

THE UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

ACQUISITION AND RETENTION OF READING PERFORMANCE ON TWO
RESPONSE DIMENSIONS AS RELATED TO "SET"
AND TACHISTOSCOPIC TRAINING

A THESIS

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

degree of

DOCTOR OF EDUCATION

BY

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Norman, Oklahoma

1955

ACQUISITION AND RETENTION OF READING PERFORMANCE ON TWO
RESPONSE DIMENSIONS AS RELATED TO "SET"
AND TACHISTOSCOPIC TRAINING

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ACKNOWLEDGMENT

I wish to express my sincere appreciation to the following persons for their invaluable guidance and assistance in this study: to Dr. Arthur W. Heilman, who directed the study; to Dr. Gail Shannon, who served as chairman; and to Dr. Edmund V. Mech, who directed the statistical treatment and method of reporting. Each gave liberally of his time and advice. In addition appreciation is expressed to Dr. William B. Ragan, and to Dr. Willard R. Lane for reading the manuscript, and for their counsel as members of the committee.

Appreciation is also extended to Miss Nettie B. Lewis and the English instructors of Capitol Hill High School, Oklahoma City, Oklahoma for their cooperation in the study. Without their assistance this study would not have been possible.

To my wife, Frances, I am indebted for continuous encouragement and helpfulness in all stages of the study.

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ACQUISITION AND RETENTION OF READING PERFORMANCE ON TWO RESPONSE
DIMENSIONS AS RELATED TO "SET" AND TACHISTOSCOPIC TRAINING¹

CHAPTER I

INTRODUCTION

In the past decade reading has received increased attention on all educational levels. This appears to result partially from a growing awareness of the role of reading in meeting personal needs and social aims, but primarily from the strategic relationship it bears to scholastic success.

Educational leaders are becoming aware of the perennial nature of the reading problem. In recognition of its importance many have added special remedial reading courses to the curriculum in the belief that this will alleviate reading problems.

Reading programs have become broader and more flexible because of the variety of materials and types of instruction. In an attempt to enrich and supplement reading instruction many schools are utilizing mechanical devices extensively in their programs. Among the more commonly used are the metronoscope, reading rate controller, reading

¹"Set" is defined operationally in this investigation as relating to any performance change in reading rate which might occur from a specific set of verbal instructions administered by the teacher to the pupils.

accelerator, reading films, metronome, and the tachistoscope. From an examination of the literature concerning the use of these devices it appears that the tachistoscope has stimulated somewhat more conjecture than most other devices often found in reading improvement programs. During World War II this particular device received wide recognition when it was utilized in training programs of the military forces. Subsequent articles and reports of the potentialities of this device quickly attracted the attention of educators and its use in schools and industry increased rapidly. Since its introduction into the classroom, it has been utilized in a wide variety of teaching fields with divergent claims of its "success." However, the most striking claims for its merit have been made in the field of reading. Upon the basis of studies found in the literature, schools have accepted the value of the tachistoscope and have purchased this device, more or less, as a cure-all for many of the infirmities existing in various reading programs.

As the tachistoscope continues to be employed in reading improvement programs the question is frequently asked, "What results can be expected from its use that would not likely occur without it?" Although definite claims have been made that reading improvement has been promoted by the tachistoscope, the crux of the controversy seems to lie in whether the improvement was primarily due to the device or whether the improvement should have been accredited to concomitant or secondary factors in the training. Reports in literature are conflicting with respect to the efficacy of tachistoscopic training on reading improvement. Among the more enthusiastic supporters of this method are Renshaw (25,26), Rust

(48), MacLatchy (21), Melcer and Brown (23), Wittels (41), and Brown (9) who report the tachistoscope to be an effective tool for teaching reading. On the other hand Weber (38), Freeburne (14), Sutherland (34), and Goins (46) did not find its use to be statistically superior to other methods of teaching reading. Dearborn (12) and Sommerfeld (43) support the theory that motivation from this novel type of training may be as responsible for gains as the machine itself.

A need for continued study arises from the inconclusiveness of some of the earlier studies. In most of these investigations, the data were collected from experiments which were apparently not adequately controlled with respect to the "tachistoscopic" variable. For example, Sommerfeld (43) in his evaluation of tachistoscopic training for reading improvement, advocates a critical investigation of the intrinsic value of tachistoscopic training because commercial organizations are enthusiastically promoting tachistoscopic devices and materials for use in schools.

The value of tachistoscopic training continues to be affirmed by some teachers and questioned by others. While some research has been done, the bulk of its evaluation comes merely from classroom use, and teacher and student testimonies. Tachistoscopic training raises more questions than it answers and as McClusky (2, p. iii) has so aptly stated: "It should serve as a stimulus to students in search of problems for research."

Related Research

Research related to the evaluation of the tachistoscope has been

catagorized by Sommerfeld (43) as follows: (1) investigations involving tests of tachistoscopic perception, (2) investigations of the effect of tachistoscopic training on the span of perception, (3) investigations of the effect of tachistoscopic training on reading achievement, and (4) investigations of the relationship between tachistoscopic span and reading ability. This study was primarily concerned with the effect of tachistoscopic training on reading rate and comprehension. Therefore, the following references to research are confined to Sommerfeld's third catagory above, namely, investigations of the effect of tachistoscopic training on reading achievement.

One of the first experiments concerning the tachistoscope dates back to 1859 with the work of Volkmann (48). Other early tachistoscopic investigations were conducted in the field of psychology during the later half of the 19th century. At the turn of the century a study by Aiken (7) stimulated new thought toward the value of short exposure training by the use of a revolving blackboard. Whipple (40) furthered this idea in a study conducted in 1910. Foster (15) and Dallenbach (10) continued visual perception training by the short exposure method initiated by Whipple. In 1915 Rusk (27) suggested that a magic lantern with a photographic shutter might be more practical in teaching larger groups than methods used previously. One of the first reports of the tachistoscope as a teaching tool in the field of reading was conducted under the direction of Carroll (2) in 1938. Results of this brief experiment indicated that pupils who were given tachistoscopic training made "marked improvement in reading efficiency in general." Although

these studies stimulated some interest, it was not until the recent reports of Renshaw (25,26) and his colleagues that the tachistoscopic techniques for reading improvement received such enthusiastic claims. In addition to his widely publicized tachistoscopic training with the Armed Forces during World War II, he also reported good results from training programs for children, college students, industrial and professional workers, and adult classes. These studies by Renshaw gave impetus to further investigations. MacLatchy (21) used Renshaw's technique for reading improvement and claimed that tests given to children receiving tachistoscopic training placed them 6 to 8 months above their grade level. Rust (48) conducted an investigation to determine to what extent college and adult groups might improve their reading rate and comprehension. Reading instruction with special emphasis on tachistoscopic training was given six groups of college students and adults. He concluded that a high correlation was found between reading rate and tachistoscopic training, thereby justifying the use of this equipment to increase the speed of reading. Wittels (41) reports results of a training course carried on by Schwarzbek at the General Electric Company in which a group of 120 employees increased their reading speed nearly one third and their comprehension averaged an 82% gain. Brown (9) reported amazing progress in rate and comprehension with an adult reading class. The class showed an average gain of 2 years in 17 class sessions. The claims made by Schwarzbek and Brown were based on training courses in which no attempt was made to control variables injected into the training. In the officer training courses at the U. S. Air University (44)

significant gains in rate without sacrificing comprehension were reported. Following a study of tachistoscopic training in the first grade reading program, Melcer and Brown (23, p. 1219) concluded that "tachistoscopic training is unquestionably an invaluable aid in promoting skills in many phases of work in the school curriculum." Although the gains of the experimental group was compared with a control group they actually did not have two equated groups. More than half of the experimental group were Mexican children most of whom spoke Spanish at home, while the control group consisted entirely of American children.

These investigations and endorsements fervently support the claims that tachistoscopic training is invaluable. However, some of these studies included other techniques of training and the relative contributions of other devices were not investigated.

Many experiments involving the tachistoscope have been well done, although a larger percent are less cogent because the experimental group had been compared with only one control group which had been given no training. Among the more objective studies which included more than one experimental group are the studies conducted by Weber (38), Freeburne (14), Sutherland (34), and Goins (46).

