DOCUMENT RESUME

ED 198 488 CS 005 877

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TITLE Relationships between Reading Time for Letters, Words, Simple Text, and Word Identification Skill: A One Year Longitudinal Study.
SPONS AGENCY Ontario Educational Research Council, Toronto.
PUB DATE [80]
NOTE 40p.

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Elementary Education; *Letters (Alphabet); Longitudinal Studies; *Oral Reading; *Reading Achievement; Reading Comprehension; Reading Instruction; *Reading Rate; *Reading Research; Reading Skills; *Word Recognition
IDENTIFIERS *Time on Task

ABSTRACT

A study was conducted to replicate earlier findings regarding the relationships between letter, word, and text reading times and measures of reading achievement and to establish the stability of reading times measures and their relationships over a one-year period. Subjects included 150 children in eight age cohorts between grades one and six. The results strongly support the earlier conclusions that good readers are superior at context-free word recognition and that skilled reading is largely "text-driven" (more affected by "bottom-up" skills involving letter and word identification than "top-down" skills involving the use of context). Both reading time measures and the Gray Oral Reading Test highest passage measure demonstrated one-year stabilities above .70 at nearly all grade levels above the first grade. (HOD)

Relationships Between Reading Time For Letters, Words, Simple Text, and Word Identification Skill: A One Year Longitudinal Study

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Running head: Longitudinal study of relations between reading times for letters, words, and text.

Abstract

Presents results of a longitudinal study of the relationship between reading times for letter, primary level context-free words, and primary text passages and reading achievement as indexed by highest passage attained on the Gray Oral Reading Test. 150 children in eight age cohorts between grades one and six were tested during a three year period. Results replicated previous findings indicating high correlations between reading times for letters and words and reading times for text as well as substantial correlations between reading time measures and reading achievement measures. Both reading time measures and the Gray highest passage measure demonstrated one-year stabilities above .70 at nearly all grade levels above grade 1. Using multiple regression analysis, reading time measures were associated with about 40 percent of Gray Highest Passage variance one year later. Results are discussed in relation to the contribution skills for using context-free information to reading skill, as well as appropriate speed-of-processing measures in reading.

Relationships Between Reading Time For
Letters, Words, Simple Text, and Word Identification
Skill: A One Year Longitudinal Study

A growing body of research literature has established that the time required to identify words out of context is closely related to other measures of reading achievement. This literature is reviewed in Stanovich, (in press) and Vellutino, (1977). (See also Shankweiler and Liberman, 1972 and Laberge and Samuels, 1974.) Biemiller (1977-78) demonstrated that the time required to identify letters is related to word identification times both in and out of context, and also related to performance on the Metropolitan Achievement Text reading comprehension scale. Biemiller argued that the existence of relationships between simple letter identification times and other indices of reading performance indicated the existence of dimension of individual difference affecting reading skill which was not dependent on the use of either orthographic structure or context in facilitating word identification. Biemiller suggested that context-free word identification times would reflect both the general identification variable indexed by letter times and the use of orthographic structure. Context-free word identification times were more highly correlated with text times than are letter times in his study.

The purpose of the present study was to replicate Biemiller's original findings regarding relationships between letter, word, and

text reading times and measures of reading achievement, and to establish the stability of the reading time measures and their relationships over a one year period.

Method

Design and Subjects

This study included seven cohorts of children who were in grades 1 to 6 in the springs of 1977, 1978, and 1979 plus one cohort which was first tested in 5th grade in the spring of 1976. The sample design is shown in Table 1.

Table 1 about here

A total of 150 children from grades 1 to 6 were included in one or more testing sessions. All children attended the laboratory school of the Institute of Child Study, Faculty of Education, University of Toronto. Most of the children come from upper middle class families. Reading instruction could best be described as eclectic and individualized, involving a combination of published readers and individualized use of the children's own stories in first and second grade, with individualized reading instruction from third grade on.[1]

Materials

Reading passages were identical to those described in Biemiller, 1977-78. A 100 word text passage was adapted from the end

of a first grade basal reader (MacInnes, 1961, p. 132-133). A 50 word list was generated by listing every second word going backwards from the end of the text. This procedure roughly reflected the frequency of words occurring in the text without maintaining any meaningful structure. A 50 letter list was constructed by making a random selection of all letters in the alphabet.

The text passage, word list, and letter list were typed on white 5 X 8 cards using pica type, double-spaced. Words and letters were presented on a left-to-right basis with single spaces between words and double spaces between letters.

In addition to the letter, word, and text passages, the children were also given the Gray Oral Reading Test, Form A (Robinson, 1967).

Two measures were derived from the Gray Oral Reading Test. The first was the summed passage score using procedures given in the text manual (Robinson, 1967, p. 7). This score reflects both reading speeds and the number of errors on each passage read successfully. Grade equivalents are derived from this score.

