READING RATE IMPROVEMENT
THROUGH COMPUTER ASSISTED INSTRUCTION

by

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READING RATE IMPROVEMENT THROUGH COMPUTER ASSISTED INSTRUCTION

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ABSTRACT

This study was designed to test the effectiveness of a computer assisted instructional program in increasing reading rates of adolescents with learning disabilities. Twenty-one students were randomly assigned to two groups. The computer program provided training in letter, word and phrase recognition, column reading, and short article reading. Each of these parts of the program allowed for controlled increases in the rate of presentation. The experimental group used the computer program in its entirety; the control group used only that portion of the program designed to provide practice in reading complete passages.

Results of the study show that, for both groups, the computer-based methods raised reading rates to near normal levels. Additionally, the experimental group's gain was reached in less time when compared to the control group. Maintenance testing, five months after the original study, indicated that both groups of students were equally able to maintain their gains in reading rate.

These students were not taught to improve their lower-level reading skills (decoding and word recognition), yet they were able to improve their rates of reading to those expected at their grade levels. However, their reading comprehension scores did not improve. It appears, therefore, that these students with learning disabilities had developed more efficient reading strategies.

Further research to replicate these results and to determine the relationships among improving reading subskills, reading rate, and reading comprehension is suggested.

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INTRODUCTION AND RATIONALE

Context of the Problem

Adolescent students with learning disabilities (LD) often lag behind their peers in reading comprehension, partly because of their inefficient reading skills. Unless and until adolescent readers can read at a rate of 200 words per minute or better, they cannot fully comprehend the meaning of much of the material that is required reading in the high school curriculum. Perfetti and Lesgold (1977) argued that many students with LD are inefficient information processors precisely because they must spend an inordinate amount of time and effort on simply decoding words. This results in a measurably slower ability to comprehend sentences and paragraphs and/or a complete inability to do so. While students are concentrating on decoding, they must deal with single words and their definitions, thus being unable to attend to the ideas presented in phrases, or for complete thoughts that are presented in complete sentences. Perfetti & Lesgold (1977) referred to this information processing problem caused by a slow reading rate as the "bottleneck" hypothesis. Without a sufficiently rapid reading rate,

students will find themselves unable to digest the complete ideas presented in these materials because, by the time slow readers read to the end of a paragraph, they will have forgotten the content of the beginning of the paragraph. Thus, a more efficient and rapid reading rate is essential to basic literacy for the adolescent student.

Previous work in the area of reading rate improvement was done in the 1950's and 1960's and focused on the efficacy of tachistoscopes, reading pacers, filmstrips, and other devices such as reading accelerators. Many writers and researchers during the 1950's and 1960's focused on the relative merits of these devices and techniques. Braam (1963) showed that not only rate but also flexibility can be developed in high-school students as a result of using some of these methods.

It seems to be both appropriate and timely to evaluate the merit of using current technology to try to increase reading rate and comprehension. Computers provide possibilities for assisting learning in a fashion that is similar to the technology of the 1960's and may also be as effective as, and possibly more efficient than, traditional teaching methods relying solely on printed text. However, there are difficulties in comparing printed text with computer-based materials. These include length and reading difficulty of materials, differences in the mode of presentation of materials (screen vs. paper) and student motivation.

The purpose of this study was to compare the relative merits of two different computer-based approaches to increasing reading speed for adolescents with LD. The goal was to investigate if one method would be superior to the other in increasing reading rate, without sacrificing comprehension, and to determine if one or the other method was superior in helping maintain any resulting gains in reading rate. One group of students followed the detailed methods presented by the computer program to learn how to recognize letters, words, phrases and passages, and practiced reading them more rapidly. The other group only practiced reading passages at increasingly rapid rates. Both groups used a commercially available computer program, specifically Speed Reader II, by Davidson & Associates, for both presentation of text and for timing.

CHAPTER II

REVIEW OF THE LITERATURE

Torgeson and Young (1984) have suggested that there are two major uses for Computer Assisted Learning (CAL) in improving Learning Disabilities educational practice. These are:

a.) to increase writing skills through the use of computers as word processors, and

b.) to increase reading proficiency through the use of the computer as a tool in improving word recognition speed and accuracy.

The arguments behind these two uses stem from the recognition that most students with LD lack good readers' easy ability to recognize words (automaticity) and to manipulate both words and sentences in their writing.

The goal of fluent reading is comprehension, and comprehension does not occur without accurate decoding. However, accurate decoding,

by itself, will not lead to comprehension, because both accuracy and speed must develop before comprehension is possible. Most students with LD do not suffer from an inability to comprehend text so much as from an inability to process text efficiently (Curtis, 1980; Frederikson, 1978). The relationship between comprehension and word recognition speed is important because "less skilled reading may be in part due to a failure to develop automaticity, thereby causing a deficit in the amount of attention available for comprehension" (Curtis, 1980, p. 656). The essential difference between students with LD (and poor readers) and good readers is that good readers spend far less time in recognizing words than do students with LD, and therefore are more able to interpret and connect longer pieces of text more efficiently (LaBerge & Samuels, 1974; Lesgold & Perfetti, 1981).

Many studies have shown that poor readers read relatively slowly (Biemiller, 1970; Curtis, 1980; Katz & Wicklund, 1971; Kolers, 1970,1975; Lesgold & Curtis, 1981; McCormick & Samuels, 1979; Perfetti & Hogaboam, 1975; Samuels, Begy, & Chen, 1975-76; Shankweiler & Liberman, 1972). It has been argued that the connection between word recognition and comprehension is more coincidental than causal (McClelland & Jackson, 1978), but others have pointed out that increasing word recognition skill leads to an improvement in reading comprehension while the reverse is not apparent (Stanovich, 1982).

The theory of automatic information processing in reading developed by LaBerge and Samuels (1974) described several stages of information processing necessary for reading. According to this theory, skilled readers are those who are able to employ each of these processes automatically. Although any one process can be attended to selectively, a reader can do so only at the expense of some other process. Furthermore, if a reader's attention is focused too much on any one process, overall reading performance, especially speed, is reduced. Thus, slow, inaccurate, or incomplete decoding of individual words will demand that the reader pay too much attention to the structure of the words and will adversely affect reading comprehension. In addition, if too much attention is paid to decoding words too frequently, and it takes too long to read an individual word, a reader's short-term memory may be taxed, resulting in preceding words being forgotten before a phrase or sentence is completed. Similarly, ideas presented in recently read phrases may be forgotten (Beck, 1977; Gough, 1972; LaBerge & Samuels, 1974; Perfetti & Lesgold, 1977). Such a situation, where short-term memory may act as a "bottleneck" to prevent reading comprehension (Perfetti & Lesgold, 1977), results in a vicious circle: a reader cannot read faster because too much attention is required to decode the words for their meaning, and comprehension fails because the reader doesn't read rapidly enough.

The "bottleneck" hypothesis suggests that these lower-level processes need to be learned to the level of automaticity before

sufficiently rapid reading is possible. It also suggests that, without sufficiently rapid reading, comprehension of more difficult material is not possible. However, Perfetti & Lesgold (1977, p. 26) cautiously pointed out that improving reading speed alone does not necessarily result in improved reading comprehension. They suggested that additional training of comprehension skills may be necessary to induce improvement in students' reading comprehension. Perfetti & Lesgold's caution appears to be vindicated in a study by Fleisher, Jenkins and Pany (1979). Fleisher, et al (1979) attempted to provide research evidence to support this relationship between decoding speed and comprehension. They trained poor readers in decoding of single words and phrases. While they found that the training significantly increased the decoding speed of single words, they found no improvement in comprehension performance. Fleisher et al. concluded that their results challenged the decoding-sufficiency or "bottleneck" hypothesis because training succeeded in increasing the single word decoding speed of poor readers to a level comparable to that of good readers, while comprehension scores were not increased.