Weber (38) conducted a study in which the first experimental group was given tachistoscopic training, and a second experimental group followed L. C. Pressey's Manual of Reading Exercises for Freshmen, while a third group served as controls. Following the training period, tests revealed no essential differences produced by the two experimental methods. In the analysis of his data, Freeburne (14) found no signifi-

cant differences between the experimental and control groups in an investigation of the influence of tachistoscopic training on college freshmen. Following Renshaw's technique of perceptual training, Goins (46) conducted an investigation with first grade pupils concerning the relation of visual perception to progress in reading. She (46, p. 163) concluded: "Tachistoscopic training received by children in this investigation had no statistically significant effect on their reading performance." In a study by Sutherland (34) involving two experimental groups and a control group, one experimental group was given tachistoscopic training and the other had training centered around Harvard Reading Films and the other Wilking Websters College Developmental Reading. Sutherland concluded that perceptual span training given before direct instruction may facilitate the students' progress. Her data, however, do not statistically support such an inference.

Lewis (19) compared a training program using the flashmeter, metronoscope, and mimeographed eye-movement exercises with another program which stressed comprehension rather than speed. The comprehension group read selections of increasing difficulty with intent to increase comprehension. There was no control group. The results showed a reading rate increase of 24.7 for the reading-rate group and 69.1 for the comprehension group. The comprehension rate remained about the same for both groups.

Allen (7), reporting on a program at a service school, concluded that the tachistoscope, when compared with other methods of supervised reading practice was of little value. In a summary of a study with

Marine Corps officers, Manolakes (22) concluded that results failed to indicate that the groups who did not receive tachistoscopic training were penalized through the lack of such training. Although tachistoscopic training was expected to produce results, the data failed to provide any basis for this assumption.

In a handbook of tachistoscopic training techniques, Barnette (2, p. 12) supports the theory that the tachistoscope will substitute for good teaching in the following statement:

There are those who insist they can "get the same results without the tachistoscope." There is little question that a superlative teacher, who has a real zeal to help children better themselves, and who is willing to devote constant energy, limitless patience, and long hours to it, can achieve very fine results indeed without the tachistoscope. The same energy, patience, and hours devoted to the same students with the tachistoscope, however, may result in improvements which are sometimes considered "educational miracles."

It should be pointed out that while commercial firms are enthusiastically promoting the sale of tachistoscopes, on the basis of such statements as that made by Barnette, there has been considerably less objective testing as to the effectiveness of the device in itself.

Tinker (36) states there is a tendency on the part of many writers to emphasize the use of various machines without a clear understanding of their validity and limitations. He believes that uncritical use of such apparatus fosters the concept that reading is a mechanical process and diverts attention from the assimilation and thinking side of reading. He adds (36, p. 476): "Fortunately, a few writers are evaluating the use of these machines and cautioning teachers on the uncritical use of them."

Dearborn (12) reflects the thinking of those who feel that some

of the credit the tachistoscope is receiving should be given to secondary factors such as the "set" of the learner. He states (12, p. 1): "Motivation through the change of the "set" of mind or the intention of the learner is a more important factor in remedial reading than the particular methods and materials of instruction." This theory is endorsed in a statement by Sommerfeld (43, p. 21) as he remarks: "The motivation which is associated with almost any method that is tried may account for the resulting improvement as much as the method itself." He concludes his evaluation of tachistoscopic studies with this statement: "Quick exposure training, in and of itself cannot influence the process of reading except as certain secondary factors such as motivation are concerned." O'Brien (24) suggests various methods for motivating students for increasing the span of perception and reading abilities, giving recognition to the fact that these methods are as important as the perceptual training itself. Stroud (33), in a study dealing with reading rate, suggests that differences in mental "set" might well affect the outcome of reading rate scores. In a school wide reading improvement program Springstead (32) reported that speed and comprehension was greatly increased through verbal motivation. In an 8 week period 83 classes out of 85 attained scores above the standard for their grade as against 50 below standard at the start. Part of the training included having pupils read as rapidly and as understandingly as possible for an interval, usually 3 or 5 minutes in length. Each computed his reading score which was recorded on a graph and displayed in the classroom to show his day-to-day progress. Springstead attributed "pride in

achievement" as a factor that spurred the children on to greater gains. Of all the activities and methods utilized, motivation was the element which received the most credit for promoting progress. In an analysis of causes of slow reading, Sisson (28) states that several devices have been found useful in increasing speed of reading with no serious loss of comprehension. However, he stresses that the same results can be achieved with motivated rapid reading without any mechanical devices. Sisson (28, p. 212) concludes his analysis with this statement: "Assuming the correction of any visual and vocabulary deficiencies, motivated rapid reading appears to be the most salutary single medium for the attainment of reading proficiency."

Glock (17) recognized instructional "set" as a determining factor when he designed an experiment to compare the relative merits of the Harvard Reading Films, experimental films designed by the experimenter, and practice from a printed page. The first two groups were given instructional "set" for improving reading rate, while the third suppressed the "set" and directed its instruction solely toward the mechanics of reading.

In contrast to the voluminous amount of research done in reading, relatively few studies have dealt with the retention of gains from any improvement programs. There are theories that gains are maintained and even continue to improve (8) as contrasted with the belief that habits of long standing are not likely to be changed permanently by a few weeks of intensive training (28). It is truly unfortunate that there are so few studies available which include retention checks on gains from

tachistoscopic training. Weber (38, p. 458) agrees that the retention factor has been neglected in most studies but adds: "In a few who have given it some consideration it appears that high degrees of retention are to be expected." In the Dartmouth Study, Imus, Rothney, and Bear (38) reported reliable evidence that gains in speed and comprehension resulting from a 6 weeks training period were retained. The retention was measured by the Iowa Silent Reading Test after an elapse of 6 months. Unfortunately the evidence is made somewhat uncertain because the controls were not retested. In the article discussing the Dartmouth Study, Weber (38, p. 459) comments:

It is hardly to be expected that increased facility in reading acquired in so short a period as six weeks should persist without loss. All motor and mental skills acquired by intensive training are subject to such lapses.

Blayne (8) found that students who benefit from special training in reading either hold their new levels of accomplishment or continue to improve. However, he concluded the number of cases reported in the study was not sufficient to warrant definite conclusion. Blayne also did not isolate devices used. In a rather carefully controlled experiment, Westover (6) compared the merits of two types of training methods designed to improve rate and comprehension of college freshmen. Six months after the training period he tested for retention of gains. It was found that gains over initial testing made by both training groups and the control group were significant for both rate and comprehension. Deal (11) instructed college students in reading and study habits for one semester. These students were retested a year later and it was found that the comparison of means showed that gains made were substantially retained.

Sisson (28, p. 212) states in his analysis of the causes of slow reading:

It is questionable, however, that any of these methods, unless long continued, will result in permanent improvement. Habits of slow detailed reading are of long standing, and it is probably too much to expect that a few weeks of training will change them.

A number of general conclusions may be drawn from the research which has been aimed at clarifying concepts in tachistoscopic training. It has been demonstrated that improvement in reading has resulted in experimental studies in which the tachistoscope was utilized. Other investigations which compared the tachistoscope with various methods of teaching reading found no significant differences between the two teaching methods. Still other studies found results that slightly favored the methods without the tachistoscope.

Research in reading related to the tachistoscope varies greatly in quality. The outstanding weaknesses in various tachistoscopic studies seem to be: (1) variables were not well controlled in the light of statistics used, hence the "conclusions" were somewhat incomplete; (2) the measurement of the "permanence" of retention was not considered; (3) groups receiving tachistoscopic training were compared only with control groups who received no training; and (4) the research has sometimes been so preoccupied with the device itself, that the contribution of possible important variables such as "set" has been neglected.

Statement of the Problem

This study was concerned with the effect of the tachistoscope and the effect of "set" for speed on the improvement of rate and comprehension in reading. The purposes of the study were: (1) to determine the

effect of the tachistoscope with verbal "set" for speed on reading rate and comprehension; (2) to determine the effect of the tachistoscope without verbal "set" for speed on reading rate and comprehension; (3) to determine the effect of verbal "set" for speed without the tachistoscope on reading rate and comprehension; (4) to compare the results of these three procedures of teaching reading; and (5) to check the retention of gains in reading rate and comprehension produced by these three methods.

The null hypotheses to be tested were: (1) there is no significant difference in reading improvement between the experimental group A given tachistoscopic training without verbal "set" for speed, the experimental group B given tachistoscopic training with verbal "set" for speed, the experimental group C given verbal "set" for speed without tachistoscopic training, and the control group D given no training; and (2) there is no difference in the retention of gains between these experimental and control groups.