The second score derived from the Gray Oral Reading Test was the Gray Highest Passage (G.H.P.) score. This was simply the number of the most advanced passage the child read successfully using Gray's criterion; making six or fewer errors. This measure was used as a rough index of the child's ability to identify increasingly difficult vocabulary. (Gray

identifies passage 3 as grade 1 level, 4 to 8 as grade levels 2 to 6 respectively, 9 to 12 as grade levels 8, 10, and 12 respectively, and 13 as "adult".)

In 1979, the Metropolitan achievement Test (1971) was given in May at all grade levels with all teachers carefully following test instructions. The following test and forms were used: Grade 1, Primary I, form G; Grade 2, Primary II, form H; Grades 3 and 4, Elementary, form F; and grades 5 and 6, Intermediate, form G. Statistical analyses were carried out using standard scores.

Procedures

All testing was carried out individually in a separate testing room by research assistants. In all cases children were first given a picture identification task (not reported in this paper), then the letter, text, and word passages. On the letter task the tester instructed the children to "read this as fast as you can and don't worry about mistakes. I'll help you if you have any problems. Start when I say "Go". Go!" A stopwatch was started on "Go". If the child hesitated over a letter, the tester would immediately say the letter for the child. The stopwatch was stopped as the last letter was read. The same procedure was used for the text and word passages with reminders to "read as fast as you can".

Errors were in fact counted and data was not used if more than three errors affecting time (e.g. corrections, lost place, etc.) were made. Data reported in this study excludes children who were unable to read all three passages.

After administering the letter, text, and word passages, the Gray Oral Reading Test was given. At this point the tester would explain that it was necessary for the children to read more carefully because errors would be counted. The test was then administered according to the manual.

All testing was tape-recorded to facilitate checking errors.

Analysis of Data

Three types of statistical procedures were used:

1. Means and standard deviations for all measures by grade.
2. Correlations between measures by grade.
3. Multiple regression analyses with letter times entered as the first independent variable, word times as the second independent variable, and (in the case of reading achievement measures) text times or the third independent variable. This approach to multiple regression analyses is based on the assumption that each additional variable involves use of skills tapped in the preceding variables plus an

additional skill (e.g. use of orthographic structure with words, and use of syntactic and semantic context with text).

In addition to computing means, correlations, and multiple regression analyses of concurrent relationships, test-retest correlations over a one year interval were computed, as were correlations and regression analyses between letter, word, and text times in a given year with text and reading achievement measures one year later.[2]

The design of the study produces non-independent groups of children in each grade and in one year longitudinal comparisons (see table 1). For this reason, all tables present both data for individual cohorts and analyses based on combined cohorts. The statistical significance of combined cohorts data cannot be considered to be independent from one grade to another except in grades with no common cohorts. However, since the concurrent relationships found for combined cohorts are very similar to those obtained both with previous samples (Biemiller, 1977-78) and in a public school standardization study of reading speeds (Biemiller, 1980), there is reason to believe that the combined cohort data is representative of relationships existing between reading measures.

Results

Changes with Age and Concurrent Relationships Between Measures

Reading Times. Table 2 shows mean reading times in seconds per letter or word for each cohort and combined cohorts for each grade. The magnitude of changes with age and pattern of differences between letter, word, and text times are consistent with previously reported findings using the same materials (Biemiller, 1977-78), although absolute means for combined cohorts are slightly lower. In comparison to a randomly sampled population of children (Biemiller, 1980), mean grade levels reported here range from the 50th to 70th percentiles, with the higher levels being obtained in grades four to six.

Table 2 about here

Performance on Standardized Reading Tests. Table 3 shows mean grade equivalent scores for the Gray Oral Reading Test[3], the mean highest passage attained on the Gray Oral Reading Test, and mean grade equivalent scores for the "Reading" (comprehension) subtest of the Metropolitan Achievement Test.

Table 3 about here

Concurrent Relationships Between Reading Time Measures. Table 4 shows concurrent correlations between text times and

letter and word times. Table 5 presents results of multiple regression analyses with text time as the dependent variable and letter and word times as independent variables. As noted in the section on methods, letter times are entered first as they provide an index of identification time that involves no higher-level processes (i.e. use of orthographic structure). Combined cohort data indicates that letter times consistently are associated with about one third of text time variance, while word times are associated with an additional third of text time variance. There is some fluctuation from year to year as was noted in previous research on reading times (Biemiller, 1977-78, pp 241-242). Note that the percentage of variance (r^2) of text time associated with word times alone (table 3) is virtually identical to the combined letter and word time percentages reported in table 4. This indicates that virtually all of the relationship between letter and text times is reflected in the relationship between word and text times.

Tables 4 and 5 about here

Concurrent Relationships Between Reading Times and Gray Highest Passage Scores. Correlations and Regressions with Gray Highest Passage scores are reported here because, unlike the Gray Oral Reading Score, the Highest Passage score is independent of

time scores. In all cases, correlations and regressions with Gray Oral Reading Scores reach higher levels than those reported for Gray Highest Passage Scores. Table 6 provides correlations for letter, word and text times with Gray Highest Passage Scores. In all combined cohort cases, and 14 out of 19 cohort comparisons, there are increasing levels of correlation as one moves from letters to words to text.