However, Blanchard and McNinch (1980) questioned whether the Fleisher et al. research was actually a test of the decoding-sufficiency hypothesis because their experiment "failed to establish a rate transfer effect to contextual reading rate and, hence, to comprehension performance" (p.563).

Also, as Perfetti & Lesgold (1977) originally pointed out, the rapid and automatic decoding necessary for comprehension accuracy involves "both automatic phonological decoding and semantic decoding" (p. 18). According to the "bottleneck" hypothesis, it is necessary to improve both word recognition speed and accuracy: "speeded word recognition practice, even with short-duration presentations, does not, in itself, exert much influence on recognition speed or on comprehension accuracy. However, when the emphasis on speeded recognition is augmented by instruction in tactics for recognition, both recognition speed and cloze test performance are improved" (p.30).

Without doubt, students with LD need to learn to read words, phrases, sentences and paragraphs with greater speed and accuracy. To this end, Torgeson (1986) argued that computers should be used to build fluency in reading by developing automatic word-recognition skills. He states that the computer is well-designed to assist in this development of "automaticity" because of its ability to efficiently provide supplemental practice on previously taught skills. As Ragosta (1982) pointed out, "The advantage of the computer for drill-and-practice activities lies in the computer's efficient use of time. For only 10 - 20 minutes daily, truly individualized drill-and-practice can be used to instruct students at their own ability levels, to provide immediate feedback to each response, to move students ahead on the basis of their mastery of subject matter, to keep records of each students' placement

in each strand of each curriculum, and to do this with demonstrable effectiveness over a period of years" (p. 32).

Torgeson (1986) also detailed the need for well-designed programs in the area of remedial reading skills that may not yet be available due to the limited memory size and capabilities of typical computers available to classroom teachers today. Until more powerful and less costly computers are readily available in the classroom, many programs will continue to be less than ideal. They will continue to be restricted in their ability to monitor student progress and suggest further areas and levels of practice. Such is the case with the program used in this experiment. Its limitations are described and some suggestions are made for improving the program in the Methods section of this paper. Since, however, computer programs can be designed to follow good educational practice and they can provide a level and degree of individualization that no teacher can provide, it makes sense to suggest improvements in capability and design now. These suggestions need to be based on sound educational arguments and clear research results that demonstrate the viability of the computer's use in the classroom.

Recently, efforts have been made to develop computer programs to assist in remediating the word-recognition skills of students with LD. Wilkinson (1983) described a computerized reading program called READINTIME which is designed to develop rapid word recognition, to

provide a variety of methods of presenting and pacing text and to assist in record-keeping. Because the word-recognition portion of this program provides practice only in recognizing words, not in recognizing their meanings, the author admits there are serious limitations to its current design. With the addition of semantically meaningful components to this portion of the program, READINTIME may prove to be a valuable tool for both teaching and research. Wilkinson describes a second portion of READINTIME that provides readers control over text selection, framing and pacing. As a tool for measuring the frequency and nature of a reader's skipping and/or rereading text, this section of READINTIME has many potential uses in reading research. It lacks, however, an ability to check readers' comprehension of text, and therefore may not be suitable as an instructional tool that would help a reader develop increased reading speed with no loss in comprehension. Nor does the program allow readers to monitor their understanding of text as they read. Both of these capabilities, if added to the program, would make a powerful teaching tool as well as a powerful instrument for research.

For the purposes of this study, it was decided to use a computer program that, while it lacks record-keeping abilities, does require readers to demonstrate an understanding of the content of the passages read. The advantage to using such a program is that it provides both controllable reading pace and a check on comprehension. It does not, however, provide practice or opportunity in vocabulary

building. This was not considered a fault in the program, at least not for the purposes of this study, because the intent here was to improve reading speed separately from any consideration of developing vocabulary skills.

Many adolescents with LD continue to read slowly even after they have gained sufficient decoding skills, largely because slow reading is their habitual reading mode/strategy. Perhaps by being shown an alternative, faster, method of reading, using materials well within their independent reading abilities, they could learn to marshal more of their decoding and automatic word recognition skills and bring them to bear on reading more quickly, more accurately, more efficiently, and with improved comprehension. To gain fluency in reading, they may well require sufficient practice at reading more rapidly than they do "naturally". The computer, because it can present text as either words, phrases, sentences, or "pages", at variable rates, may be well suited to this task.

Previous work in the area of reading rate improvement was done in the 1950's and 1960's and focused on the efficacy of tachistoscopes, reading pacers, filmstrips, and other devices such as reading accelerators. This research found mixed results for the use of mechanical aids to reading. Questions were raised about the relative merits of mechanical aids and well-motivated reading. Some studies questioned the effectiveness of the tachistoscope and other pacing

devices in improving reading rate, vocabulary or comprehension (Anderson & Dearborn, 1952; Manolakes, 1952; Bormuth & Acker, 1961; Jones & Van Why, 1963). Tinker (1967) summarized these findings by stating that the use of such devices resulted in improvements in reading skills that were "no greater than that resulting from motivated reading alone" (p. 608). Few of these studies reported that the effects of reading rate improvement increased other reading skills, in particular vocabulary and/or comprehension. Other studies, however, were more positive about the usefulness of these devices. Brown (1958) described and supported the utility of the tachistoscope in improving reading skills, including rate. Braam (1963) showed that not only rate but also flexibility can be developed in high school students as a result of using some of these methods. As a result of these kinds of studies, much interest was generated in these devices, and many schools and clinics employed them. However, one of the major criticisms made of tachistoscopes and other devices was that the gains made in reading rate, while as good as those made by more text-oriented methods, did not transfer to reading normal text and that these gains, therefore, were artificial and transitory (Spache, 1963; Tinker, 1967).

Similarly, gains in reading rate that may occur when using a computer cannot be counted as useful if they are dependent on the controlled presentation available only through the computer. Hafner (1967, p.289) discussed the ways in which skills learned by any mechanical method need to be transferred to normal reading materials,

unaided by mechanical devices. Any gains in reading rate must transfer to written text if they are to be of benefit to students whose primary reading materials are books and papers. Provision was made throughout this study to measure the transfer of reading rate improvement to normal textual material.

It would be useful to demonstrate to both computer-using educators and to those skeptical about the viability of computers in schools that reading instruction is one area where the computer is a valuable adjunct to traditional methods of instruction. The computer combines the abilities of the tachistoscope, the reading accelerator, the reading pacer, and the filmstrip in its ability to present text. It can display words, phrases, sentences and paragraphs, either in isolation or as continuous text. Its rate of presentation can be adjusted and its results can be monitored. It can also provide instant feedback regarding levels of achievement and reading rate, thus providing incentive to students to continue to improve.

Many adolescent students with LD read at a rate that is considerably less than the average for their peers, often no faster than 120 words per minute. Harris (1968) and Taylor, Frackenpohl, & Pettee (1960) presented norms for reading rates (with comprehension) at each grade level. For high school students, they are as follows:

GRADE:	7	8	9	10	11	12
RATE:	195	204	214	224	237	250

Clearly, reading rates of students with LD need to be increased. The goal of this study was to improve the reading rates of the students involved to these norms or higher.

Improving reading rate necessitates an increase in both word-recognition and in sentence and paragraph comprehension. Provision was made for students in the experimental group of the study to practice rapid word and phrase recognition as well as to increase their rate of reading of sentences and paragraphs. Students in the control group were provided an abundance of practice in reading only complete articles at increasingly rapid rates.

Computer assisted instruction, with its ability to vary the speed and manner of presenting text, can be particularly useful in practicing and developing increased reading rate. However, a well-designed reading rate improvement program must also include consideration of reading comprehension. There is no benefit to a student in improving reading rate if it is gained at the expense of understanding. Reading rate and comprehension are interdependent. Fisher (1967) argued for the use of a reading score measure that is a product of both rate and comprehension, thus rendering a consistent measure of overall reading rate improvement. This score, called a Reading Efficiency Score (REF), is obtained by multiplying reading rate, measured in words per minute (WPM), by reading accuracy, measured as a percent of correct

responses to questions about the content of what was read. Because it combines these two variables, and because it tends to weight comprehension more when speed rises and speed more when comprehension drops, the REF score also makes comparisons between easy and hard reading material more meaningful. This measure of reading efficiency was included as a dependent variable throughout this study on all measures of both computer-aided and normal textual material.