In view of the summary of the earlier research and investigations, the present study was concerned with the following conditions: (1) normal pupil groups and their teachers were utilized, (2) an effort was made to employ "set" as a variable, thus permitting its possible influence to be examined critically, (3) retention was considered an important evaluative measure, and (4) three experimental groups, each receiving a separate treatment, were compared with each other and with an independent control group.

With the above features incorporated, the problems of this investigation were approached keeping in sight the need for practical application to the classroom.

CHAPTER II

THE EXPERIMENTAL PROCEDURE

Design of the Experiment

To test the hypotheses stated in Chapter I, a study was designed which provided for three experimental groups to undergo instruction in reading improvement simultaneously, and one control group which would receive no special instruction in reading for the same period of time. This experimental design is presented in summary form on the following page.

The effects of these different treatments were measured in terms of the changes in reading rate and comprehension as measured by posttest I (Y_1) against the pretest (X). As a test for the permanency of the gains or losses effected through each of these methods of instruction, a second posttest (Y_2) was administered. As an index of reading rate and comprehension the Diagnostic Reading Test, Survey Section,¹ Form A was administered prior to instruction and the Diagnostic Reading Test, Survey Section, Form B was administered at the conclusion of the program of instruction. Diagnostic Reading Test, Survey Section, Form C was administered nine weeks after the termination of the program of instruction

¹Published by the Committee on Diagnostic Reading Tests, Inc., Kingscote Apartment 3G. 419 W. 119 Street, New York 27, New York.

SUMMARY OF EXPERIMENTAL PROCEDURES*

Group	Treatment	Measurement (X)	Eight Week Training Period (T)	Posttest Measurement I (Y ₁)	Nine Week Interval (I)	Posttest Measurement II (Y ₂)
A	Tachisto- scope	<u>Diagnostic</u> <u>Reading Test</u> , <u>Survey Sec-</u> <u>tion</u> , Form A	Groups A, B, and C each received 20 minutes of instruc- tion on the improve- ment of reading skills two days a week. Groups A and B employed the use of the tachisto- scope. Group B em- phasized speed	<u>Diagnostic Read-</u> <u>ing Test</u> , <u>Survey</u> <u>Section</u> , Form B was administered to all subjects to obtain rate and comprehen- sion scores for the purpose of checking gains or losses ac- quired during the "acquisition" period.	No special instruction in the im- provement of reading was given.	<u>Diagnostic</u> <u>Reading Test</u> , <u>Survey Sec-</u> <u>tion</u> , Form C was adminis- tered to all subjects for the purpose of checking retention of gains or losses
B	Tachisto- scope and verbal "set" for speed	was adminis- tered to all subjects to obtain ini- tial rate and comprehension scores.	whereas group A did not. Group C emphasized speed in verbal instruc- tion and employed 1000 word rate- check each train- ing period. Group D served as control and received no special instruction in reading.			acquired dur- ing the "acquisition" period as evidenced by posttest I.
C	Verbal "set" for speed plus rate check					
D	Control-- no special instruc- tion in reading improve- ment					

*The procedure presentation follows a left-to-right sequential pattern.

to serve as a check on retention of gains or losses effected through the different treatments in the program.

Selection of Subjects

Three hundred and ninety-six students at Capitol Hill High School, Oklahoma City, Oklahoma were selected to participate in the study. Tenth grade students were selected on the assumption that they would be somewhat less "aware" of subject matter content than upper-classmen, since this was their first year in Capitol Hill High School. Subjects were not informed that this special reading instruction was foreign to the regular course content, but were led to believe that it was a part of the general program. There were fewer interruptions in the 10th grade class routine than in the 11th and 12th grade classes. Choice of periods for enrollment operated more freely with sophomores than with upper classmen. Enrollment was somewhat less selective with respect to ability grouping. Of the 16 classes of 10th grade English in the High School, two classes of accelerated students and two classes of retarded students were excluded from the experiment leaving a total of 12 classes whose enrollment was a typical representation of 10th grade English students.

Three classes were selected for each group. The classes chosen for groups A and B were selected on the basis of physical conditions of the room such as lighting, window shades, electrical outlets, portable seats, et cetera, conducive to optimum tachistoscopic training. Classes in groups C and D were placed in their respective groupings by random assignment. The instructors used in the experiment were those

who regularly taught the groups.

Age spread and sex were comparable in each group. The initial reading scores as measured by Sections 1 and 3 of Form A of the Diagnostic Reading Test indicated no statistically significant difference in the mean score of each group.

As an additional experimental control, subjects who were absent from one or more sessions were eliminated from the study. This resulted in unequal group N's, and in order to facilitate statistical analysis, the groups were made proportional or equalized by using a table of random sampling numbers.

A Description of the Experimental Treatments

Four groups of 10th grade English students attending Capitol Hill High School, Oklahoma City, Oklahoma received instruction in reading improvement as follows:

Treatment for Group A

Experimental group A was given sixteen tachistoscopic training sessions of twenty minutes each, twice a week, extending over a period of eight weeks. At each session introductory remarks preceded the exposure of slides. These remarks which never exceeded five minutes dealt with mechanical, psychological, and sociological aspects of reading. Exposure of tachistoscopic slides averaged sixteen minutes for each session. Accompanying instructions for each slide stressed good habits of reading, however mention of speed was excluded. Tachistoscopic training began with presentation of digits and nonsense forms and progressed in difficulty through words, phrases, complex sentences and ended with

paragraphs.

Treatment for Group B

Experimental group B differed from experimental group A in that a verbal "set" for speed was provided in the introductory remarks and in the accompanying instruction. The objective of the verbal instructions was to establish a "mind-set" for more rapid reading performance on the part of each subject. The verbal instructions were designed to create this "mind-set" by encouraging and urging students to increase their reading speed in all their reading in and out of class.

Treatment for Group C

Experimental group C differed from Experimental groups A and B in that no tachistoscopic training was provided. No special instructional materials were employed other than those used in regular classroom procedures. Verbal instructions by the teacher promoted a "set" for speed. These instructions dealing with correct reading mechanics and other simple rules to be observed in effective reading never exceeded ten minutes. Following these remarks aimed at motivation, a 1000 word rate-check was given. This served the dual purpose of checking reading speed and provided usage for the reading techniques discussed. A supplementary American literature book was utilized for this rate check.

Treatment for Group D

Experimental group D served as the control group and received no special reading instruction of any type, but was given the pretest (X),

posttest I (Y_1), and posttest II (Y_2).

Testing Procedures

All subjects were tested Thursday and Friday preceding the first week of training. The test administered to obtain the initial measurement was the Diagnostic Reading Test, Survey Section (grade 7 through college freshmen) Sections 1 and 3 of Form A. This test was scheduled with a series of tests being administered by the High School Guidance Department and the administrator was accepted as part of the guidance staff.

The formal "Directions for Administration" as published by the Committee on Diagnostic Reading Tests were followed in administering the test to all subjects. Separate answer sheets were employed.

All subjects were given the posttest I (Y_1) the day following their sixteenth lesson. The test administered for the purpose of checking gains or losses against the initial measure was the Diagnostic Reading Test, Survey Section (grade 7 through college freshmen), Sections 1 and 3 of Form B. The formal "Directions for Administration" were followed as in the initial measurement. The only additional introductory remark was to the effect that the test was a periodic check similar to those made in other subject matter areas.

Nine weeks beyond posttest I (Y_1) all subjects were again tested. The test administered, for the purpose of checking retention of gains or losses as evidenced on posttest I (Y_1) against the pretest (X), was the Diagnostic Reading Test, Survey Section (grade 7 through college freshmen), Sections 1 and 3 of Form C. The same introductory remark was

made, i.e., "You are being given another periodic check in reading." The formal "Directions for Administration" were followed as in the two previous measurements.

Program of Instruction

Materials Used

Tachistoscopic exposures.--Principles of tachistoscopic training described by Barnette (2) in a manual for tachistoscopic teaching guided the construction of slides. The combination of numbers with phrases and sentences was used in light of research (45) in which it has been concluded that a combination method of numbers and phrases is the best method to employ in tachistoscopic training. Modifications were made in light of the procedure used in the University of Oklahoma Reading Clinic.

A total of 1800 exposures on 124 multiple-target slides were used by experimental groups A and B. The slides used were standard lantern slides, $3\frac{1}{4}$ x 4 inches.