Table 6 about here

Table 7 indicates that for combined cohorts, typically 40 to 50% of highest passage variance is associated with time measures within grades. Note that text time correlations (table 6) are of a magnitude equivalent to variance associated with all three measures in multiple regression. These data clearly indicate a strong relationship between the time required to identify words in context (and related simpler time measures), and the ability to identify difficult vocabulary as indexed by the Gray Highest Passage scores.

Table 7 about here

Relationships between M.A.T. Reading Comprehension Scores and Reading Times. Tables 8 and 9 show correlations and results of

Multiple regression analyses between a reading comprehension test and reading times, for the 1979 testing period. While the samples are small, reading times are consistently associated with 40 to 60 percent of reading comprehension variance.

Tables 8 and 9 about here

One Year Longitudinal Relationships Between Measures

Developmental Stability of Measures. Table 10 presents correlations for each measure over a one year period. Results indicate moderate to high stabilities for all measures.

Table 10 about here

Longitudinal Relationships Between Reading Time Measures. Tables 11 and 12 show correlations and multiple regression analyses of text times with letter and word times one year earlier. Total percentages of text time variance associated with earlier letter and word times ranges from 45 to 60 percent. The relative contributi of letter and word times varies, probably due to the small sample sizes. However, these data indicate that measures not involving the use of context remain strongly related to the time required

to read contextual material one year later.

Tables 11 and 12 about here

Longitudinal Relationships Between Reading Times and Grey Highest Passage Scores. Tables 13 and 14 indicate that substantial relationships exist between the ability to identify difficult words (indexed by the Grey Highest Passage score) and reading times one year earlier. Only in two out of ten cohorts did the percentage of variance fall below 40%, while the median was near 70%. Text times contributed relatively little to the association once letter and word times were taken into account.

Tables 13 and 14 about here

Discussion

Data reported in this study and in Biemiller (1977-78 and 1980) strongly support Stanovich's (in press) conclusion that good readers are superior at context-free word recognition. They are also consistent with Juel's (1980) conclusion that skilled reading is largely "text-driven" - i.e. more affected by "bottom-up" (Rumelhart, 1977) skills involving letter and word identification rather than "top-down" skills involving the use of context. This

discussion will be concerned with factors affecting context-free word recognition times as well as studies on the effects of modifying reading speed and their implications.

Letter Recognition Times. The finding that letter identification time is highly correlated with text word recognition time both concurrently and over a one year period supports Stanovich's view that use of orthographic structure is not the only variable involved in fluent word identification. The existence of some fairly general developmental identification speed variable which changes primarily with age is consistent with the findings of Eckert and Eichorn (1977) regarding the development of reaction time, and Denckla and Rudel (1976) and Doehring (1976) regarding picture and letter naming times. Rourke (1975), Denckla and Rudel (1976), Speer and Lamb (1976), Vellutino (1977) and Lesgold, Resnick, and Beck, (note 1) have shown correspondances between slow general identification times and poor reading. In the present study, reading times per text word are consistently about .19 seconds less than reading times per letter at all grade levels sampled. It appears that whatever capacity is tapped by letter reading times sets a limit on how rapidly text words can be identified.

Word Reading Times and Orthographic Structure. The consistent finding in this study that context-free word identification times add significantly to prediction of text identification times both

concurrently and over one year periods at grades 1 through 6 is in conflict with Stanovich's suggestion that use of orthographic structure "does not distinguish good from poor readers once the child has passed the initial stages of reading acquisition." (Stanovich, in press; Stanovich and West, in press). Instead, this finding is consistent with the finding that good readers have a greater knowledge of orthographic structure (Allington, 1978; Scheerer-Newmann, 1978), and that they use this knowledge to facilitate reading.

Correlational vs. Experimental Relationships Between Word Identification Times and Reading Fluency and Comprehension.

A recent study by Fleisher, Jenkins, and Pany (1979) raises some questions about the validity of interpreting letter and word times as indicators of a general identification ability and use of orthographic structure respectively. Noting that"the data base for the presumed influence of decoding or comprehension is essentially correlational," Fleisher et al undertook to modify context-free word identification speeds experimentally, and examined the effects of this modification on text reading speeds and several comprehension measures. In brief, they report that increasing grade 4 and 5 poor readers' context-free word identification speed to average levels did not increase reading speed in context as much as would be expected on the basis of correlational data,

and had virtually no impact on comprehension measures (Cloze performance, answering factual and inferential questions, and retelling stories). Word training did reduce errors. Training in reading phrase units did increase text times to .27 seconds per word faster than context-free word times as would be expected from correlational data, and increased Cloze performance significantly although not to average readers' levels. However, phrase-training had no impact on the other comprehension measures.