Hypotheses

It was hypothesized that a course in reading rate training, following either of two methods, would significantly increase the rate of reading of adolescent students with LD, with no loss in their comprehension. It was further hypothesized that a complete computer assisted learning program would increase these skills at a greater rate than a program which consists exclusively of computer assisted timed reading practice sessions.

CHAPTER III

METHOD

Subjects

The participants in this study were twenty-one students currently enrolled in a Learning Assistance Center program at Argyle Secondary School in North Vancouver, located in a middle to upper-middle class neighbourhood. These students were already enrolled in a program of remedial reading, writing and/or spelling instruction. All had received remedial instruction in the past, as elementary school students, and had I.Q. scores that were average or higher. Their deficits in reading ability were sufficiently large - they were reading about 2-3 grades below grade placement. Because of the discrepancy between adequate intelligence and academic achievement, their earlier diagnosis of learning disabilities in elementary school appeared to be valid.

The students were randomly divided into two groups. The number of girls and boys in both groups was equivalent (30% girls; 70% boys). The average reading ability, as measured by a recently

administered diagnostic test, was approximately equal in both groups. All students and their parents gave their informed, written consent to take part in the study.

The average age of students in Group 1 was 15.4 years (S.D.=0.88), and in Group 2 was 15.6 years (S.D.=0.71). The average grade placement for students in Group 1 was 9.6 (S.D.=0.77), with a range of grades 8 - 11; average grade placement for students in Group 2 was 10.4 (S.D.=0.75), with a range of grades 9 - 11. The average grade-equivalent score in reading comprehension on the Stanford Diagnostic Reading Test (SDRT), Blue level, for Group 1 was 5.7 (S.D.=1.6), and for Group 2 was 6.4 (S.D.=1.8). The average grade-equivalent score in reading rate on the SDRT for Group 1 was 7.2 (S.D.=1.7), and for Group 2 was 7.4 (S.D.=2.4). Prior to training, the average reading rate, measured in words per minute, based on three passages taken from BBR, book 2, was 153 WPM for Group 1, and 140 WPM for Group 2.

Procedures

Students were divided into two groups: Group 1 received the entire computer instructional program, which comprised instruction and practice in reading letters, words, phrases, and passages at increasingly rapid rates. Group 2 used only that portion of the computer instructional program that provided practice in reading passages at

increasingly rapid rates. Both groups used the same mode of practice, and the same computer program.

It was important to ensure that students in both groups received equal time at the computer, so that the amount of time on the computer did not become a confounding factor in the results of the study. Therefore, since students in Group 1 spent an average of 30 minutes per session in reading rate warm up and practice, those in Group 2 spent an average of 15 minutes on reading rate practice followed by 15 minutes on computer-based spelling practice using Spell-It. Since this program was produced by the same manufacturer (Davidson), this effectively controlled for differences in the instructional materials each group used. Each student, in both groups, was able to practice his/her reading improvement at the computer every second day, for a total of 20 sessions per student, over the 6-week period of the experiment. Thus, each student received close to 600 minutes (10 hours) of practice on the computer.

Stimuli: Computer Program

Speed Reader II consists of a master program disk backed by a data-disk containing 20 "eye-movement" passages and 15 "speed-reading" passages. Three supplementary data-disks are available (labelled A, B, and C), each of which contained 20 additional "eye-movement" passages

and 15 additional "speed-reading" passages. The passages provided with the master program disk are intended for use by adults. Those included on Data-disks A, B, and C are appropriate for those reading at different levels: Grades 4 to 6, 7 to 9, and 10 to 12, respectively. "Eye-movement" passages on these data-disks are each approximately 150 to 180 words long; "Speed-reading" passages on these data-disks are each approximately 400 words long. Both types of passages are graded by difficulty level, using the Fry and Dale-Chall methods of grade-level evaluation - a combined measure of sentences per 100 words and syllables per 100 words. It is possible to edit the "eye-movement" and the "speed-reading" passages, and to add passages to the disks, using the program's built-in editing functions. It is possible, but not remarkably easy to do so. The editing procedure employs a very rudimentary word-processor which requires changes to be made line by line, not by word or by letter, so that changes to the entries can be time-consuming and laborious. At least 5 additional passages were added to each data-disk, in order to have a sufficient number of passages available for student practice and testing. This avoided the repetition of any one passage by any one student. These additional passages, of the same length and difficulty, were taken from Timed Readings (Spargo & Williston, 1980), books 3, 5 and 7.

Group 1 students followed all the procedures available through the Complete Speed Reader II computer program. These included warm-up exercises, eye-movement lessons, column-reading lessons, and

passage-reading lessons. They also consisted of timed reading tests before, during and after the experiment.

Warm-up Exercises. The warm-up exercises consisted of two parts: practice with letters, followed by practice with words. In each phase of the warm-up sessions, the letters or words were presented initially for one second, and then disappeared from the screen. Students were then prompted to type what was seen. Correct letters appeared beneath the ones typed so that students could quickly identify any errors. If they typed the presented letters or words correctly, another set was presented on the screen, however, this time for less time. Speed of presentation was labelled on the screen as a number, not in words per minute. That is, an indication appeared on the screen that this is speed 1, or this is speed 2, etc., to a maximum of speed 15.

Warm-up Exercises (letters). Letters were presented initially two at a time. When students reached their maximum recognition speed - whether this was the maximum speed possible (15) or whether it was less - they were instructed to practice with three, and lastly with four letters. On reaching their limits, the program presented a summary of the practice session, detailing the number of attempts with 2, 3 and 4 letters, the percentage of correct responses, and the last obtained speed with each set of letters. At this point, they were instructed to record the results and proceed to practicing with words.

Warm-up Exercises (words). The warm-up exercises with words used the same procedures as those for the warm-up exercises with letters, except that groups of words rather than letters were practiced. Again, the words were presented two at a time, initially for one second, and then disappeared from the screen. Here, a phrase such as: "jog cautiously" or "gorgeous students" was presented, initially for one second. Students were prompted to type the phrase, and, if successful, read another phrase, presented for less time, up to a maximum of speed 15. If correct, they would see the next phrase presented for less time, until they had reached their maximum recognition speed, at which point they moved to the next level, consisting of three-word phrases. The final level of warm-up practice consisted of four-word phrases presented on the screen. After completing this level, students were instructed to record the results. Records were kept by hand on a modified version of the record sheet provided in the program package. The program is not capable of recording on disk the progress of individual students.

This phase of the warm-up session presented serious difficulties, not encountered previously, for many students. Unless the phrase was correctly spelled when the student re-typed what was seen, it was counted as incorrect, and the next phrase would be presented at the same speed. As a result, many students never got beyond speed 1 in this portion of the warm-up sessions. Most students could read the phrase accurately, but had difficulty either with spelling it or with typing it exactly. It was not possible to modify this part of the

program to allow students to practice word recognition with easier words. Since this did not accurately reflect their ability to read the phrase presented, it was seen to be an invalid approach to rapid recognition of phrases, and had to be discontinued as a part of the warm-up sessions after the first three sessions for each student in this group. This phase of the program could be improved greatly by allowing students to select from a choice of possible phrases, including good distractors.