Targets were introduced during the eight week period in the following sequence: (1) digits and spaced digits, (2) words, (3) phrases, (4) phrased sentences, (5) sentences, (6) phrased paragraphs, (7) unphrased paragraphs. See Appendix B for samples of exposures used.

Tachistoscope.--The tachistoscope in this study is an overhead projector with a flashmeter attachment manufactured and sold by Keystone View Company, Meadville, Pennsylvania. The tachistoscope was mounted on a portable table which supplied adequate storage space for material and targets.

Screen.--The screen used for target exposure was a portable 45 x 60 beaded screen.

American literature book.--The American literature book, Prose and Poetry for Appreciation, by Lucas and Ward was used for the 1000 word rate check by group C. The book was a supplementary literature book available in the daily classroom activities. It was reserved for this purpose for the eight week period.

Graphs.--Group C used graphs to record their progress in reading from lesson to lesson.

Stop watch.--A stop watch was provided each instructor of classes comprising group C. The rate-check was taken at each session following a discussion on the mechanics and importance of reading.

Newspapers.--Group C used newspapers for one instructional period in a demonstration of how to read the newspaper. The students had daily access to the newspaper in all rooms.

Lesson plans.--Each lesson plan was constructed by the investigator and each instructor of the nine experimental groups was supplied with detailed lesson plans at least two days in advance of the lesson. Introductory remarks were prepared along with accompanying instructions for the tachistoscopic exposures used by groups A and B. Two samples of lesson plans used by each group are presented in Appendix A.

Response sheets.---Response sheets were furnished groups A and B periodically for the purpose of checking individual achievement to compare progress of the groups in mastery of slides.

Number and Length of Instructional Periods

Groups A, B, and C received sixteen instructional periods of twenty minutes each. Training began on October 4, 1954 and ended November 24, 1954. Instructional periods were distributed throughout the school day with classes scheduled for both morning and afternoon for all groups. Experimental group A was scheduled for periods 9:00-10:00, 1:00-2:00, and 2:00-3:00. Experimental group B was scheduled for periods 10:00-11:00, 11:00-12:00, and 1:00-2:00. Experimental group C was scheduled for periods 11:00-12:00, 1:00-2:00, and 2:00-3:00. The control group D met their regularly scheduled English classes at the periods 11:00-12:00, 12:00-1:00, and 2:00-3:00.

Seating Arrangement for Tachistoscopic Training

The trainees were not given a visual test prior to the training, however they were permitted to move more or less at will to find a visually desirable location. Once they located this position they remained in the seat chosen for the remainder of the experiment. No trainee was closer than eight feet to, nor farther than twenty feet from the screen.

Position of Tachistoscope and Screen

The tachistoscope was moved into each room prior to the instructional period and was always placed the same distance from the screen and checked for focus.

Techniques Used during Instructional Periods

Attendance was checked and announcements were made prior to the instructional periods, thus eliminating disruptions from late arrivals.

The classroom door was closed and the instructional periods were carefully scheduled to avoid interruptions.

Normal classroom illumination was maintained for all groups. However, light-colored shades were adjusted to prevent direct glare from the windows during tachistoscopic training. A lighted room is highly recommended in manuals for tachistoscopic teaching in that it facilitates written responses and provides for adequate observation of student reactions.

At the beginning of the tachistoscopic training session, the following pre-exposure instructions were given to all trainees: (1) "Focus your eyes on the screen at the place indicated by the spot at the top of the screen" (Screen was adjusted for type of slide by rolling it up or down depending on the width of exposures), (2) "Lean back in your seats in a comfortable position," and (3) "Prepare for the alert." The alert for the exposure was designated as "Ready?--Now!" The alert remained unchanged for the experiment, since this procedure seemed satisfactory in directing attention to the screen. The alert was given in an even steady rhythm count.

The exposures were not repeated for those who failed to grasp the flash, thus encouraging strict attention. After the command "Ready" a two second interval was allowed before the command "Now" was given. In the first training session all visual stimuli were flashed on the screen for one-tenth of a second, and for one-twenty-fifth of a second for the second training session. Thereafter the visual stimuli were flashed on the screen for one-one-hundredth of a second with the excep-

tion of paragraphs which were exposed for periods of time which forced the subject to read at 350 words a minute or faster.

Tachistoscopic slides were numbered from 1 to 124. The slides were progressive in difficulty. The order of presentation was in accord with the number sequence. Each instructor presented the targets in like manner. The criterion of mastery by 75% of the group governed the sequential introduction of all phases of tachistoscopic training. Written responses by the students furnished evidence of mastery.

The introductory and accompanying remarks in the first two lessons were devoted to a general introduction into good reading habits and present day needs for possessing these habits. Subsequent lessons devoted a specified length of time to a discussion of the mechanics of reading which preceded the tachistoscopic training. Lessons prepared for group C incorporated more detailed discussion of efficient reading. Many examples were supplied regarding a student's need for good reading habits. The pattern of facts and statements followed by group B and C was very similar. Instructions given to group A included many of the facts and statements given to groups B and C, however speed was not emphasized as a major objective in proficient reading, and verbal "set" for speed was eliminated from the instruction for group A. If a student was curious enough to ask a question relative to the effect of such training on speed, he was answered by the instructor for group A in such a manner as follows: "It may increase your speed." Immediately the instructor would divert the attention of the students toward other goals of the training such as phrase reading, reading for key words, et cetera.

The subjects in groups B and C were urged and encouraged to read faster in all their reading. Related statements of remarkable gains made by students who had gone through a reading improvement course, statements relating to lessening of study time, statements about provisions for wider and more enjoyable reading were among the many comments used in motivating the students for faster reading.

Lessons three through sixteen were devoted to the following topics: "Widening Your Eye Span," "Eliminating Vocalization," "Checking Regression," "Acquiring Fewer Fixations," "Developing Better Rhythm," "Reading for Key Words," "Learning to Skim," "Reading the Newspaper Efficiently," "Developing Different Reading Rates," "Building a More Adequate Vocabulary," "Achieving Greater Understanding from Reading," and "Rules for Daily Practice in Good Reading Habits."

Demonstration slides of some of the mechanics were projected on the screen for group A and B during the short introduction of each topic. The instructors for group C used the chalkboard for such demonstrations. In the lesson on newspaper reading group C utilized newspapers available in the room.

The introductory remarks presented by each instructor were followed by questions when time permitted. Group C utilized class discussion more extensively since the remarks covered at least half of the twenty minute instructional period.

The rate-check for group C was taken from a supplementary American literature book, Prose and Poetry for Appreciation by Lucas and Ward. The books were reserved for this specific purpose during the experiment.

The students were instructed to open the books to a specified page at which point the rate-check would begin. They were then instructed to read to a certain line on a succeeding page at which point the rate-check would terminate. Upon locating the specific page all students were required to look up. The class began reading upon a signal given orally by the instructor. Upon completion of the material designated the student closed his book and immediately glanced at the chalkboard, from which he took the last number written as his time for reading the selection. The instructor began recording the time as soon as the first student completed reading the material and recorded the time every five seconds thereafter until the last student finished reading. Upon completion each student recorded his speed on a graph. At the termination of each instructional period the instructor immediately introduced a different topic for discussion or progressed with the regular classroom assignment.

CHAPTER III

STATISTICAL ANALYSIS

Analysis of Rate Scores During "Acquisition"

The primary statistical technique used in the ensuing analysis was the analysis of covariance. Since it was not feasible to "equate" experimental groups before the start of the experiment proper, the only alternative which remained was to use the pupils in each of 12 classrooms as they actually were. Clearly, this brings up the problem of accounting for initial differences in ability on the reading tests employed. Fortunately the covariance analysis obviates the necessity of "equating" groups beforehand, and takes into account initial levels of ability, when applying this statistic to the final scores. In effect, all subjects start from the "same place," and any differences that are found at a subsequent testing can be more defensibly attributed to the experimental treatments, than to other factors.

For example, Edwards (3, p. 335), in his discussion on covariance, states:

The analysis of covariance is a synthesis of the method of regression and the method of analysis of variance. The analysis of covariance is applicable to any experiment in which a source of variation, which it may not be possible to equalize between the various experimental groups prior to the experiment proper, can be measured. An adjustment is then made for this source of variation in the analysis of the outcomes of the experiment, but

where the subjects in the various groups have not been equated with respect to this variable prior to their assignment to the experimental conditions. If a record can be obtained of initial performance during the course of the experiment proper, the outcomes of the experiment may be adjusted for this source of variation.