Fleisher et al's results could be interpreted as casting some doubt on the view that context-free word identification reflects an important reading skill. However, their study suffered from two flaws. First, the measure of context-free word identification speed was a single list of 75 words which was repeated a number of times. As they note, repeated administration of the same list may have yielded spuriously high estimates of the trained children's context-free word identification speeds. In the author's own experience, reading speeds will increase for the same list given frequently over a short interval. This is probably because the list is partially memorized, thus reducing the word identification processing time. This problem can be avoided by varying the order of the list.

Second, and more importantly, Fleisher et al report using an average of only 3½ training sessions to increase reading speed. This is probably not sufficient to achieve "automaticity" of rapid reading responses. For example, Laberge and Samuels (1974) report

that 13-14 training sessions were necessary to reach an asymptote for naming times for novel letters, and this asymptote was still substantially higher than naming times for familiar letters. It seems unlikely that the 3½ sessions used by Fleisher et al would have resulted in more rapid automatic decoding rates. Rather, as they suggest, attention to word identification may actually have been increased to the detriment of comprehension.

Other studies of the effects of more extended training on contextual reading speed have indicated increases in comprehension skills. (Samuels, 1979; Dahl, note 1). Unfortunately, these studies do not report effects on context-free word identification and hence do not provide definitive evidence on the relationship between context free reading speed and comprehension.

Implications for Research. Further research on the effects of training for speed, and even more on the general quantity of reading experience is badly needed. In the author's experience (Biemiller, Bowden, McKinnon, and Weinburg, note 3; Biemiller and Hoag, note 4), increased reading practice may affect slow readers' oral reading speeds for words and text, but not letters. Laberge and Samuels (1974) also report no practice effects for reading times for familiar letters. This suggests that letter times for experienced readers typically reflect a capacity variable which cannot be modified through experience. However, improvements in word and text reading time could be attained by children whose

word reading times are slower than their letter reading times, or whose text times are less than .20 or .25 seconds faster than their word reading times. Attaining these gains is likely to depend on practice. Unfortunately, poor readers are likely to read less than able readers and consequently have less opportunity to refine their use of orthographic and possibly contextual information (Biemiller, 1977-78). The best treatment in many cases, may simply be increased practice. The findings of Samuels (1979) and Dahl (note 2) are consistent with this hypothesis. Durkin's (1978-79) observation that children spend relatively little of their instructional time reading, and Kiesling's (1977-78) finding that added "instructional time" yields reading gains for poor readers are also consistent with this hypothesis.

A final note. In studies of reading fluency, it is important to distinguish between the time required to read words and reading rate. These two measures are not linearly related. For example, in Fleisher et al's (1979) study, children exposed to phrase training demonstrated that same difference between context-free word times and text times as average reading controls: .27 seconds per word. However, the control group had a much larger difference berween context-free word reading rate and text reading rate (62 w.p.m.) than the phrase-trained poor readers (40 w.p.m.). This is because their context-free word reading rate differed.

Table 15 illustrates the effect of using reading times versus reading rates. In the present study, the difference between reading times for letters and reading times for text was virtually constant across grades at .19 seconds, while the difference between context-free word times and text times declined by one third to a level approaching the letter-text difference. Correspondingly, the difference between letter and word times almost disappears by grade 6. However, when reading rates are calculated, there are very large changes across age in the differences between text rates and letter or word rates, while there is almost no variation in the difference between letter and word rates. These data suggest that reading times are likely to be more useful both for analysing reading processes and for predicting reading performance.

Table 15 about here

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Footnotes

This study would not have been possible without the cooperation of the children and staff of the Laboratory School of the Institute of Child Study, Faculty of Education, University of Toronto. I also wish to thank Helen Brown, Joanne Lane Myers and Victoria Pidutti for conducting the testing, and Midian Kurland for statistical analysis. Finally, I wish to thank the Ontario Educational Research Foundation for financial support.

[1]No major differences in reading performance were observed in comparison to children tested in the same school 6 to 9 years earlier when most reading instruction was built around basal readers. (See Biemiller, 1977-78.)

[2]Two year longitudinal analyses are not presented as sample sizes are too small. (8, 7, and 14 for grades 2-4, 3-5, and 4-6 respectively.)

[3]The Manual of the Gray Oral Reading Test (Robinson, 1967) gives separate grade equivalent norms for males and females. Grade equivalents presented here are based on those given for males.