Eye Movement Lessons. After completing the warm-up session, students in Group 1 were instructed to take an "eye-movement" lesson. These lessons consisted of passages that were approximately 150 to 180 words long, and were presented as phrases that moved across the screen in much the same manner as one reads normal text. That is, a group of words would flash on the top left side of the screen and then disappear, followed immediately by another group of words on the right side. Phrases would continue to be presented in this manner, back and forth, down the screen. Passages were constructed so that two phrases were presented on each line of the screen. The third phrase would immediately appear at the far left of the screen, down one line from the previous phrases. The effect of this manner of presentation was to closely mimic a normal method of reading - left to right eye-movement, line by line, down the page. When the phrases reached the bottom line of the screen, the same procedure would repeat itself, until the end of the article. Speed of presentation, not in words per minute, but on a

scale from 1 (slow) to 9 (fast), was selected by the student. Before students began reading any "eye-movement" passage, they were prompted to enter the speed at which they wished to proceed. Few students in the experimental group were able to read these passages at a speed higher than Speed 3. After reading each passage, students were instructed to take a comprehension quiz consisting of four multiple-choice questions to test their accuracy of understanding, and to record the name of the passage read, their accuracy score (as a percentage) and their speed.

The intention of this portion of the computer assisted lessons was to give students in the experimental group an opportunity to read in a manner that many of them reported was different from their previous reading experience - i.e. in phrases. Indeed, they were forced to do so. Previously, many of them stated, they had read word by word. It was thought that this portion of the CAI, along with the next, would be most beneficial in assisting students to learn to read more rapidly and in a more efficient manner.

Column Reading Lessons. Students in the experimental group were next instructed to read passages in columns, either with or without a line, down the center of the screen. In this mode of presentation, each phrase was centered on the screen, one phrase only occupying one line, so that the phrases that comprised the article required the student to scan vertically down the screen, not left to right, across, and then down the screen. The optional vertical line was

available as an aid to focusing one's attention on reading each phrase in as few eye-movements as possible. Students were able to select from the same list of twenty "eye-movement" passages. Again, speed was selectable, but this time in words per minute, ranging from 100 to 2000 WPM. Students were directed to select speeds appropriate to their previously measured abilities, and none exceeded 350 words per minute. Again a comprehension quiz consisting of four multiple-choice questions followed each passage, and students recorded the name of the passage read, their accuracy score (as a percentage) and their speed.

Although the program suggests that it is possible to read each phrase in only one eye-span, this was not physically possible. Many phrases consisted of three or four words, and were comprised of up to 20 characters. Research on eye-movements has established that a skilled reader has a visual span of about 15 - 25 characters, which is approximately 2-4 words, but can accurately discriminate only 7 or 8 letters in any one eye-span (Rayner & McConkie, 1977; Wilkinson, 1983, p.185) Additionally, when reading unfamiliar, expository material, skilled readers fixate almost every word individually (Just & Carpenter, 1980). Most of the students in this study were not skilled readers, and thus found they could not see all of each phrase in the time provided. With continued practice, most reported that they were able to see most of the phrases. They did report, however, that they found the optional vertical line distracting. Even if they were able to follow the method of focusing on the vertical line provided, as suggested by the authors of Speed Reader II they stated that they were able to read the letters at

the extremities of each phrase only as blurs, and any unfamiliar words required them to slow down to a rate that would not enable them to read the other words presented in the same phrase.

Reading Passage Lessons. The final portion of the computer aided learning program consisted of reading passage lessons. Students selected from a list of 15 reading selections, each approximately 300-400 words in length, and at an appropriate level of reading difficulty. They next selected the speed, in words per minute, at which they would read each passage, and the "window size" of its presentation. Speeds selected by the students ranged from 100 to 400 words per minute, as determined by their previous timed reading tests, and was increased by 10 WPM after successfully completing each passage. Successful completion of a passage meant obtaining 70% or better on the comprehension quiz that followed each passage. If they were not able to obtain this level of accuracy, they repeated the same reading rate on the next passage, until they did achieve 70% or better on the quiz.

"Window size" referred to the number of lines that appeared on the screen at one time. This could range from 1 to 12 lines, but most students preferred to use 3 to 4 lines, as this gave them a better "feel" for their speed of reading. Following each passage was an eight item, multiple-choice comprehension quiz. Students then recorded the name of the passage they had read, their rate of reading, and their accuracy score (as a percentage).

Most students had little difficulty in practicing with this portion of the program, with the exception of the method required to choose a reading passage. They had to select from the catalogue of 35 passages provided on the screen. If they were doing an "eye-movement" lesson, they had to choose from among the list of 20 "eye-movement" passages, identified on screen by an "EM" prefix to the name of the passage itself. If they were doing a "speed-reading" lesson, they had to choose from among the list of 15 "speed-reading" passages, identified on screen by a "SR" prefix to the passage name. After deciding which passage to read, ensuring that it was not one of the ones they had previously read, they then had to type the exact name of the passage, complete with its proper prefix, spelling and punctuation. This required accurate typing and spelling skills, and was initially a major cause of frustration. With practice, all students were able to do this correctly, but an easier method of selecting passages should be developed by the authors of the program. The original passages that accompany the program, and which are intended for use by adults, are able to be selected by number. It would seem to be only reasonable that selecting passages be made just as simple for younger and/or less skilled readers.

Timed Reading Tests. Timed reading tests were used to compute students' reading rate and comprehension, using materials supplied on the supplemental data disks. These tests were taken four times by all students: once as a pretest, before doing any lessons; once as a posttest, on completion of the six weeks of lessons; and twice

during the reading rate experimental period: students in both groups took one test after their first 6 sessions on the computer, and another after their 12th session. Students selected a passage from the list of "speed-reading" passages on the appropriate data disk, again entering its name along with the required "SR" prefix, after ensuring that it was not one they had read in a previous lesson.

In these tests, the passage was presented as "pages" of text, one screenful at a time. When the students finished reading a "page", they pressed the space bar on the computer keyboard and the next "page" of text appeared. They continued in this manner until the end of the passage. Their reading rate appeared on the screen after they had read the passage in its entirety, and they recorded this in words per minute. They then took an eight item multiple-choice quiz to determine their accuracy of comprehension, and recorded their score as a percentage, along with the name of the passage they had read. Aside from some initial difficulty with selecting a passage, as noted above, this portion of the program offered no new problems.

Group Differences in Procedures. Students in Group 1 used all portions of the Speed Reader II program, as outlined above. Students in Group 2 used only the Timed Reading tests and the Reading Passage lessons. In essence, the experimental group practiced for a considerable amount of time with Warm-up, Eye Movement, and Column Reading lessons, in addition to doing what all students in the control group did only: practicing with the Reading Passage lessons and taking

the Timed Reading tests. Because students in Group 1 required an average of 30 minutes per lesson to complete their work, and because students in Group 2 required only an average of 15 minutes to do theirs, Group 2 students made up the time difference on the computer by practicing their spelling skills, using Spell-It, another computer program designed by the same company that designed Speed Reader II. In this way students from both groups had equal amounts of time on the computers during the experiment.

Independent Variable

Both groups of students with LD received six weeks of training in rate of reading improvement. Group 1 received computer assisted instruction in letter, word, and phrase recognition, as well as practice in phrase and passage reading, while Group 2 received computer-based timed reading practice only. This instruction, for both groups, included two parts: First, abundant practice with easy reading materials to develop fluency; and, second, practice with a series of timed reading exercises with comprehension checks. Motivation for both groups was controlled, involving both immediate feedback and the intrinsic reward for improvement of being able to move upwards to a higher rate of reading.

Dependent Variables

Measures on three dependent variables were collected in this study: **reading rate, reading fluency,** and **reading comprehension. Reading rate** is defined as the rate at which a student is able to read with fluency, flexibility and comprehension, measured in words per minute. Students in both groups were advised to increase their reading rates relative to their beginning levels. As they progressed, increased and achievable targets were set.

Reading fluency is defined as the ability to read with relative ease and without losing the gist of the text. Initially, and throughout the project, students in both groups read material that was well within their independent reading ability. This was measured as Reading Efficiency (REF), as described above.

Reading comprehension is defined as the ability to understand and remember the content (purpose, main ideas, details, sequence of events, etc.) of a reading passage. Each and every timed reading passage, for both groups, was followed by questions focusing on these content areas.

