

READING COMPREHENSION: A FUNCTION OF THE  
INTERACTION OF LEARNER APTITUDE AND  
TEXT DIFFICULTY LEVEL

Jacob G. Beard and Donald W. Shontz  
Florida State University

The reading difficulty, or comprehensibility, of textual material has been widely investigated. As a result of these investigations elementary school reading texts are carefully "graded" by controlling vocabulary, sentence complexity and sentence length. It seems evident that pupils having low reading skill and low verbal ability will be more successful in learning from materials of low reading difficulty rather than high reading difficulty; it is not as evident, but possible, that pupils having high verbal ability and reading skill would achieve best on materials written at a relatively high level of reading difficulty. If this proved to be true it would be possible to maximize achievement by assigning pupils to materials according to their verbal or reading ability level. It is also possible that abilities other than verbal are involved in differential achievement under two levels of reading difficulty.

In order to obtain a gain in achievement from differential assignment to instructional treatments it is necessary that there be an interaction between the aptitude of the pupils and the instructional treatment used. The general theory involved in this approach to individualization of instruction was discussed at length by Cronbach at a symposium on learning and individual differences (Gagne, 1967). John Hills discusses the aptitude by treatment interaction theory and its implications for college admissions elsewhere in this publication.

The purpose of this study was to investigate reading difficulty of textual material as a form-of-content variable in the context of the aptitude treatment interaction hypothesis. The aptitudes studied were: deduction, verbal, reasoning, and perceptual speed. The treatments were reading passages written at different levels of difficulty. The criterion of learning was comprehension as measured by a multiple-choice test over the material contained in the reading passage.

#### Subjects

The subjects were 73 sixth-grade pupils from a predominately Negro elementary school. All sixth-grade

pupils were tested but only those who had relevant ability measures on record were included in the study. The ability tests had been given approximately eight months earlier. The median verbal IQ, derived from the California Test of Mental Maturity, was 78 for the experimental group.

In addition to the subjects described above, a portion of the experiment was replicated using 200 fifth grade pupils from two predominately white public schools. The results obtained from this group of subjects will be discussed separately.

The subjects were randomly assigned to two treatment groups. After the data for those having ability scores were tabulated, it was found that 36 had received Treatment I and 37 had received Treatment 2.

### Materials

The reading passages were from a graded reading series having parallel versions at different levels of linguistic complexity (Bond and Cuddy, 1956). Two alternate versions of each passage cover the same content but one version has greater vocabulary range, greater sentence complexity, longer sentences, and longer paragraphs. These two versions are referred to as the "original" and the "classmate" editions. The original and classmate versions of a story entitled, "The Shining Metal" were chosen as experimental passages. They were short enough to be read in a class period and the two versions had greater differences in reading difficulty than did other pairs of passages examined. Cloze scores were computed for the passages in an earlier study. In that study, sixth-grade pupils restored 37 per cent of the deleted words to the classmate version and 21 per cent to the original version of "The Shining Metal" passage. The classmate version contained a total of 897 words and the original 1,175 words. The stories provided to the students were typed with single spacing and reproduced by mimeograph.

A thirty-item four-choice test was constructed on the content of "The Shining Metal." The items dealt with general and specific story content common to both versions. Kuder-Richardson 20 reliabilities were computed for the test, using the separate data from each of the treatment groups. The reliability coefficient was .84 for the scores from the classmate group and .79 for those from the original group.

Four cognitive abilities were used as predictor variables and these are described below.

A. Deduction - The ability to interpret correctly a verbal argument or progression of evidence and to form a valid

inference based on the interpretation (Test 8, "Inferences," of the California Test of Mental Maturity).

B. Verbal - The ability to understand ideas expressed in words (The "Words Test" and "Pictures Test" of the Primary Mental Abilities).

C. Reasoning - The ability to solve logical problems (The "Figure Grouping" and "Word Grouping" tests from the Primary Mental Abilities).

D. Perceptual Speed - The ability to recognize similarities and differences between objects or symbols with speed and accuracy (The "Perceptual Speed" test from the Primary Mental Abilities).