To the foregoing Edwards (3, p. 355) later adds:

In experiments of this sort, the analysis of covariance may be effectively used to reduce the error mean square in the test of significance.

The reader, who might desire presentation of the mathematical concepts underlying the analysis of covariance technique, can profitably refer to Chapter 17 in Edwards' Experimental Design in Psychological Research (3).

Members of each group in the experiment were exposed to different experimental conditions which have been explained and referred to as A, B, C, and D in Chapter II of this report. This particular section of the presentation deals with the rate performance under the experimental conditions as measured by a variable which is designated as Y_1 . Prior to obtaining the measures of Y_1 under the experimental conditions, each subject was given a pretest rate measure which is designated as X.

The rate scores of four groups of subjects on X, the pretest measure, are recorded in Table 1 from high to low in order of magnitude. The rate scores of the same four groups of subjects under the experimental conditions Y_1 are recorded in Table 2. For computational purposes, the position of the scores in Table 1 corresponds directly with the position of the scores in Table 2. For example, the subject in group A who has an initial score on X of 368 has a score under the experimental condition Y_1 of 325. The other scores were paired in a similar fashion.

TABLE 1

PRETEST RATE SCORES MADE BY FOUR GROUPS OF TENTH GRADE STUDENTS ON
THE SURVEY SECTION OF THE DIAGNOSTIC READING TEST*

Groups									
No.**	A	B	C	D	No.	A	B	C	D
1.	368	520	394	498	21.	238	238	238	225
2.	351	355	360	299	22.	230	238	234	221
3.	338	342	347	295	23.	225	234	234	217
4.	325	325	347	290	24.	221	234	230	217
5.	321	325	329	273	25.	221	230	225	217
6.	308	321	321	269	26.	212	230	225	212
7.	290	321	303	260	27.	212	230	221	204
8.	290	321	282	256	28.	208	225	221	191
9.	290	286	277	256	29.	204	225	217	191
10.	282	286	264	256	30.	204	221	212	178
11.	277	282	260	247	31.	204	208	208	173
12.	273	282	260	243	32.	199	208	208	165
13.	273	269	260	234	33.	195	208	208	165
14.	269	269	243	230	34.	186	199	208	160
15.	264	264	243	230	35.	178	195	182	147
16.	260	256	243	230	36.	173	186	182	143
17.	256	247	243	225	37.	160	186	182	143
18.	256	247	238	225	38.	160	152	147	139
19.	238	243	238	225	39.	143	134	139	130
20.	238	243	238	225					

*Rate scores are expressed in units of words per minute.

**Number designates subjects for each group in rank order. Subjects will maintain this assigned number in subsequent tables.

As an initial step in computing the analysis of covariance, Edwards (3) suggests that an analysis of variance be carried out separately for both the pretest and the posttest scores. However, Edwards (3) points out one of the requisite assumptions underlying the analysis of variance is that homogeneity of variance between groups of data must exist. In order to test for this requisite assumption, Bartlett's Test

TABLE 2

POSTTEST I (Y_1) RATE SCORES MADE BY FOUR GROUPS OF TENTH GRADE STUDENTS
ON THE SURVEY SECTION OF THE DIAGNOSTIC READING TEST

Groups									
No.	A	B	C	D	No.	A	B	C	D
1.	325	546	546	485	21.	312	247	312	212
2.	360	377	468	355	22.	230	316	329	269
3.	428	472	520	299	23.	243	230	360	208
4.	464	529	537	286	24.	217	433	364	208
5.	315	546	546	234	25.	243	282	312	191
6.	269	455	451	316	26.	225	303	299	238
7.	329	390	416	251	27.	212	290	451	251
8.	269	303	542	282	28.	191	251	338	160
9.	238	546	485	277	29.	156	338	282	160
10.	286	355	338	299	30.	184	347	221	165
11.	269	529	347	260	31.	193	316	286	178
12.	251	360	360	251	32.	221	251	238	147
13.	263	442	520	208	33.	193	199	316	221
14.	251	247	416	256	34.	208	208	342	173
15.	269	316	507	243	35.	173	316	351	165
16.	342	277	511	264	36.	191	217	247	182
17.	225	360	329	269	37.	136	269	277	130
18.	191	234	546	299	38.	173	212	273	126
19.	456	277	433	238	39.	139	251	182	169
20.	295	429	511	264					

of Homogeneity of Variance (3, p. 198) was computed for the data in Table 1. The obtained Chi Square of 1.597 failed to reach significance at the .05 level of confidence and indicated that the homogeneity of variance assumption had been satisfied.

Having met the homogeneity assumption, the appropriate analysis of variance was computed for the pretest rate scores of all subjects. The summary of this analysis is given in Table 3, and it is obvious that

TABLE 3

ANALYSIS OF VARIANCE OF PRETEST (X) RATE SCORES MADE BY FOUR GROUPS OF
TENTH GRADE STUDENTS ON THE SURVEY SECTION OF THE
DIAGNOSTIC READING TEST

Source of Variation	Sum of Squares	df	Mean Square	F
Between groups	22256.823	3	7418.941	
Within groups	<u>562205.617</u>	<u>152</u>	3698.721	2.006
Total	584462.440	155		

though there is some variation among the various groups, it was not statistically significant. The obtained F value of 2.006 falls short of the F value of 2.67 required for a statistically significant difference at the .05 level of confidence for 3 and 152 degrees of freedom. It can be concluded, therefore, that the differences between the pretest means are only chance differences, and not "significant" in any rigorous sense.

Now, following the computational model for the analysis of covariance as described by Edwards (3) the analysis of variance was computed for the posttest (Y_1) rate scores as presented in Table 2. The summary of the analysis is given in Table 4. From the table of F one finds that for 3 and 152 degrees of freedom the obtained F value of 23.89 is statistically significant beyond the .01 level of confidence. Hence, the hypothesis that the groups are random samples from a common population must be rejected. In effect, significant differences existed between the experimental groups on the posttest (Y_1) measure.

According to Edwards (3) the next step in the covariance analysis was to analyze the total sum of cross products in exactly the same

TABLE 4

ANALYSIS OF VARIANCE OF POSTTEST I (Y_1) RATE SCORES MADE BY FOUR GROUPS OF TENTH GRADE STUDENTS ON THE SURVEY SECTION OF DIAGNOSTIC READING TEST

Source of Variation	Sum of Squares	df	Mean Square	F
Between groups	598117.140	3	199392.98	
Within groups	<u>1268075.696</u>	<u>152</u>	8342.60	23.896*
Total	1866192.836	155		

*Significant beyond the .01 level of confidence.

manner that the total sums of squares for X and Y_1 had been analyzed. Table 5 presents the sums of squares and cross products of the X and Y_1 measures, that is, the pretest (X) and posttest (Y_1) rate scores, as derived from data presented and summarized in Tables 1 through 4.

TABLE 5

SUMS OF SQUARES AND CROSS PRODUCTS OF PRETEST (X) AND POSTTEST I (Y_1) RATE SCORES MADE BY FOUR GROUPS OF TENTH GRADE STUDENTS ON THE SURVEY SECTION OF THE DIAGNOSTIC READING TEST

Source of Variation	df	Σx^2	Σxy	Σy^2
Between groups	3	22256.823	76692.56	598177.140
Within groups	<u>152</u>	<u>562205.617</u>	<u>628744.59</u>	<u>1268075.696</u>
Total	155	584462.440	705437.15	1866252.836

From Table 5 necessary values were obtained for computing the errors of estimate required for computing the final step in the analysis of covariance. The analysis of covariance on the pretest (X) and the posttest (Y_1) rate scores is summarized in Table 6. It will be noted

that the sum of squares of errors of estimate within groups will have 151 degrees of freedom, which is 1 less than the 152 degrees of freedom available for the within-groups sum of squares. The additional degree of freedom is lost in calculation of the regression coefficient. It will be noted that the degrees of freedom for the sum of squares of errors of estimate for the total will be 1 less than the number of degrees of freedom for the total sum of squares. This loss is also attributed to the calculation of the regression coefficient for the total. Thus, the degrees of freedom for this sum of squares will be equal to 154.