Reading ability - vocabulary, comprehension and rate - was measured by the Stanford Diagnostic Reading Test (SDRT). Reading rate was also measured in normal textual materials, using averages obtained in three trials/sessions on materials in Be a Better Reader - Book 2 (BBR). Reading rate was measured additionally by a test using materials supplied in the computer program - Speed Reader II. All tests were administered both before and after the experiment, using identical

procedures but different passages from or different forms of the same tests. It should be noted that the tests of reading comprehension employed here differed from those used on the SDRT, and on the computer assisted instructional (CAI) materials, in that these were not multiple-choice questions. On the BBR materials, students were required to provide word, phrase or sentence answers to questions after reading the 700 - 1200 word text. They were not permitted to look back at the text for information. Because these questions required greater precision and quantity of recall, and because they offered none of the clues so often provided in multiple-choice questions, all students found them more difficult, although they also found them to be closer to the kinds of tests they ordinarily encountered in school.

Significance

It was hoped that this study would show that the computer can be of assistance in the area of reading rate instruction at the high school level. By using a relatively well-designed and flexible, commercially-available computer program, it is hoped that other educators will be able to incorporate these findings in their own repertoires of teaching methods. While the computer is being used with increasing frequency in Learning Assistance Centers, very few studies have been done to determine objectively what advantages it offers over other methods of instruction. Some educators have welcomed the computer with open arms, and with little experience to judge its utility.

Others have shied away from using it, suspecting it to be just another technological gimmick. It is also hoped that this study will encourage other educators and researchers to study other areas where the computer may be of use to other groups of students, and especially to adolescents with LD.

CHAPTER IV

RESULTS

Data Analysis

On average, both groups improved their rates of reading on the computer by about 28 words per minute. These increases in reading rate have successfully transferred to textual reading material as well. Prior to the experiment, the average reading rate, measured by three passages taken from BBR, book 2, for Group 1 was 153 WPM; for Group 2 it was 140 WPM. After the experiment, the average reading rate on three different passages from the same book was 175 WPM for both groups (Table 1). Measures of the students' reading rates using printed material and the Stanford Diagnostic Reading Test (SDRT) showed significant gains for both groups, although the students in Group 2 made greater gains in their ability to read these materials at a more efficient rate.

Table 1

Group Gains in Reading Rate on the Stanford Diagnostic Reading Test (SDRT), in Grade Equivalents, and on Text Materials from Be A Better Reader (BBR), Book 2, in Words per Minute

	SDRT			BBR		
	PRETEST	POSTTEST	GAIN	PRETEST	POSTTEST	GAIN
GROUP 1 (N=11)						
AVERAGE	7.1	8.0	0.9	153	175	22
MINIMUM	4.8	5.3	-0.8[1]	85	103	-37
MAXIMUM	11.5	10.7	3.5	234	294	132
STAND. DEV.	1.6	1.5	1.1	44	51	46
GROUP 2 (N=10)						
AVERAGE	7.1	8.3	1.3	140	175	36
MINIMUM	4.6	6.8	-0.9	61	111	-22
MAXIMUM	9.9	13.0	3.5	189	268	115
STAND. DEV.	1.7	1.7	1.4	39	51	37
BOTH GROUPS (N=21)						
AVERAGE	7.1	8.2	1.1	147	175	28
MINIMUM	4.6	5.3	-0.9	61	103	-37
MAXIMUM	11.5	13.0	3.5	234	294	132
STAND. DEV.	1.6	1.6	1.2	43	51	43

1 Minimum and maximum gain scores refer to the minimum or maximum gain made by any single student in each group.

On average, students in Group 1 increased their reading rates by the equivalent of **0.9** grade levels; those in Group 2 increased theirs by the equivalent of **1.3** grade levels (Table 1). These results were obtained in six weeks time, and despite each student being limited to using the computer only every other day because of the limited number of computers (2) available in the Learning Assistance Center.

The original hypotheses of this study were:

1. Students in the experimental group (Group 1) would show an increase in reading rate sooner than those in the control group (Group 2). The dependent measure of this was the two Timed Reading Tests taken on the computer during the progress of the experiment.

2. Students in the experimental group (Group 1) would show a greater increase than those in the control group (Group 2) in reading rate, with no loss of comprehension, as measured by three measures:

   a. A fourth and final Timed Reading Test taken on the computer at the conclusion of the experiment.

   b. Three passages from Be a Better Reader, Book 2.

   c. The Reading Rate subtest of the Stanford Diagnostic Reading Test, Blue level.

Statistical analyses of the results do show that Hypothesis One was supported. There was a significant difference in the amount of time required by the two groups to improve their rates of reading.

Table 2 shows the results of two-tailed t-tests comparing the gains in reading rates made by both groups of students on the computer-based timed reading tests. **Time 1** refers to the reading rate scores obtained by students before they began to use the computer program. **Times 2** and 3 refer to the intermediate tests of reading rate, done during the study, after six and twelve sessions on the computer. **Time 4** refers to the final test of reading rate, taken immediately after completing the use of the computer program.

Table 2

Group Reading Rate Gains on Computer-based Timed Reading Tests using Comparisons between Pretest (Time 1), Two Interim (Times 2 & 3), and Posttest (Time 4) Measures

			SEPARATE VARIANCE ESTIMATE		
VARIABLE	N	MEAN GAIN	STANDARD DEVIATION	F VALUE	2-TAIL PROB.
Time 1 vs. 2					
Group 1	11	33.1	19.73	1.27	0.729
Group 2	10	14.9	17.50		
Time 2 vs. 3					
Group 1	11	7.0	28.91	1.57	0.493
Group 2	10	19.8	36.19		
Time 3 vs. 4					
Group 1	11	19.8	44.12	2.59	0.168
Group 2	10	29.8	27.41		

There was a significant difference in the gains made during the first three weeks of the program (**Time 1** vs. **Time 2**). After six sessions with the computer program, Group 1 students had improved their rates of reading by a greater degree than had Group 2 students. However, by the tenth week (**Time 2** vs. **Time 3**), there was no significant difference between the gains made by both groups. Similarly, by the end of the experimental computer use (**Time 3** vs. **Time 4**), there was no significant difference in their gains. Thus, the major advantage accruing to Group 1 students was a decrease in the time it took them to achieve their increased reading rates. This appears as a clear substantiation of Hypothesis One.

However, Hypothesis Two was not supported. Students in the experimental group (Group 1) did not show a greater increase than those in the control group (Group 2) in reading rate. No statistically significant difference between the two groups could be found on any of the other measures used.

Tables 3, 4 and 5 present the results of two-tailed *t*-tests carried out on the performances of both groups of students on the Timed Reading Tests, before, during and after the experiment. Three scores were obtained for each group of students on all four CAI tests: reading rate (Table 3), accuracy (Table 4), and efficiency (Table 5). These tests were administered four times during the course of the study: as a pretest, as two interim tests, and as a posttest.

The third measure, reading efficiency, was obtained by multiplying reading rate times accuracy. This product of rate and accuracy serves to balance out any gains in rate that may have come at the expense of losses in accuracy. Thus, a student who reads at a rate of 200 WPM with 70% accuracy would receive a Reading Efficiency Score (**REF**) of 200 X .70 = 140. If, on a subsequent test, this student were able to read at, say 300 WPM, but obtained an accuracy score of only 50%, the **REF** score (300 X .50 = 150) would reflect the fact that this was not a great gain in reading efficiency.