#### Procedure

The reading passages were distributed to the subjects with instructions to study them carefully because they would be asked questions about them later. One treatment group studied the original version and the other group studied the classmate version. They were instructed to record the number of minutes they spent studying the passage and to close their booklets when finished. After the pupils had studied the passage, the booklets were put aside and the achievement test was distributed. Time was allowed for the pupils to attempt all test items.

#### Analyses

The mean time spent on studying the passage and the mean achievement score were computed for the classmate and for the original version groups.

Because the number of words contained in the two versions was different, each achievement score was divided by the number of minutes devoted to studying the passage to derive a rate-of-learning or "efficiency" score.

The principal data were analyzed by plotting the regression line for achievement efficiency on ability under each of the treatment conditions. A separate plot of the two regression lines was made for each of the ability measures. The efficiency scores were used as the criterion of achievement in constructing the regression lines.

In addition to the regression plots, the mean, standard deviation, correlation with achievement, efficiency, regression coefficient, and regression line cross-over point were computed for each ability measure. The

differences between slopes of the paired regression lines were tested for significance using an adaptation of a technique described by Kenny and Keeping in Mathematics of Statistics (1951).

### Results

The group given the original version of the story devoted more time to the study of the passages than the group that studied the classmate version. The mean time for each is shown in Table 1. The difference between mean study times is not as large as might be expected on the basis that the classmate version contained only 75 per cent as many words as the original.

Table 1

Means: Achievement Score, Study Time, and Efficiency Score for the Two Treatment Groups

	Treatment Group	
	Classmate	Original
Achievement Score	15.7	14.4
Study Time	15.6	16.1
Efficiency Score	1.01	.89

To determine if the increase in achievement attributed to the classmate version applies uniformly throughout the range of ability in the experimental group, the regression lines for achievement on ability were plotted for each of the ability measures. The regression plot for "Reasoning" is shown in Figure 1. The regression lines for the remaining three abilities are not shown but those for all four abilities reflect a similar interaction effect and cross within the score range. For all four ability measures the classmate version resulted in greater "payoff" at lower ability levels. For example, a student having a "Reasoning" score of 35 and studying the original version would have a predicted achievement (efficiency) score of 1.3 while the same subject would have a predicted achievement score of 1.6 if he studied the classmate version. In other words, a student having a reasoning score of 32 who studied the classmate version would