TABLE 6

ANALYSIS OF COVARIANCE OF PRETEST (X) AND POSTTEST I (Y_1) RATE SCORES
MADE BY FOUR GROUPS OF TENTH GRADE STUDENTS ON THE SURVEY
SECTION OF THE DIAGNOSTIC READING TEST
(Group N = 39)

Source of Variation	Sum of Squares of Errors of Estimate	df	Mean Square	F
Total	1775201.361	154		
Within groups	<u>564917.016</u>	<u>-151</u>	3741.172	
Adjusted means	1210284.345	3	403428.115	107.83*

*Significant beyond the .01 level of confidence.

The value of F for the test of significance of the adjusted means was obtained by dividing the mean square for the adjusted means 403428.115 by the mean square for the errors of estimate within groups 3741.172. The obtained value of F which is equal to 107.83 was based upon 3 and 151 degrees of freedom, and from the table of F one finds

that this has a probability of less than .01 and is thus statistically significant. The meaning of this significant value of F is that it indicates that the differences between the means of the experimental groups on the Y_1 variable cannot be accounted for by differences in mean level of initial ability as measured by X , the pretest trial.

The significant F value indicated pronounced differences between the adjusted Y_1 -means, but it did not reveal which Y_1 -means differ significantly from each other. In order to find these differences steps 7, 8, and 9 in Garrett's Analysis of Covariance (5) provided an adequate model for answering this question. Garrett (5) recommends that the adjusted Y -means be computed and then tested for differences by the t -test. This was carried out and Table 7 presents the adjusted Y_1 -means for rate scores.

TABLE 7

ADJUSTED MEANS ON POSTTEST I (Y_1) RATE SCORES MADE BY FOUR GROUPS OF TENTH GRADE STUDENTS ON THE SURVEY SECTION OF THE DIAGNOSTIC READING TEST

Groups	N	\bar{X}	\bar{Y}	$\bar{Y} \cdot \bar{X}$ (adjusted)
A	39	244.6154	254.7436	252.2458
B	39	256.0256	344.1538	328.8845
C	39	245.6667	387.4102	383.7367
D	39	223.1795	235.8205	257.2833
General Means		242.3718	305.5345	305.5345

Following step 9, as presented by Garrett (5), it was found that the standard error of the difference between any two means is 43.80. For 151 degrees of freedom the difference required between the adjusted means of any two groups is 114.31 at the .01 level of confidence, 86.72 at the .05 level of confidence and 72.70 at the .10 level of confidence. The obtained values were acquired by computing the general formula for giving t-values. Table 8 presents the magnitude of difference on the adjusted means between groups, taken two at a time.

TABLE 8

DIFFERENCES BETWEEN THE ADJUSTED MEANS ON POSTTEST I (Y_1) RATE SCORES
MADE BY FOUR GROUPS OF TENTH GRADE STUDENTS ON THE
SURVEY SECTION OF THE DIAGNOSTIC READING TEST

Groups*	Magnitude of Difference Between Groups Taken Two at a Time	Levels of Significance		
		.10	.05	.01
A-B	75.85	Yes	No	No
A-C	131.63	Yes	Yes	Yes
A-D	5.04	No	No	No
B-C	58.63	No	No	No
B-D	70.82	Yes	No	No
C-D	126.45	Yes	Yes	Yes

*Group A--Tachistoscope without verbal "set" for speed
 " B--Tachistoscope with verbal "set" for speed
 " C--Verbal "set" for speed with rate-check without the
 tachistoscope
 " D--Controls who received no special instruction in reading

It is clear by reference to Table 8 that the adjusted mean for group C was significantly higher than the adjusted means for groups A

and D at the .01 level of confidence and the adjusted mean for group B was significantly higher than the adjusted means for groups A and D at the .10 level of confidence. Differences in the adjusted means for groups A and D, and groups B and C do not differ significantly at the .01, .05, or at the .10 level of confidence.

Analysis of Comprehension Scores During "Acquisition"

This section deals with comprehension scores under the experimental conditions measured by a variable which is designated as Y_1 . Prior to obtaining the measures of Y_1 under the experimental conditions, each subject was given a pretest comprehension measure which is designated as X.

The comprehension scores of four groups of subjects on X, the pretest measure, are recorded in Table 9 in corresponding order to the scores presented in Table 1. For example, the subject in group A who has an initial rate score on X of 368 has an initial comprehension score of 14. The comprehension scores of these four groups of subjects under the experimental conditions Y_1 are recorded in Table 10. The position of the scores in Table 10 corresponds directly with the position of the scores in Table 9. For example, the subject in group A who has an initial score on X of 14 has a score under the experimental condition Y_1 of 17. The other scores were paired in similar fashion.

As an initial step in computing a covariance analysis, Edwards (3) suggests that an analysis of variance be carried out separately for both pretest and posttest scores. However, Edwards (3) points out one of the requisite assumptions underlying the analysis of variance is that

TABLE 9

PRETEST (X) COMPREHENSION SCORES MADE BY FOUR GROUPS OF TENTH GRADE STUDENTS ON THE SURVEY SECTION OF THE DIAGNOSTIC READING TEST*

Groups									
No.	A	B	C	D	No.	A	B	C	D
1.	14	26	32	37	21.	34	24	34	22
2.	27	29	31	20	22.	30	14	32	22
3.	31	19	31	37	23.	27	14	23	25
4.	29	15	29	27	24.	29	20	19	28
5.	28	22	22	29	25.	24	26	6	27
6.	23	31	11	28	26.	16	28	22	15
7.	30	27	28	28	27.	27	18	29	25
8.	22	13	23	20	28.	21	30	31	23
9.	29	27	29	27	29.	22	26	12	18
10.	31	24	24	27	30.	25	23	26	13
11.	25	25	31	21	31.	15	14	18	12
12.	14	19	24	29	32.	27	22	14	18
13.	22	33	33	16	33.	9	18	19	16
14.	25	10	29	29	34.	21	26	23	19
15.	33	18	33	29	35.	24	26	22	26
16.	25	32	34	24	36.	23	26	12	7
17.	26	14	24	33	37.	13	18	15	21
18.	15	21	33	27	38.	9	21	15	11
19.	11	29	27	24	39.	12	10	10	9
20.	13	32	25	30					

*Comprehension scores are expressed in terms of the number of correct responses out of a possible score of 40.

homogeneity of variance between groups of data must exist. In order to check this requisite assumption, Bartlett's Test of Homogeneity of variance (3, p. 198) was computed for the data in Table 9. The obtained Chi Square of 1.660 failed to reach significance at the .05 level of confidence and indicated that the homogeneity of variance assumption had been satisfied.

Having satisfied the homogeneity of variance assumption, the

TABLE 10

POSTTEST I (Y_1) COMPREHENSION SCORES MADE BY FOUR GROUPS OF TENTH GRADE STUDENTS ON THE SURVEY SECTION OF THE DIAGNOSTIC READING TEST

Groups									
No.	A	B	C	D	No.	A	B	C	D
1.	17	22	25	28	21.	35	26	36	20
2.	23	38	30	27	22.	31	17	36	24
3.	30	21	30	35	23.	31	18	25	28
4.	27	15	31	26	24.	32	15	24	30
5.	35	21	23	27	25.	23	24	15	27
6.	33	28	17	25	26.	25	28	24	17
7.	30	26	27	29	27.	20	24	31	12
8.	28	26	16	17	28.	29	31	31	25
9.	33	19	28	23	29.	18	29	18	14
10.	33	23	28	23	30.	31	20	32	16
11.	24	18	31	19	31.	12	16	20	23
12.	19	13	24	30	32.	31	18	17	20
13.	23	31	25	20	33.	18	22	18	17
14.	19	9	30	30	34.	29	22	29	20
15.	30	24	23	26	35.	24	28	22	21
16.	24	33	31	22	36.	22	27	14	13
17.	33	24	15	34	37.	22	18	18	24
18.	20	22	30	20	38.	11	18	24	19
19.	9	27	20	27	39.	12	18	20	12
20.	13	28	26	27					

appropriate analysis of variance was computed for the pretest comprehension scores of all subjects. The summary of this analysis is given in Table 11, and it is obvious that though there was some variation in the means of various groups, it was not "significant." The obtained F value of .4178 falls short of the F value of 2.67 required for a statistically significant difference at the .05 level of confidence for 3 and 152 degrees of freedom. It can therefore be concluded that the differences

TABLE 11

ANALYSIS OF VARIANCE OF PRETEST (X) COMPREHENSION SCORES MADE BY FOUR GROUPS OF TENTH GRADE STUDENTS ON THE SURVEY SECTION OF THE DIAGNOSTIC READING TEST

Source of Variation	Sum of Squares	df	Mean Square	F
Between groups	62.327	3	20.776	
Within groups	<u>7562.615</u>	<u>152</u>	49.754	.4178
Total	7624.942	155		

between the pretest means are only chance differences and not "significant."