Table 1

Cohort Number by Grade and Year

	Grade					
	1	2	3	4	5	6
Year						
1976	-	-	-	-	1	-
1977	6	5	4	3	2	1
1978	7	6	5	4	3	2
1979	8	7	6	5	4	3

Table 2

Mean Seconds per Unit For Children Able To Read Word and Text Passages. (Standard Deviations in Parentheses)

Measure & Year	Grade					
	1	2	3	4	5	6
Sample Sizes					20[a]	
1977	3	13	14	19	18	17
1978	5	11	16	12	17	14
1979	12	19	21	15	9	15
all	20	43	51	46	64	46
Letters					.54 (.08)[a]	
1977	.76 (.11)	.63 (.10)	.58 (.17)	.46 (.08)	.46 (.06)	.47 (.07)
1978	.92 (.19)	.72 (.14)	.57 (.08)	.54 (.15)	.43 (.08)	.43 (.07)
1979	.84 (.16)	.71 (.15)	.61 (.12)	.48 (.07)	.45 (.09)	.39 (.07)
all	.85 (.16)	.69 (.14)	.59 (.13)	.49 (.11)	.47 (.09)	.43 (.07)
Words					.62 (.16)[a]	
1977	.84 (.22)	.65 (.16)	.67 (.23)	.50 (.12)	.50 (.09)	.48 (.10)
1978	1.00 (.34)	.91 (.31)	.63 (.16)	.60 (.19)	.46 (.11)	.46 (.09)
1979	1.01 (.26)	.78 (.21)	.63 (.15)	.51 (.13)	.43 (.09)	.39 (.08)
all	.99 (.27)	.77 (.24)	.65 (.18)	.53 (.15)	.52 (.14)	.45 (.10)
Text					.36 (.14)[a]	
1977	.53 (.13)	.41 (.14)	.41 (.15)	.29 (.07)	.29 (.05)	.27 (.07)
1978	.59 (.34)	.63 (.26)	.39 (.12)	.33 (.15)	.24 (.05)	.25 (.05)
1979	.72 (.27)	.48 (.17)	.39 (.12)	.30 (.10)	.22 (.07)	.19 (.04)
all	.66 (.28)	.50 (.20)	.39 (.13)	.30 (.11)	.29 (.11)	.24 (.07)

Table 3

Mean Grade Equivalent Scores for the Gray Oral Reading Test and Metropolitan Achievement Test (reading comprehension) and Gray Highest Passage Scores. (N's in parentheses)

Measure & Year	Grade 1	2	3	4	5	6
Gray Oral Reading[a]					5.0 (20)	
1977	2.5 (3)	3.7 (13)	4.3 (14)	7.2 (19)	9.0 (18)	8.7 (17)
1978	3.0 (5)	2.7 (11)	3.9 (16)	5.8 (12)	9.9 (17)	9.3 (14)
1979	1.9 (12)	2.8 (19)	3.9 (21)	5.6 (15)	8.3 (9)	9.3 (15)
combined	2.1 (20)	2.9 (43)	3.9 (51)	6.4 (46)	8.0 (64)	9.0 (46)
Gray Highest Passage					7.7 (20)	
1977	5.3 (3)	6.2 (13)	6.8 (14)	10.3 (19)	10.5 (18)	10.4 (17)
1978	6.8 (5)	6.6 (11)	8.2 (16)	9.3 (12)	12.1 (17)	11.9 (14)
1979	3.7 (12)	5.4 (19)	6.3 (21)	8.0 (15)	9.8 (9)	10.6 (15)
combined	4.7 (20)	6.0 (43)	7.0 (51)	9.3 (46)	10.0 (64)	
M.A.T. Reading Comprehension						
1979	2.3 (12)	3.6 (19)	5.3 (20)	7.7 (14)	9.7 (8)	9.8 (15)

[a]Grade equivalents based on norms for males for form A of the Gray Oral Reading Test.

Table 4

Concurrent Correlation Coefficients with Text Time

Measure and Year	Grade 1	2	3	4	5	6
Sample Size					20[d]	
1977	3	13	15	19	18	17
1978	5	11	16	12	17	14
1979	12	19	21	15	9	15
combined	20	43	52	46	64	46
Letters					.56[a,d]	
1977	e	.63[b]	.55[b]	.46[b]	.58[a]	.60[a]
1978	.20	.42	.74[a]	.64[a]	.85[a]	.42[c]
1979	.84[a]	.61[a]	.64[a]	.70[a]	.19	.53[b]
combined	.57[b]	.55	.60[a]	.62	.64	.61
Words					.89[a,d]	
1977	e	.92[a]	.88[a]	.74[a]	.70[a]	.89[a]
1978	.94[b]	.95[a]	.67[b]	.89[a]	.87[a]	.75[a]
1979	.87[a]	.93[a]	.76[a]	.82[a]	.69[b]	.71[a]
combined	.88[a]	.94[a]	.78[a]	.83[a]	.87[a]	.84[a]

[a] $p < .01$

[b] $p < .05$

[c] $p < .10$

[d] 1976

[e] sample too small

Table 5

Percentage of Text Time Variance Associated with Concurrent Letter and Word Times