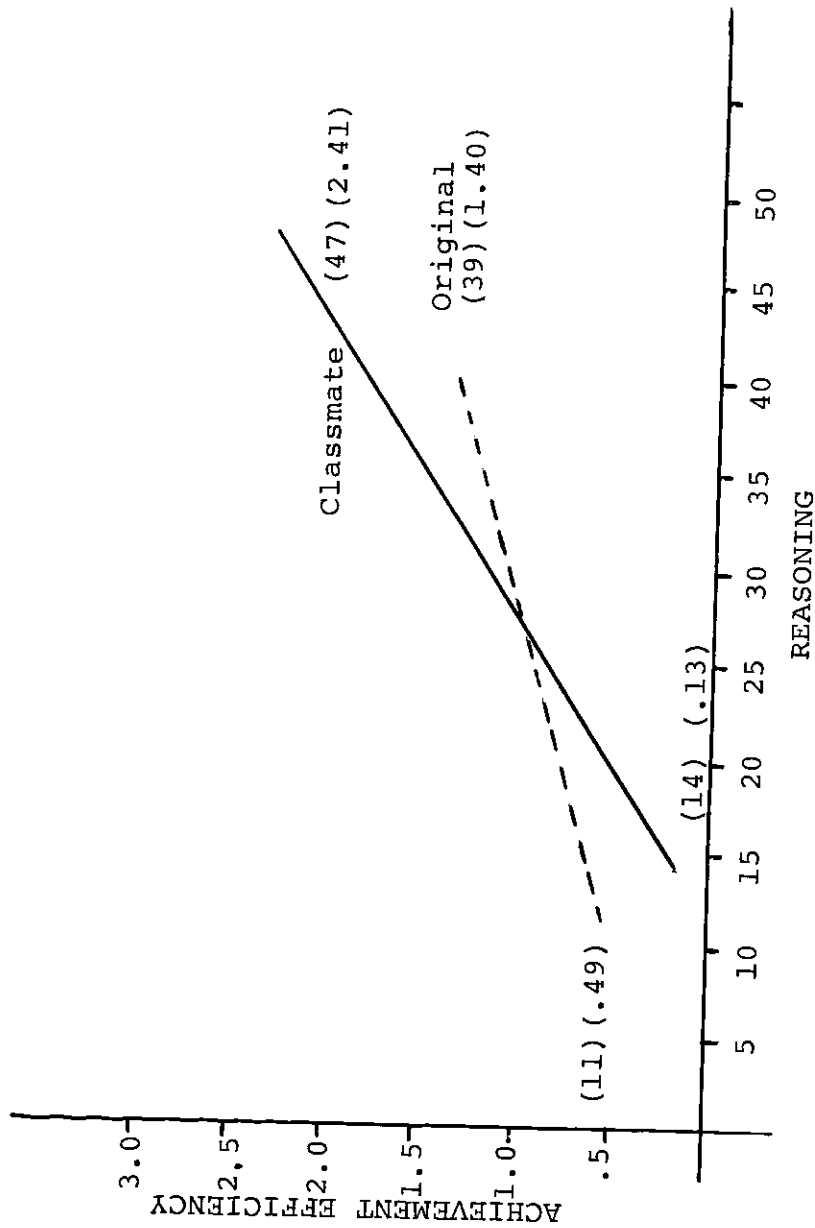


Figure 1. Regression lines of achievement efficiency on reasoning ability for classmate and original study groups.

have the same predicted achievement score as a student having a reasoning score of 37 who studied the original version.

Another comparison of between-treatment regression appears in Table 2. Only the reasoning regression slopes were significantly different, although the regression coefficients for the classmate version were greater than those for the original in every comparison.

The crossover points of the regression lines were generally to the left of the mean. Further examination of the data revealed that the differences in achievement, between the "original" and the "classmate" groups, were greater in the upper ability level than the lower levels, where the differences were small or nonexistent. At the low extreme of the ability scales the pupils performed poorly regardless of the reading level of the material given.

It was then hypothesized that the low extreme of this group was beyond the help which this material supplies, and that the upper ability level for this group actually constituted a low ability group relative to the general population. Under this hypothesis the regression lines would be expected to reverse their relative positions if the experiment were replicated on a group more representative of the normal population.

The hypothesis was tested by replicating a part of the experiment using a group of 200 subjects comprising the total fifth grade class from two schools judged to be typical in academic performance. The procedures and materials were the same in the replication as in the initial experiment except only the PMA Reasoning test scores were included as ability measures.

The results of the replication are shown in Figures 2 and 3. The regression lines for the replication group (Figure 2) have about the same relative orientation as those for the initial group except that the regression lines for the replication group do not actually cross within the score range. The classmate version resulted in superior achievement throughout the range of ability.

The regression lines in Figure 3 are based on the same subjects as those in Figure 2 but the criterion of achievement is the number of items correctly answered, rather than an "efficiency" score. There is no interaction effect present when "number correct" is the achievement criterion.

Table 2

## Comparison of Within-Treatment Regressions

Ability Factor	Treatment Group	M	S.D.	Correlation with Criterion	Regression Coefficient	t	t for difference	Crossover Point	
								Raw	Z
Deduction (CTMM)	Classmate	6.8	2.4	.55	.16	3.9		6.0	-0.3
	Original	6.4	2.7	.42	.09	2.8	1.4	6.0	-0.2
Verbal (PMA)	Classmate	23.6	8.0	.84	.07	9.0		18.0	-0.7
	Original	22.9	7.0	.72	.06	6.2	1.0	18.0	-0.7
Reasoning (PMA)	Classmate	28.0	7.1	.69	.07	5.6		27.0	-0.1
	Original	26.6	6.2	.37	.03	2.3	2.1	27.0	-0.1
Perceptual Speed (PMA)	Classmate	11.8	4.8	.56	.08	3.9		8.0	-0.8
	Original	11.9	4.5	.43	.05	2.8	1.1	8.0	-0.9
Achievement Score/Time	Classmate	1.1	.7						
	Original	1.0	.6						