Table 3

Analysis of Variance of Group Means on Computer-based Timed Reading Test Performance in Rate using Pretest, Two Interim, and Posttest Measures

				POOLED VARIANCE ESTIMATE
VARIABLE	MEAN	STANDARD DEVIATION	F VALUE	2-TAIL PROB.
PRETEST				
GROUP 1 (N=11)	171.3	26.2	1.80	0.374
GROUP 2 (N=10)	181.4	35.2		
INTERIM 1				
GROUP 1	204.4	33.9	1.45	0.566
GROUP 2	196.3	40.9		
INTERIM 2				
GROUP 1	211.4	36.4	3.24	0.081
GROUP 2	216.1	65.5		
POSTTEST				
GROUP 1	231.2	55.6	1.78	0.382
GROUP 2	245.9	74.2		

Table 4

Analysis of Variance of Group Means on Computer-based Timed Reading Test Performance in Accuracy using Pretest, Two Interim, and Posttest Measures

				POOLED VARIANCE ESTIMATE
VARIABLE	MEAN	STANDARD DEVIATION	F VALUE	2-TAIL PROB.
PRETEST				
GROUP 1 (N=11)	79.2	18.9	3.42	0.078
GROUP 2 (N=10)	87.3	10.2		
INTERIM 1				
GROUP 1	89.6	11.0	1.54	0.512
GROUP 2	83.1	13.6		
INTERIM 2				
GROUP 1	78.3	16.9	2.03	0.303
GROUP 2	83.5	11.9		
POSTTEST				
GROUP 1	73.1	19.2	2.11	0.277
GROUP 2	79.2	13.2		

Table 5

Analysis of Variance of Group Means on Computer-based Timed Reading Test Performance in Efficiency using Pretest, Two Interim, and Posttest Measures

			POOLED VARIANCE ESTIMATE	
VARIABLE	MEAN	STANDARD DEVIATION	F VALUE	2-TAIL PROB.
PRETEST				
GROUP 1 (N=11)	133.5	30.7	1.42	0.588
GROUP 2 (N=10)	158.0	36.6		
INTERIM 1				
GROUP 1	182.1	31.0	2.05	0.280
GROUP 2	163.2	44.4		
INTERIM 2				
GROUP 1	165.6	47.1	1.24	0.735
GROUP 2	178.8	52.5		
POSTTEST				
GROUP 1	167.5	47.2	1.24	0.739
GROUP 2	192.2	52.5		

On all the above measures, no significant difference between the two groups could be found. Differences between the two groups on measures of rate, accuracy and efficiency, done once before, twice during, and once after the experiment, were found to be less than significant: [*F*'s (1,19) = 1.80, 1.45, 3.24, and 1.78, *p* > .05] for measures of rate; [*F*'s (1,19) = 3.42, 1.54, 2.03, and 2.11, *p* > .05] for measures of accuracy; [*F*'s (1,19) = 1.42, 2.05, 1.24, and 1.24, *p* > .05] for measures of efficiency. *T*-values for both pooled and separate variance estimates yielded two-tailed probabilities that were also well below significance.

The second hypothesis also stated that students in the experimental group would perform significantly better on non-computer-based tests of reading ability, especially reading rate, as measured by the Stanford Diagnostic Reading Test and by three additional passages taken from Be a Better Reader. However, again no reliable differences were found.

Table 6

Analysis of Variance of Group Mean Pretest Scores in Reading Rate, Comprehension, and Vocabulary on the Stanford Diagnostic Reading Test and in Reading Rate and Comprehension on Text Materials from Be a Better Reader

EFFECT .. GROUP

Univariate F-tests with (1,19) D.F.

Variable	Hypoth. MS	Error MS	F	Sig. of F
SDRT				
Rate	.42	89.82	.01	.946
Comprehension	38.50	55.79	.68	.418
Vocabulary	71.00	46.22	1.54	.230
BBR				
Rate	964.96	1951.70	.49	.490
Comprehension	477.27	220.46	2.16	.158

Multivariate tests of significance were performed to determine, first, if there were any group differences on the Stanford Diagnostic and Be a Better Reader pretest scores. The multivariate analyses on the above five measures show that the two groups did not differ from each other: [F (5,15) = .68, $p > .05$]. On the Stanford Diagnostic Reading Test, measures were obtained for both groups in reading rate, in reading comprehension, and in reading vocabulary. To determine if there was any source of variance between the two groups on these measures, univariate analyses of variance were examined. The results show that no reliable differences can be found on any of these three measures (rate, comprehension, or vocabulary): [F's (1,19) = .01, .68, and 1.54, respectively, $p > .05$]. On only one measure do the two groups appear to approach being significantly different - the Comprehension subtest of the SDRT , and this (Sig. of F = .158) is still well beyond what can be interpreted to be statistically significant.

Similarly, on tests of reading rate using ordinary textual materials as found in the three passages taken from Be a Better Reader (BBR), no significant difference was found to exist in either reading rate or in reading comprehension, [F's (1,19) = .49 and 2.16, respectively, $p > .05$]. Thus one can conclude that the two groups did not differ from each other on measures of reading ability prior to the experiment.

After the study was over, students in both groups showed improvements in their reading abilities, as measured by both the Stanford Diagnostic Reading Test and the Be a Better Reader materials at the conclusion of the experiment. However, none of the scores obtained by the experimental group was found to be significantly different from those of the control group, as shown in Table 7.

Table 7

Analysis of Variance of Group Mean Posttest Scores in Reading Rate, Comprehension, and Vocabulary on the Stanford Diagnostic Reading Test (SDRT) and in Reading Rate and Comprehension on Text Materials from Be a Better Reader (BBR)

EFFECT .. GROUP

Univariate F-tests with (1,19) D.F.

Variable	Hypoth. MS	Error MS	F	Sig. of F
SDRT				
Rate	7.09	53.69	.13	.720
Comprehension	96.44	68.24	1.41	.249
Vocabulary	13.72	58.28	.24	.633
BBR				
Rate	1.31	2915.50	.00	.983
Comprehension	237.70	179.34	1.33	.264

Here, again, multivariate tests of significance were performed to determine if there were any group differences on the Stanford Diagnostic and Be a Better Reader posttest scores. Again, the multivariate analyses on these measures showed that the two groups did not differ from each other: [F (5,15) = .27, $p > .05$]. Also, the results of the univariate tests showed that no reliable differences could be found on any of the three measures in the Stanford Diagnostic Reading Test (rate, comprehension, vocabulary): [F's (1,19) = .13, 1.41 and .24, respectively, $p > .05$]. Nor could they be found in the measures of rate and comprehension using the three passages from Be a Better Reader: [F's (1,19) = .00 and 1.33, respectively, $p > .05$].

However, students in both groups did make average gains in reading rate of one grade equivalent after the six-week period of this study, with no significant change in comprehension. Table 8 shows their scores in reading vocabulary and comprehension before and after the study, and their gains in these areas:

Table 8

Group Gains in Reading Vocabulary and Comprehension measured in Grade Equivalents on the Stanford Diagnostic Reading Test (SDRT)

	VOCABULARY			COMPREHENSION		
	PRETEST	POSTTEST	GAIN	PRETEST	POSTTEST	GAIN
GROUP 1 (N=11)						
AVERAGE	6.2	7.7	1.6	5.7	5.6	-0.1
MINIMUM	4.0	4.0	-0.5	3.2	3.1	-1.9
MAXIMUM	8.4	12.9	4.7	8.3	7.2	2.6
STAND. DEV.	1.2	2.2	1.7	1.6	1.3	1.4
GROUP 2 (N=10)						
AVERAGE	7.0	8.1	1.1	6.4	7.1	0.7
MINIMUM	5.5	5.4	-2.7	2.8	2.7	-1.4
MAXIMUM	10.2	12.2	4.3	8.3	12.1	4.8
STAND. DEV.	1.4	1.9	1.9	1.7	2.7	2.1
BOTH GROUPS (N=21)						
AVERAGE	6.6	7.9	1.3	6.0	6.3	0.3
MINIMUM	4.0	4.0	-2.7	2.8	2.7	-1.9
MAXIMUM	10.2	12.9	4.7	8.3	12.1	4.8
STAND. DEV.	1.4	2.1	1.8	1.7	2.2	1.8

The average grade placement for students in Group 1 was 9.6 (S.D.=0.77), and average grade placement for students in Group 2 was 10.4 (S.D.=0.75). Thus, students in Group 1 had average reading comprehension scores that were **3.9** G.E. levels below their average grade placement; students in Group 2 had average reading comprehension levels that were **4.0** G.E. levels below their average grade placement. Similarly, Group 1 students had average reading rate scores that were **2.4** G.E. levels below their average grade placement; Group 2 students had average reading rate scores that were **3.0** G.E. levels below their grade placement.