Following Edwards' (3) computational model for the analysis of covariance, the analysis of variance was computed for the posttest (Y_1) comprehension scores as presented in Table 10. The summary of the analysis is given in Table 12. From the table of F it was found that for 3 and 152 degrees of freedom, the obtained F value of .9774 falls short of the F value of 2.67 required for statistically significant difference at the .05 level of confidence. It can therefore be concluded that the differences are not "significant."

TABLE 12

ANALYSIS OF VARIANCE OF POSTTEST I (Y_1) COMPREHENSION SCORES MADE BY FOUR GROUPS OF TENTH GRADE STUDENTS ON THE SURVEY SECTION OF THE DIAGNOSTIC READING TEST

Source of Variation	Sum of Squares	df	Mean Square	F
Between groups	116.552	3	38.851	
Within groups	<u>6041.846</u>	<u>152</u>	39.749	.9774
Total	6158.398	155		

The next step in the covariance analysis was to analyze the total sum of the cross products in exactly the same manner that the total sums of squares for X and Y_1 were treated. Table 13 presents the sums of squares and cross products of the X and Y_1 measures, pretest and posttest comprehension scores, as derived from data presented and summarized in Tables 9 through Table 12.

TABLE 13

SUMS OF SQUARES AND CROSS PRODUCTS OF PRETEST (X) AND POSTTEST I (Y_1)
COMPREHENSION SCORES MADE BY FOUR GROUPS OF TENTH GRADE
STUDENTS ON THE SURVEY SECTION OF THE
DIAGNOSTIC READING TEST

Source of Variation	df	Σx^2	Σxy	Σy^2
Between groups	3	62.327	49.481	116.552
Within groups	<u>152</u>	<u>7562.715</u>	<u>5167.923</u>	<u>6091.846</u>
Total	155	7624.942	5217.404	6158.398

From Table 13 the necessary values were obtained for computing the required errors of estimate. As the concluding step, the analysis of covariance was carried out between the pretest and posttest comprehension scores and presented in summary form in Table 14. It should be noted that the sum of squares of errors of estimate within groups now has 151 degrees of freedom, which is 1 less than the 152 degrees of freedom available for the within-groups sum of squares. The additional degree of freedom was lost in calculation of the regression coefficient. It will also be noted that the degrees of freedom for the sum of squares of errors of estimate for the total is 1 less than the number of degrees

TABLE 14

ANALYSIS OF COVARIANCE OF PRETEST (X) AND POSTTEST I (Y_1) COMPREHENSION
 SCORES MADE BY FOUR GROUPS OF TENTH GRADE STUDENTS ON
 THE SURVEY SECTION OF THE DIAGNOSTIC READING TEST
 (Group N = 39)

Source of Variation	Sum of Squares of Errors of Estimate	df	Mean Square	F
Total	2588.364	154		
Within groups	<u>2510.339</u>	<u>151</u>	16.625	
Adjusted means	78.025	3	26.008	1.564

of freedom for the total sum of squares. This loss was also attributed to the calculation of the regression coefficient for the total. Thus, the degrees of freedom for this sum of squares is equal to 154.

The value of F for the test of significance of the adjusted means was obtained by dividing the mean square for the adjusted means 26.008 by the mean square for the errors of estimate within groups 16.625. The obtained value of F which is equal to 1.564 was based on 3 and 151 degrees of freedom, and from the table of F one finds that this falls short of the value 2.67 required for statistically significant difference at the .05 level of confidence for 3 and 151 degrees of freedom. It can be concluded, therefore, that the differences between the means of the experimental groups on the Y_1 variable are only chance differences and not "significant."

Steps 7 and 8 in Garrett's (5) analysis of covariance were carried out to compute the adjusted Y_1 -means for comprehension scores. Table 15 presents this analysis in summary form. Since the adjusted means

TABLE 15

ADJUSTED MEANS ON POSTTEST I (Y_1) COMPREHENSION SCORES MADE BY FOUR GROUPS OF TENTH GRADE STUDENTS ON THE SURVEY SECTION OF THE DIAGNOSTIC READING TEST

Groups	N	\bar{X}	\bar{Y}	$\overline{Y \cdot X}$ (adjusted)
A	39	22.590	24.590	24.860
B	39	22.308	22.744	23.200
C	39	23.974	24.718	24.040
D	39	23.051	23.154	23.106
General Means		22.981	23.802	23.802

of the experimental groups failed to yield statistically significant differences, it was unnecessary to apply the t-test to the comprehension scores.

Analysis of Rate Scores on the Retention Check (Y_2) Nine Weeks after "Acquisition" As Compared with Rate Scores at the End of "Acquisition" (Y_1)

The next step in the analysis was to compare any changes in rate performance after 17 weeks (Y_2) with the level of responding at the termination of the training period at the end of 8 weeks (Y_1). Due to absences the analysis of retention scores was reduced to 30 subjects in each group. Nine was the largest number of absences in any one group during the retention check. Groups were equalized with respect to numbers of subjects by use of a table of random numbers. The reader desiring to identify the subjects dropped may compare Table 16 with Table 2.

The rate scores of four groups of subjects on Y_1 , posttest I

TABLE 16

POSTTEST I (Y_1) RATE SCORES MADE BY FOUR GROUPS OF TENTH GRADE STUDENTS
ON THE SURVEY SECTION OF THE DIAGNOSTIC READING TEST

Groups									
No.	A	B	C	D	No.	A	B	C	D
1.	325	546	520	355	16.	295	429	329	264
2.	428	377	537	299	17.	312	247	360	212
3.	464	472	546	234	18.	230	316	364	269
4.	315	529	451	316	19.	217	433	312	208
5.	269	546	416	251	20.	225	303	299	191
6.	329	455	485	277	21.	212	290	338	251
7.	238	546	347	299	22.	191	251	282	160
8.	286	355	360	260	23.	156	338	221	160
9.	269	529	520	251	24.	184	347	286	165
10.	263	360	416	208	25.	193	316	238	178
11.	251	442	507	256	26.	221	251	316	221
12.	269	247	507	243	27.	193	199	342	173
13.	342	316	329	264	28.	208	208	351	165
14.	225	277	433	277	29.	173	316	247	182
15.	456	277	312	238	30.	173	364	277	130

measure, are recorded in Table 16. The rate scores of the same four groups of subjects on the retention measure (Y_2) are recorded in Table 17. The position of the scores in Table 16 corresponds directly with the position of the scores in Table 17. For example, the second subject in group A who has a posttest score (Y_1) of 428 has a score on the retention measure (Y_2) of 312. The other scores are paired in similar fashion.

Again, Edwards' (3) model for computing the analysis of covariance was followed and as an initial step a separate analysis of variance was carried out on both posttest I (Y_1) and posttest II (Y_2) scores.

The summary of the analysis of posttest I (Y_1) rate scores is

TABLE 17

POSTTEST II (Y_2) RATE SCORES MADE BY FOUR GROUPS OF TENTH GRADE STUDENTS
ON THE SURVEY SECTION OF THE DIAGNOSTIC READING TEST

Groups									
No.	A	B	C	D	No.	A	B	C	D
1.	325	511	429	355	16.	269	386	373	273
2.	312	381	429	303	17.	277	251	373	221
3.	394	360	355	273	18.	243	290	321	286
4.	325	347	329	316	19.	243	325	321	217
5.	312	342	329	191	20.	230	269	295	238
6.	316	355	511	282	21.	212	247	286	269
7.	286	329	338	295	22.	225	251	290	191
8.	312	286	260	238	23.	173	247	243	191
9.	269	264	355	251	24.	182	221	195	204
10.	290	342	442	212	25.	199	243	234	152
11.	290	429	520	260	26.	217	221	277	182
12.	273	407	446	247	27.	247	199	282	173
13.	451	273	303	282	28.	173	212	290	199
14.	286	282	390	273	29.	191	290	217	173
15.	225	277	295	251	30.	191	165	234	143

given in Table 18. From the table of F one finds that for 3 and 116 degrees of freedom the obtained F value of 20.339 is statistically significant beyond the .01 level of confidence. Thus, significant differences existed between the groups on the posttest I (Y_1) measure.