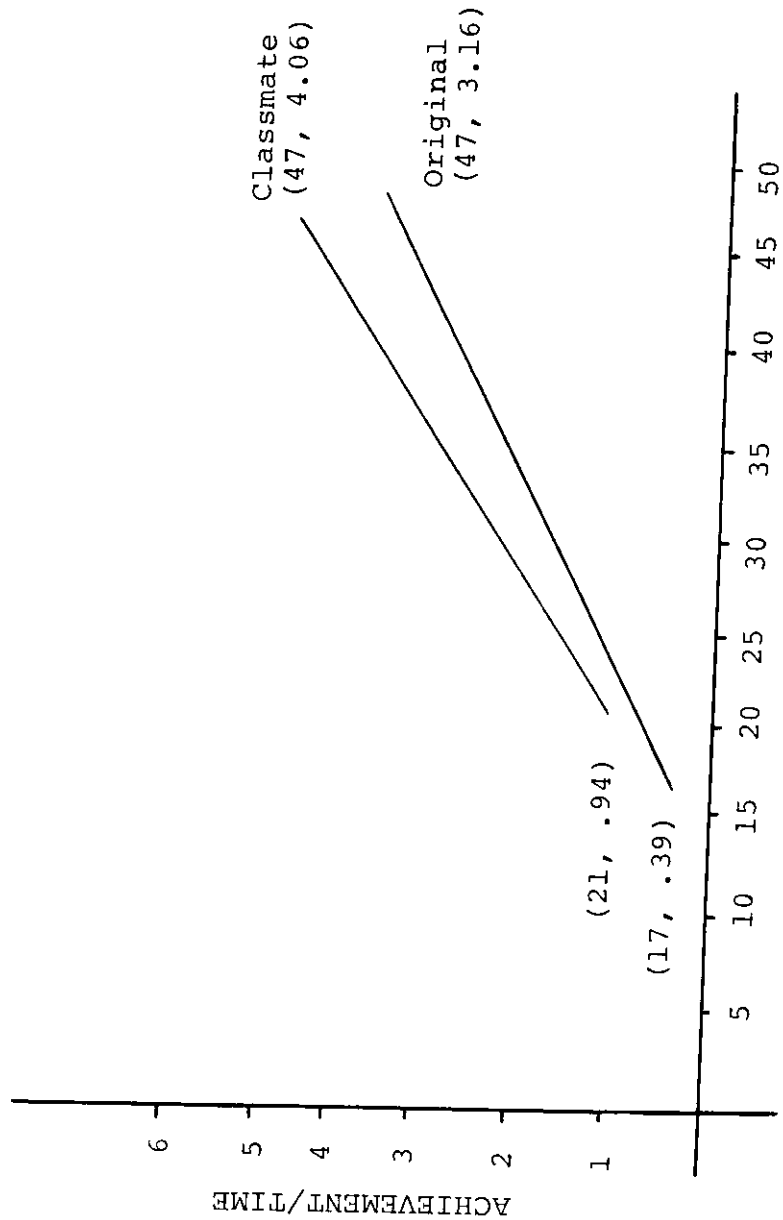


Figure 2. Regression lines of achievement efficiency on reasoning aptitude for classmate and original study groups: replication sample.