Measure & Year	Grade 1	2	3	4	5	6
Sample Size					20[d]	
1977	3	13	15	19	18	17
1978	5	11	16	12	17	14
1979	12	19	21	15	9	15
combined	20	43	52	46	64	46
Total % Text Variance Associated with Letter and Word Variance					79%[a,d]	
1977	e	85%[a]	77%[a]	56%[a]	51%[a]	82%[a]
1978	98%[b]	93%[a]	60%[a]	85%[a]	80%[a]	58%[a]
1979	87%[a]	86%[a]	60%[a]	67%[a]	56%[c]	50%[b]
combined	72%[a]	90%[a]	62%[a]	70%[a]	54%[a]	71%[a]
% Text Variance Associated with Letter Variance					31%[b,d]	
1977	e	39%[b]	30%[b]	21%[b]	34%[b]	35%[b]
1978	4%	18%	55%[a]	41%[b]	73%[a]	18%
1979	68%[a]	37%[a]	41%[a]	49%[a]	4%	28%[b]
combined	32%[a]	30%[a]	36%[a]	38%[a]	28%[a]	38%[a]
Additional % Text Variance Associated with Word Variance					48%[a,d]	
1977	e	46%[a]	47%[a]	35%[a]	17%[b]	47%[a]
1978	94%[b]	75%[a]	5%	44%[a]	7%[b]	40%[a]
1979	19%[a]	49%[a]	19%[b]	18%[b]	52%[b]	22%[b]
combined	46%[a]	60%	26%[a]	32%[a]	25%[a]	33%[a]

[a] p .01 (based on analysis of regression variance)

[b] p .05 "

[c] p .10 "

[d] 1976 sample too small

Table 6

Concurrent Correlation Coefficients with Grey Highest Passage Scores

Measure & Year	Grade 1	2	3	4	5	6
Sample Size						
1977	3	13	15	19	18	17
1978	5	11	16	12	17	14
1979	12	19	21	15	9	15
combined	20	43	52	46	64[d]	46
Letters						
1977	e	-.47[c]	-.44	-.51[b]	-.41[b]	-.61[a]
1978	-.21	-.48	-.48[b]	-.38	-.71[a]	-.04
1979	-.21	-.39[b]	-.39[b]	-.56[b]	-.01	-.48[b]
combined	-.06	-.42[a]	-.44[a]	-.42[a]	-.57[a,d]	-.38[a]
Words						
1977	e	-.44[c]	-.72[a]	-.60[a]	-.70[a]	-.80[a]
1978	-.80[b]	-.77[a]	-.46[b]	-.70[a]	-.60[a]	-.22
1979	-.57[b]	-.66[a]	-.50[a]	-.69[a]	-.41	-.72[a]
combined	-.53[a]	-.58[a]	-.56[a]	-.59[a]	-.71[a,d]	-.52[a]
Text						
1977	e	-.58[b]	-.83[a]	-.69[a]	-.65[a]	-.86[a]
1978	-.90[b]	-.79[a]	-.56[b]	-.78[a]	-.74[a]	-.20
1979	-.50[b]	-.79[a]	-.64[a]	-.90[a]	-.63[b]	-.83[a]
combined	-.63[a]	-.63[a]	-.66[a]	-.73[a]	-.74[a,d]	-.56[a]

[a] p .01

[b] p .05

[c] p .10

[d] 1976

[e] sample too small

Table 7

Percentage of Grey Highest Passage Variance Associated with Concurrent Letter, Word, and Text Times

Measure & Year	Grade 1	2	3	4	5	6
Sample Size						
1977	3	13	15	19	20[d] 18	17
1978	5	11	16	12	17	14
1979	12	19	21	15	9	15
combined	20	43	52	46	64	46
Total % GHP Variance Associated with L,W,T.						
1977	e	48%	69%[a]	53%[a]	64%[a,d] 57%[a]	76%[a]
1978	100%[b]	65%[b]	33%	68%[b]	60%[a]	8%
1979	46%	65%[a]	41%[b]	81%[a]	41%	74%[a]
combined	52%[a]	42%[a]	44%[a]	53%[a]	57%[a]	32%[a]
% GHP Variance Associated with Letter Times						
1977	e	22%	20%[c]	26%[b]	22%[b,d] 16%[c]	37%[a]
1978	5%	23%	23%[c]	14%	50%[a]	0%
1979	4%	15%[c]	15%[c]	31%[b]	0%	23%[c]
combined	0%	17%[a]	19%[a]	17%[a]	33%[a]	14%[b]
% Additional GHP Variance Associated with Word Times						
1977	e	2%	32%[b]	11%	35%[a,d] 35%[a]	31%[a]
1978	63%	36%[b]	3%	50%[a]	0%	8%
1979	36%[b]	29%[a]	10%	17%[c]	27%	30%[b]
combined	40%[a]	16%[a]	13%[a]	20%[a]	17%[a]	13%[b]
% Additional GHP Variance Associated with Text Times						
1977		24%[c]	18%[b]	17%[b]	7%[c,d] 6%	8%[c]
1978	32%	6%	7%	4%	10%[c]	0%
1979	6%	21%[a]	16%[b]	33%[a]	14%	21%[b]
combined	12%[c]	9%[b]	12%[a]	16%[a]	7%[a]	5%[c]

