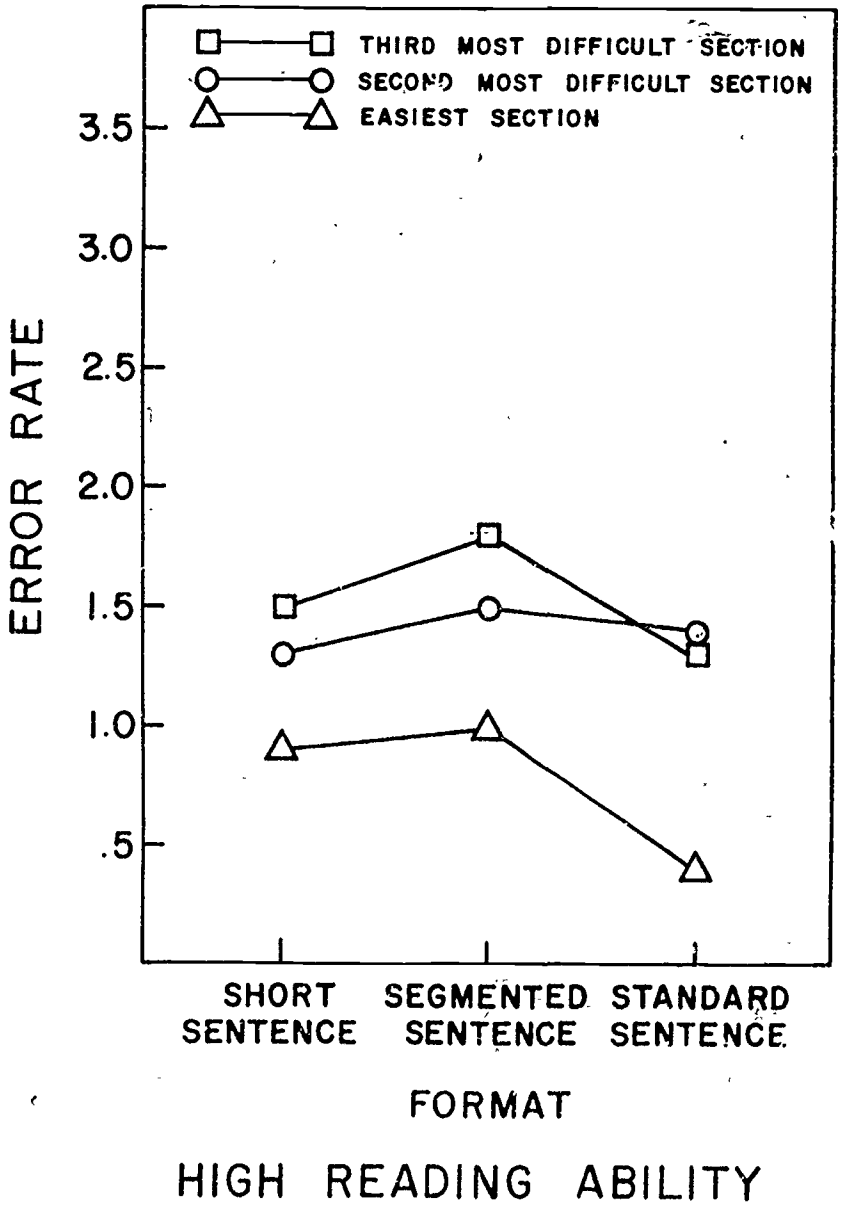
MIDDLE ABILITY READERS
HIGH ABILITY READERS
SHORT SENTENCE
PARSED SENTENCE
STANDARD SENTENCE
PASSAGE FORMAT



LOW READING ABILITY



HIGH READING ABILITY

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