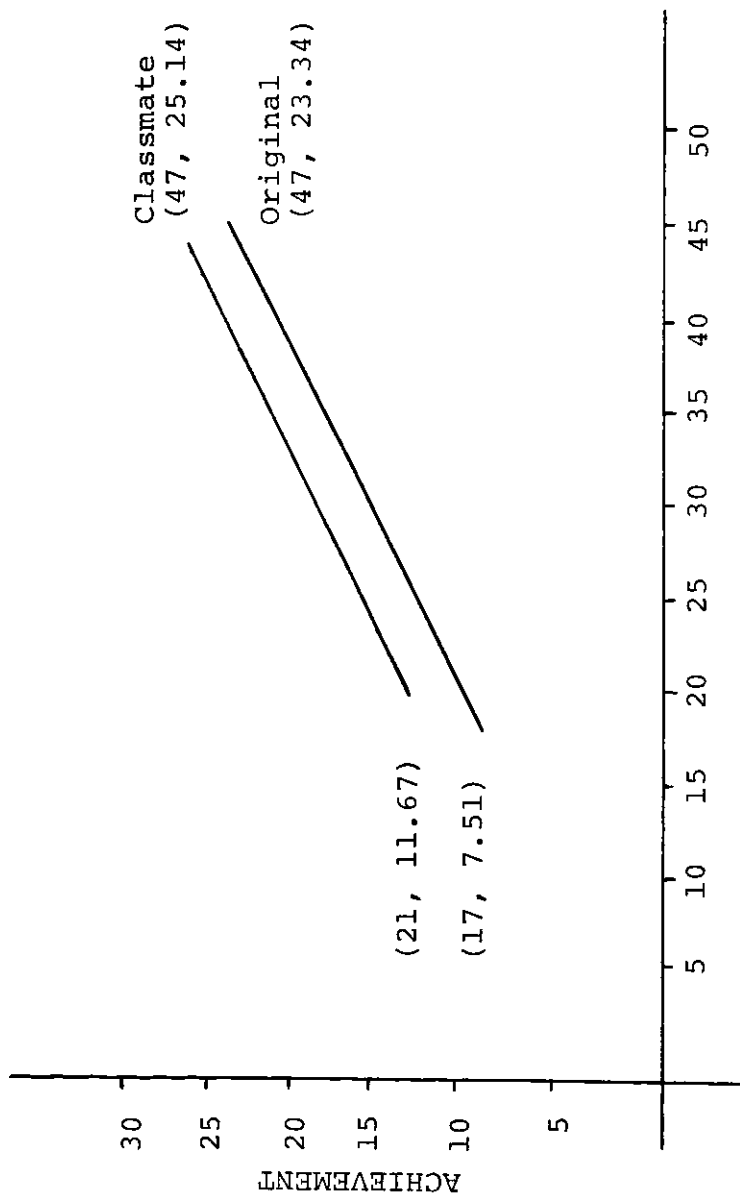


Figure 3. Regression lines of achievement on reasoning aptitude for classmate and original study groups: replication sample.

## Summary

Sixth grade pupils were asked to read either of two versions of a story. The two versions were parallel in content but different in linguistic complexity. An achievement test, having content validity for both versions of the story, was administered following the reading of the story. The mean achievement score for the group which read the simpler version was higher than the mean for the group which read the more complex version, but not significantly so.

Measures of four cognitive aptitudes were also obtained for the subjects: deduction, verbal, reasoning, and perceptual speed. A regression line for achievement efficiency (number correct divided by time spent reading the passage) on each of the ability measures was computed for the group which read the simple version and for the group which read the more complex version. The two regression lines for each ability measure were plotted on a common set of coordinate axes to facilitate comparison of their slopes.

The regression lines exhibited an interaction effect although the difference in the slopes of the lines were significant only in the case of those for reasoning ability. Surprisingly, the increase in achievement associated with study of the simpler version tended to become larger as each ability increased.

In view of the above results, and since the subjects were of lower than average ability, a part of the experiment was replicated using 200 pupils who were more nearly typical in distribution of academic aptitude. Only reasoning ability and achievement scores were obtained for the replication group.

The regression lines for the replication group also reflected an advantage for those who read the simple version, with the greatest advantage for the pupils at the upper ability levels.

When regression lines for achievement raw score on reasoning ability were plotted the interaction effect was not present; the regression lines were nearly parallel. This indicates that the trend toward an interaction effect observed when the efficiency scores were used was caused by differences in reading speed rather than differences in amount learned.

It is concluded that a simple writing style facilitates the transmission of information throughout the range of ability found in typical classrooms. The hypothesized interaction between ability and style of writing was not supported by the results of this study.

## References

- Bond, G. L., and Cuddy, M. C. Stories to remember. Chicago: Lyons and Carnahan, 1956.
- Bond, G. L., and Cuddy, M. C. Stories to remember: classmate edition. Chicago: Lyons and Carnahan, 1956.
- Gagne, R. M. (ed.) Learning and individual differences. Columbus: Charles Merrill Books, Inc., 1967. 265 p.
- Kenney, J. F., and Keeping, E. S., Mathematics of statistics: part two. Princeton: D. Van Nostrand, 1951.