[a] p .01 based on analysis of regression variance

[b] p .05 " " " " " "

[c] p .10 " " " " " "

[d] 1976

[e] sample too small

Table 8

Correlation Coefficients Between M.A.T. "Reading" Scores and Letter, Word, and Text Times

	Grade					
Measure	1	2	3	4	5	6
Sample Size	12	19	20	14	8	15
Letters	-.56[b]	-.23	-.47[b]	-.67[a]	-.35	-.01
Words	-.62[b]	-.66[a]	-.64[a]	-.55[b]	-.45	-.55[b]
Text	-.65[a]	-.70[a]	-.77[a]	-.52[b]	-.56[c]	-.47[b]

[a] p .01

[b] p .05

[c] p .10

Table 9

Percentage of MAT "Reading" Score Variance

Associated With Concurrent Letter, Word, and Text Times

(Data for 1979 only)

	Grade					
Measure	1	2	3	4	5	6
Sample Size	12	19	20	14	8	15
Total % MAT Variance Associated with Reading	44%	58%[a]	60%[a]	46%[c]	39%	64%[a]
% MAT Variance Associated With Letter Times	32%[c]	5%	23%[b]	45%[a]	12%	0%
Additional % Variance Associated With Word Times	10%	49%	18%[b]	0%	10%	62%[a]
Additional % Variance Associated with Text Times	2%	4%	19%[b]	1%	17%	2%

[a] p .01

[b] p .05

[c] p .10

Table 10

Developmental Stability of Measures:

One Year Longitudinal Correlations (n's in parentheses)

	Grades				
Measure & Years	1-2	2-3	3-4	4-5	5-6
Letters					.74 (17)[a,e]
1977-1978	.86 (8)[b]	.79 (15)[a]	.94 (10)[a]	.72 (16)[a]	.76 (14)[a]
1978-1979	.41 (15)[c]	.68 (13)[a]	.53 (12)[b]	.92 (7)[a]	.88 (15)[a]
combined	.38 (23)[b]	.57 (28)[a]	.89 (22)[a]	.76 (23)[a]	.81 (46)
Words					.83 (17)[a,e]
1977-1978	d	.44 (9)[a]	.82 (9)[a]	.59 (16)[a]	.66 (14)[a]
1978-1979	.69 (5)[c]	.93 (9)[a]	.82 (12)[a]	.90 (7)[a]	.80 (15)[a]
combined	.70 (8)[b]	.77 (18)[a]	.81 (21)[a]	.66 (23)[a]	.77 (46)[a]
Text					.89 (17)[a,e]
1977-1978	d	.83 (11)[a]	.84 (9)[a]	.65 (16)[a]	.79 (14)[a]
1978-1979	.72 (8)[b]	.93 (11)[a]	.90 (12)[a]	.96 (7)[a]	.88 (15)[a]
combined	.59 (11)[b]	.85 (22)[a]	.87 (21)[a]	.85 (23)[a]	.88 (46)[a]
Grey Score					.86 (17)[a,e]
1977-1978	.92 (14)[a]	.81 (15)[a]	.96 (10)[a]	.93 (16)[a]	.94 (14)[a]
1978-1979	.90 (17)[a]	.97 (13)[a]	.92 (12)[a]	.97 (7)[a]	.90 (15)[a]
combined	.88 (31)[a]	.85 (28)[a]	.94 (22)[a]	.93 (23)[a]	.81 (46)[a]
Grey Highest Passage					.73 (17)[a,e]
1977-1978	.87 (14)[a]	.85 (15)[a]	.87 (10)[a]	.83 (16)[a]	.58 (14)[b]
1978-1979	.87 (17)[a]	.87 (13)[a]	.87 (12)[a]	.90 (7)[a]	.75 (15)[a]
combined	.85 (32)[a]	.78 (28)[a]	.70 (22)[a]	.77 (23)[a]	.53 (46)

[a] p .01

[b] p .05

[c] p .10

[d] sample under 5

[e] 1976-77

Table 11

Correlation Coefficient of Letter and Word

Times with Text Times One Year Later

	Grades				
Measure & Years	1-2	2-3	3-4	4-5	5-6
Sample Size					17[d]
1977-78	3	9	9	16	14
1978-79	5	9	12	7	15
combined	8	18	21	23	46
Letters					.62[a,d]
1977-78	e	-.22	.48	.35	.34
1978-79	.08	.82[a]	.91[a]	.19	.77[a]
combined	-.03	.66[a]	.58[b]	.26	.66[a]
Words					.72[a,d]
1977-78	e	.38	.85[a]	.58[a]	.59[a]
1978-79	.75[c]	.92[a]	.72[a]	.79[b]	.80[a]
combined	.51[c]	.86[a]	.78[a]	.64[a]	.74[a]

[a] p .01

[b] p .05

[c] p .10

[d] 1976-77

[e] sample too small

Table 12

Percentages of Text Times Variance Associated With Letter and Word Time Variances One Year Earlier (n's in parentheses.)