Six weeks later, Group 1 students (average grade placement now 9.8) had reduced their deficits in reading rate to **1.7** G.E. below grade; Group 2 students (average grade placement now 10.6) had reduced their deficits in reading rate to **1.9** G.E. below grade. However, students in both groups had made only minor changes in their reading comprehension performance: Group 1 students had actually reduced their scores by an average of **0.1** G.E., and Group 2 students had increased theirs by an average of only **0.7** G.E. on SDRT comprehension measures.

Students in both groups did show interesting average gains in reading vocabulary as measured by the SDRT. Group 1 students had obtained an average vocabulary score of 6.2 G.E. on the pretest, 7.7 on

the posttest, and thus were **2.1** grade levels below their average grade placement by the end of the six weeks. Group 2 students had obtained an average vocabulary score of 7.0 G.E. on the pretest, 8.1 on the posttest, and thus were **2.5** grade levels below their average grade placement by the end of the six weeks.

MAINTENANCE:

A follow-up set of reading rate and accuracy tests was administered to all members of both groups, five months after the experiment, to see if there were any differences in their abilities to maintain their gains in reading rate. These maintenance tests consisted of one more CAI reading rate and accuracy test and an additional passage taken from Be a Better Reader. Similar tests of significance were performed and analyzed. The results appear in Table 9.

This maintenance testing took place five months later than the original experiment, and by this time, one of the students had moved to another school district and could not take part in the re-testing procedures. As a result, the maintenance test analyses are based on the results of 20, not the original 21, participants. Univariate tests of significance were performed to determine if there were any group differences on the Be a Better Reader and CAI maintenance test scores. Results are shown in Table 9, below.

On the Be a Better Reader test, measures were obtained for both groups in reading rate and reading accuracy. Similarly, on the CAI test, measures were obtained in reading rate, in reading accuracy). To determine if there was any source of variance between the two groups on these measures, both multivariate and univariate analyses of variance were run. The multivariate analyses on these four measures show that the two groups again did not differ from each other: [F (4,15) = 1.44, $p > .05$]. The results of the univariate test analysis also show that no reliable differences can be found on either of the measures of rate or accuracy: [F's (1,18) = .83 and .84, respectively, $p > .05$], for the BBR measures; and [F's (1,18) = .57 and 2.64, respectively, $p > .05$], for the CAI measures.

Table 9

Analysis of Variance of Group Means on Maintenance Measures of Reading Rate and Accuracy on Text Materials from Be a Better Reader (BBR) and on Computer-based Timed Reading Tests (CAI)

EFFECT .. GROUP

Univariate F-tests with (1,18) D.F.

Variable	Hypoth. MS	Error MS	F	Sig. of F
BBR				
RATE	5516.68	6658.50	.83	.375
ACCURACY	280.32	332.97	.84	.371
CAI				
RATE	2801.02	4889.71	.57	.459
ACCURACY	815.88	309.62	2.64	.122

Since there again were found to be no statistically significant differences in these Maintenance test results, it can be concluded that both methods of instruction employed in this study were equally successful in allowing students to maintain the gains in reading rate they had made during the experiment. Accuracy scores were not significantly different from those obtained in previous portions of the experiment. Table 10 shows the maintained average reading rates, compared to pre-experimental and post-experimental rates. Clearly, the students in both groups were able to maintain their reading rates on the textual materials selected from Be a Better Reader. There was some loss of reading speed on the CAI materials, but this may well have resulted from a lack of practice with a mechanical reading method which is different from the ordinary methods.

Table 10

Group Means on Pretest, Posttest, and Maintenance Measures of Reading Rate using Computer-based Timed Reading Tests (CAI) and Textual Materials from Be a Better Reader (BBR)

	BBR			CAI		
	PRETEST	POST	MAINTEN.	PRETEST	POST	MAINTEN.
GROUP 1 (N=11)						
AVERAGE	153.3	175.0	196.7	171.3	231.2	202.5
MINIMUM	85	103	146	137	163	106
MAXIMUM	234	294	296	210	376	361
VARIANCE	1971.7	2632.0	1721.5	624.7	2813.1	3319.2
STAND. DEV.	44.4	51.3	41.5	25.0	53.0	57.6
GROUP 2 (N=9)						
AVERAGE	140.8	176.6	230.1	180.7	243.9	226.3
MINIMUM	61	111	100	114	138	140
MAXIMUM	189	268	434	233	390	373
VARIANCE	1698.8	2926.9	11213	1230.7	5469.2	5722.7
STAND. DEV.	41.2	54.1	105.9	35.1	74.0	75.6
BOTH GROUPS (N=20)						
AVERAGE	147.7	175.7	211.8	175.5	236.9	213.3
MINIMUM	61	103	100	114	138	106
MAXIMUM	234	294	434	233	390	373
VARIANCE	1887.5	2765.3	6268.5	919.3	4048.3	4540.8
STAND. DEV.	43.4	52.6	79.2	30.3	63.6	67.4

Analyses of within-group differences between the means on the above results were done to determine if there were any significant changes in each group's maintained reading rates compared to their pretest rates. These two-tailed *t*-tests indicated that there was no significant difference for either group on the CAI measures. There was, however, a significant difference for both Groups 1 and 2 in the measures of the BBR materials [t (1,10) = -4.13, for Group 1, and t (1,8) = -3.30, for Group 2, p's < .05]. Again, these results indicated that both groups benefitted equally from the procedures used in the study.

Thus, the results of this study confirm the utility of the computer-based reading materials in improving the reading rates of adolescent students with LD. Hypothesis One was supported: the experimental group succeeded in improving their reading rates to near normal sooner than did the control group. Hypothesis Two, however, was not supported: the experimental group did not succeed in improving their reading abilities (vocabulary, comprehension and/or rate) beyond the improvements made by the control group.

CHAPTER V

DISCUSSION

The first hypothesis of this study was:

Students in the experimental group (Group 1) would show an increase in reading rate sooner than those in the control group (Group 2). The dependent measure of this was the two Timed Reading Tests taken on the computer during the progress of the experiment.

The results from measures of reading rate using the computer program indicated that, while both groups of students made gains in reading rate both during and at the end of the experiment, neither group made gains that were significantly different from the other. However, there was a significant difference in the time required by Group 1 students to increase their reading rates. This group enjoyed a clear advantage in the first two weeks of the study. By using the entire program, they were able to bring their rates of reading to within

normal rates much sooner than were students in Group 2. On all the other measures, no significant differences between the two groups could be found, as discussed in the Results chapter. No reliable differences between the two groups on measures of rate, accuracy and efficiency were found across the other three times they were measured.

Thus, one can conclude that the use of warm-up sessions, eye-movement lessons, and column-reading lessons by Group 1 students did allow them some advantage in learning to read more quickly. They appear to have been able to do so sooner than did the students in Group 2 who used only the basic practice exercises. However, both groups received equal benefits from their use of the program over the full six weeks of the study, and both maintained some of their gains in reading rate five months later.

The second hypothesis of the study was that students in the experimental group (Group 1) would show a greater increase than those in the control group (Group 2) in reading rate, with no loss of comprehension, as measured by three further measures:

a. A fourth and final Timed Reading Test taken on the computer at the conclusion of the experiment.

b. Three passages from Be a Better Reader, Book 2.

c. The Reading Rate subtest of the Stanford Diagnostic Reading Test, Blue level.