	Grades				
Measure & Years	1-2	2-3	3-4	4-5	5-6
Sample Size					17[d]
1977-78	3	9	9	16	14
1978-79	5	9	12	7	15
combined	8	18	21	23	46
Total % Text Variance Associated with Letter & Word Times					54%[a,d]
1977-78	e	32%	73%[b]	34%[c]	35%[c]
1978-79	67%	87%[a]	86%[a]	70%	67%[a]
combined	45%	74%[a]	63%[a]	48%[a]	55%[a]
% Text Variance Associated with Letters					39%[a,d]
1977-78	e	5%	23%	12%	11%
1978-79	1%	67%[a]	83%[a]	4%	60%[a]
combined	0%	44%	33%[a]	6%	43%[a]
Additional % Text Variance Associated With Words					15%[c,d]
1977-78	e	27%	50%[b]	22%[c]	24%[c]
1978-79	66%	20%[b]	3%	66%	7%
combined	45%[c]	30%[a]	29%[a]	42%[a]	12%[a]

[a] p .01

[b] p .05

[c] p .10

[d] 1976-77

[e] sample too small

Table 13

Correlation Coefficient of Letter, Word, and Text Times

with Grey Highest Passage Scores One Year Later

	Grades				
Measure & Years	1-2	2-3	3-4	4-5	5-6
Sample Size					17[d]
1977-78	3	9	9	16	14
1978-79	5	9	12	7	15
combined	8	18	21	23	46
Letters					-.68[a,d]
1977-78	e	-.04	-.47	-.40[c]	-.32
1978-79	-.10	-.53[c]	-.83[a]	-.12	-.61[a]
combined	-.27	-.44[c]	-.53[a]	-.18	-.55[a]
Words					-.78[a,d]
1977-78	e	-.15	-.87[a]	-.51[b]	-.36
1978-79	-.85[c]	-.57[c]	-.55[b]	-.74[b]	-.62[a]
combined	-.75[b]	-.51[b]	-.68[a]	-.51[a]	-.62[a]
Text					-.89[a,d]
1977-78	e	-.-5	-.84[a]	-.50[b]	-.39[c]
1978-79	-.96[a]	-.60[b]	-.80[a]	-.85[a]	-.68[a]
combined	-.87[a]	-.51[b]	-.75[a]	-.63[a]	-.64[a]

[a] p .01

[b] p .05

[c] p .10

[d] 1976-77

[e] sample too small

Table 14

Percentages of Grey Highest Passage (GHP) Variance

Associated with Letter, Word, and Text Times One Year Earlier

Measure & Years	Grades 1-2	2-3	3-4	4-5	5-6
Sample Size					17[d]
1977-78	3	9	9	16	14
1978-79	5	9	12	7	15
combined	8	18	21	23	46
Total % GHP Variance Associated with Letter, Word & Text Times					81%[a,d]
1977-78	e	3%	77%[b]	32%	17%
1978-79	95%	42%	71%[b]	73%	46%[c]
combined	86%[b]	28%	58%[a]	42%[b]	43%[a]
% GHP Variance Associated with Letter Times					46%[a,d]
1977-78	e	0%	22%	16%	10%
1978-79	1%	28%	70%[a]	2%	37%[b]
combined	7%	19%[c]	28%[b]	3%	31%[a]
Additional % GHP Variance Associated with Word Times					17%[b,d]
1977-78	e	2%	54%[a]	10%	4%
1978-79	85%[a]	6%	0%	64%[c]	4%
combined	55%[b]	7%	20%[b]	28%[a]	9%[b]
Additional % GHP Variance Associated with Text Times					18%[a,d]
1977-78	e	1%	1%	7%	3%
1978-79	10%	8%	1%	9%	5%
combined	21%	1%	10%[c]	10%[c]	3%

[a] p .01

[b] p .05

[c] p .10

[d] 1976-77

Table 15

Differences Between Letter, Word, and Text Times and Rates

	Grade					
Measures & Variable	1	2	3	4	5	6
Sample Size[a]	20	43	51	46	64	46
Words & Letters						
seconds/unit	.14	.08	.06	.04	.04	.02
units/minute[b]	10.0	9.1	9.39	9.2	10.0	6.2
Words & Text						
seconds/word	.33	.27	.26	.23	.22	.21
words/minute[b]	30.3	42.1	61.5	86.8	89.2	116.7
Letters & Text						
seconds/word	.19	.19	.20	.19	.18	.19
units/minute[b]	20.3	33.0	46.2	77.6	79.2	110.5

[a] combined cohorts

[b] units/minute calculated from average seconds/unit for each measure.

$$\text{Units/minute} = \frac{60}{\text{(sec./unit)}}.$$