The results from posttest measures of reading rate on textual and diagnostic materials showed that neither group of students differed significantly in their reading abilities after the study. Multivariate tests of significance determined there were no group differences on the Stanford Diagnostic and Be a Better Reader posttest scores. The results from maintenance measures of reading rate on textual and computer measures also showed that neither group of students differed significantly in their reading abilities five months after the study.

Therefore, the second hypothesis was not supported. Students in the experimental group did not perform significantly better on tests of reading ability, especially reading rate, as measured by the Stanford Diagnostic Reading Test and by three additional passages taken from Be a Better Reader.

The obvious conclusion to be drawn from these results is that, with the exception of some initial advantage gained by Group 1 students in the first two weeks, it did not matter in which treatment group a student was placed. While both groups made gains in reading rate during and after the experiment, as measured by computer, standardized and textual materials, neither group differed from the other in reading rate or comprehension, either before or after the experiment. Thus, one can conclude that, after the first two weeks of the study, the extra time spent by the experimental group on warm-up, eye-movement and column-reading lessons, provided them no greater

benefit than merely practicing reading passages at increasingly rapid rates provided the students in the control group.

It has been noted that there was considerable variation in the results obtained by individual students in both groups, before, during and after the experiment. Given the wide range of reading abilities demonstrated by the various students in both groups, this was to be expected. Although there was some reduction in reading rate after the five month wait, most of the students in both groups had maintained a faster reading rate than they had possessed before the study began.

Because students in both groups made gains in reading rate on average of one grade equivalent in the six-week period of this study, despite little improvement in comprehension performance, it can still be argued that the methods employed here were beneficial in that they induced in the students with LD more efficient reading strategies. These students did read inefficiently before partaking in the experiment. Specifically, Group 1 students had average reading rate scores that were **2.4** G.E. levels below their average grade placement; Group 2 students had average reading rate scores that were **3.0** G.E. levels below their grade placement. Similarly, students in Group 1 had average reading comprehension scores that were **3.9** G.E. levels below their average grade placement; students in Group 2 had average reading comprehension levels that were **4.0** G.E. levels below their average grade placement.

Six weeks later, Group 1 students (average grade placement now 9.8) had reduced their deficits in reading rate to **1.7** G.E.; Group 2 students (average grade placement now 10.6) had reduced their deficits in reading rate to **1.9** G.E. However, students in both groups had made only minor changes in their reading comprehension performance: Group 1 students actually lost an average of **0.1** G.E., and Group 2 students gained an average of only **0.7** G.E. on SDRT comprehension measures.

Thus, while students in both groups made appreciable gains in reading efficiency as a result of the methods used in the study, they were not greatly aided in their abilities to read with better comprehension. Improving reading comprehension, while not directly dealt with in this study, is still the major goal of reading instruction. Additional training in comprehension skills appears to be necessary if these students with LD are to overcome their reading comprehension deficiencies.

In this study, no attempt was made to increase students' reading vocabulary skills. Interestingly, students in both groups did show average gains in reading vocabulary as measured by the SDRT. For Group 1 students, the average gain in vocabulary scores by the end of the six-week study was **1.6** grade levels; for Group 2 it was **1.1** grade levels. However, in reading vocabulary, group 1 students were still 2.1 grade levels below their average grade placement, while Group 2

students were 2.5 grade levels below their average grade placement in reading vocabulary.

The students with LD in this study were able to increase their reading vocabulary skills to levels closer to those expected of students at their grade levels. These increases in their reading rate and vocabulary scores thus allowed them to decrease the time and attention they required to read individual words, as well as longer passages of connected discourse. In this sense, they were decreasing the load on their short-term memories, because they were able to read the same amount of material in less time. Despite these increases, their reading comprehension scores did not improve. Their reading comprehension scores still lagged behind their grade-level peers by at least 3.0 grade levels. The fact that they were able to read more quickly, with measurably increased vocabulary skills, without any great gain or loss in comprehension, suggests that their gains in reading rate were a result of improving their inefficient reading habits.

The results of this study suggest it is necessary, but may not be sufficient, to increase these students' reading rates for comprehension to improve. It may be additionally necessary to increase comprehension skills in these students at the same time as they are taught to increase their reading rates. Thus the results reinforce the caution raised by Perfetti & Lesgold (1977) that simply improving reading speed may not necessarily result in improved comprehension.

It may be also necessary to allow more time for learning rapid reading skills before greater gains in reading comprehension can be made. The results of this study came after only six weeks of teaching and practice. By extending this teaching over six months, it may be possible to realize greater increases in reading comprehension. Because reading skills, for adolescents in particular, have psychological overtones, it may be that increasing reading rate leads to increased self-image and motivation to read. If so, improved reading comprehension may follow as a result of improved willingness to read.

Further research on the relationship between speed of information processing and reading comprehension is in order. The eye-movement exercises in the computer program failed to increase the comprehension abilities of students with LD. These exercises may have served to induce a more efficient reading strategy, e.g. reading whole phrases at a time rather than word-by-word, which is a typical reading strategy in poor readers. Thus, in face of these students' improved reading rates, there may be other factors that inhibit their achieving greater comprehension. These factors need to be identified and researched.

The results of this study do not indicate that one or the other of the two methods used was clearly better than the other. While students in Group 1 gained an advantage in the first two weeks by

using the computer program in its entirety, they did not retain any greater gains in reading efficiency after six weeks than did Group 2 students. It is suggested that future attempts be made to replicate the results of this study, to see if similar results are obtained by using computer programs to assist these kinds of students in developing more rapid reading skills. It is also suggested that future research investigate the effects of such teaching over longer periods of time. This kind of information will help identify the more appropriate and more efficient tools to be used in instructing adolescents with LD. Moreover, there should be an additional treatment group in which comprehension skills training is given after students have gone through the entire Speed Reader II program. This will make it possible to directly test what Perfetti & Lesgold (1977) suggested. It is recalled that they suggested comprehension skills training may be necessary for reading improvement (additional to improvement in reading rate) to occur.

In the meantime, the results of this study suggest that some computer assisted instructional methods designed to increase reading rate have merit. Care needs to be taken in how such programs are designed and in how they are used. Some evidence exists in this study that such programs can be used to assist adolescents with LD to increase their reading rates more quickly than by simply practicing more rapid reading. The amount of time spent on learning to read more

quickly in this study may not have been enough to allow these students to fully realize their potential to improve their reading comprehension performance. Improved reading performance, even if in relatively superficial areas such as rate, may be important in helping these students develop a greater willingness to read, and thereby a greater ability to read.

APPENDIX A

Student Comments in support of the use of CAI to improve reading rate.

During and after the study, most students reported they believed they were reading more smoothly and efficiently. Often similar students in other studies have made gains in reading comprehension or vocabulary, but these gains and their benefits were subtle, and not easily perceived by the students themselves. In this study, the students appear to have found the gains to be quite perceptible. The following comments were made by the students after the initial experiment:

> I don't read everything over anymore. I used to go back and re-read each word; now, I read more smoothly.
>
> I like reading on the computer because it forces me to read faster and without looking back. Before, I often went back to make sure of a word, but now I don't really have to.
>
> I notice I can read books faster and more smoothly now.
>
> I can read faster now and (still) get the idea.

> I can read much better. Like, I've read a novel for the first time. I can skim for information in Social Studies.
>
> My Socials teacher says I'm reading better out loud in class. I can read without stopping on every fifth word like I used to.
>
> I really notice it in Science - I used to have to read it over again to understand it; now I just have to read it once.
>
> I do notice I'm reading faster. I used to take three weeks to read a novel in English, but now I don't take so long.
>
> I read novels more quickly and efficiently. My memory of the story is better.

These comments indicate that the students themselves are now more aware of the nature of their own reading methods and feel more in control of the methods they use in reading different texts. This in itself makes the methods used in this study worthwhile. With continued practice, these students could take even more responsibility for their own progress. For students whose reading abilities and attitude towards reading have never been particularly certain, this is a major accomplishment.

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