Now, continuing with Edwards' (3) computational design for the analysis of covariance, an analysis of variance was computed on posttest II (Y_2) rate scores as presented in Table 17. The summary of the analysis is given in Table 19. From the table of F it is clear that for 3 and 116 degrees of freedom the obtained F value of 10.419 is statistically significant beyond the .01 level of confidence. Hence, the rejection of the hypothesis that the groups were random samples from a

TABLE 18

ANALYSIS OF VARIANCE OF POSTTEST I (Y_1) RATE SCORES MADE BY FOUR GROUPS
OF TENTH GRADE STUDENTS ON THE SURVEY SECTION OF
THE DIAGNOSTIC READING TEST

Source of Variation	Sum of Squares	df	Mean Square	F
Between groups	457317.300	3	152439.100	
Within groups	<u>869390.300</u>	<u>116</u>	7494.744	20.339*
Total	1326707.600	119		

*Significant beyond the .01 level.

common population is tenable. Clearly, significant differences continued to exist among the groups on the posttest II (Y_2) measure.

TABLE 19

ANALYSIS OF VARIANCE OF POSTTEST II (Y_2) RATE SCORES MADE BY FOUR GROUPS
OF TENTH GRADE STUDENTS ON THE SURVEY SECTION OF
THE DIAGNOSTIC READING TEST

Source of Variation	Sum of Squares	df	Mean Square	F
Between groups	151723.700	3	50574.566	
Within groups	<u>563051.900</u>	<u>116</u>	4853.896	10.419*
Total	714775.600	119		

*Significant beyond the .01 level of confidence.

The next step in the covariance analysis was to analyze the total sum of cross products in exactly the same manner that the sums of squares for Y_1 and Y_2 had been analyzed. Table 20 presents the sum of squares and cross products of the Y_1 and Y_2 measures, posttest I and

TABLE 20

SUMS OF SQUARES AND CROSS PRODUCTS OF POSTTEST I (Y_1) AND POSTTEST II (Y_2) RATE SCORES MADE BY FOUR GROUPS OF TENTH GRADE STUDENTS ON THE SURVEY SECTION OF THE DIAGNOSTIC READING TEST

Source of Variation	df	ΣY_1^2	$\Sigma Y_1 Y_2$	ΣY_2^2
Between groups	3	457317.300	253809.960	151723.700
Within groups	<u>116</u>	<u>869390.300</u>	<u>509205.300</u>	<u>563051.900</u>
Total	119	1326707.600	763015.260	714775.600

posttest II rate scores, as derived from data presented and summarized in Tables 16 through 19.

From Table 20 the necessary values were obtained for computing the required errors of estimate. This led to the final step in the analysis of covariance. Table 21 summarizes this analysis of covariance carried out between the posttest I (Y_1) and posttest II (Y_2) rate scores.

TABLE 21

ANALYSIS OF COVARIANCE OF POSTTEST I (Y_1) AND POSTTEST II (Y_2) RATE SCORES MADE BY FOUR GROUPS OF TENTH GRADE STUDENTS ON THE SURVEY SECTION OF THE DIAGNOSTIC READING TEST
(Group N = 30)

Source of Variation	Sum of Squares of Errors of Estimate	df	Mean Square	F
Total	275950.730	118		
Within groups	<u>263728.891</u>	<u>115</u>	2293.729	
Adjusted means	12221.839	3	4077.279	1.778

It should be noted that the sum of errors of estimate within groups now has 115 degrees of freedom which is 1 less than the 116 degrees of freedom available for the within-group sum of squares. The additional degree of freedom was lost in calculation of the regression coefficient. It will also be noted that degrees of freedom for the sum of squares of errors of estimate for the total was 1 less than the number of degrees of freedom for the total sum of squares. This loss was also attributed to the calculation of the regression coefficient for the total. Thus, the degrees of freedom for the sum of squares was equal to 118.

The value of F for the test of significance of the adjusted means was obtained by dividing the mean square of the adjusted means 4077.279 by the mean square for the errors of estimate within groups 2293.729. Although it is obvious that there were some variations in the mean value of the various groups, the obtained F value of 1.778 falls short of the F value of 2.70 required for a statistically significant difference at the .05 level of confidence, for 3 and 115 degrees of freedom.

The obtained value of F indicates that the difference among the means of the experimental groups on the Y_2 variable can be accounted for by the differences in mean level of reading ability as measured by Y_1 , the posttest I trial, since the means of the groups on the Y_2 variable have been "adjusted" by the analysis to a common mean posttest I level of performance on Y_1 .

Steps 7 and 8 in Garrett's (5) analysis of covariance were carried out to compute the adjusted Y_2 -means for rate scores. This analysis is presented in summary form in Table 22. Since the mean differences

TABLE 22

ADJUSTED MEANS ON POSTTEST II (Y_2) RATE SCORES MADE BY FOUR GROUPS OF TENTH GRADE STUDENTS ON THE SURVEY SECTION OF THE DIAGNOSTIC READING TEST

Groups	N	\bar{Y}_1	\bar{Y}_2	$\bar{Y}_1 \cdot \bar{Y}_2$
A	30	263.7333	264.6000	290.7369
B	30	362.7333	300.0733	268.2260
C	30	375.0667	332.0733	293.0020
D	30	231.9000	238.0333	282.8150
General Means		308.3584	283.6951	283.6951

failed to reach statistical significance it was not necessary to apply the t-test to check for any specific differences between groups, taken two at a time.

Analysis of Comprehension Scores on the Retention Check (Y_2)
Nine Weeks after "Acquisition" As Compared with
Comprehension Scores at the End of
"Acquisition" (Y_1)

This section deals with comprehension scores measured by a variable designated as Y_2 which is compared with comprehension scores measured by the variable designated as Y_1 . As was previously noted, absences during the retention check reduced the total N of each group to 30 cases.

The comprehension scores of four groups of subjects on Y_1 , the posttest I measure, are recorded in Table 23 in corresponding order to the rate scores presented in Table 16. For example, the first subject in group A who has a rate score on Y_1 of 325 has a comprehension score on

TABLE 23

POSTTEST I (Y_1) COMPREHENSION SCORES MADE BY FOUR GROUPS OF TENTH GRADE STUDENTS ON THE SURVEY SECTION OF THE DIAGNOSTIC READING TEST

Groups									
No.	A	B	C	D	No.	A	B	C	D
1.	17	22	30	27	16.	13	28	36	27
2.	30	38	31	35	17.	35	26	25	20
3.	27	21	23	27	18.	31	17	24	24
4.	35	15	17	25	19.	32	15	15	28
5.	33	21	27	29	20.	25	28	24	27
6.	30	28	28	29	21.	20	24	31	12
7.	33	19	31	23	22.	29	31	18	25
8.	33	23	24	19	23.	18	29	32	14
9.	24	18	25	30	24.	31	20	20	16
10.	23	13	30	20	25.	12	16	17	23
11.	19	31	23	30	26.	31	18	18	17
12.	30	9	31	26	27.	18	22	29	20
13.	24	24	15	22	28.	29	22	22	21
14.	33	33	20	34	29.	24	28	14	13
15.	9	27	36	27	30.	11	18	18	24

Y_1 of 17. All scores were paired in similar fashion. The comprehension scores of these four groups of subjects on the retention measure Y_2 are recorded in Table 24. The position of the scores in Table 24 corresponds directly with the position of the scores in Table 23. For example, the subject in group A who has a posttest score on Y_1 of 17 has a score on the retention measure Y_2 of 16. The other scores were paired in similar fashion.

Because means and variances were somewhat proportional the comprehension scores were transformed. Square roots of each score (\sqrt{X}) were obtained in order to overcome this relationship. Table 25 presents the square roots of the comprehension scores presented in Table 23.

TABLE 24

POSTTEST II (Y_2) COMPREHENSION SCORES MADE BY FOUR GROUPS OF TENTH GRADE STUDENTS ON THE SURVEY SECTION OF THE DIAGNOSTIC READING TEST

Groups									
No.	A	B	C	D	No.	A	B	C	D
1.	16	28	30	27	16.	13	26	26	30
2.	24	31	28	32	17.	35	24	21	23
3.	33	25	28	25	18.	27	23	27	21
4.	33	17	13	32	19.	26	22	9	24
5.	27	23	22	30	20.	19	23	26	30
6.	32	26	31	22	21.	24	26	30	17
7.	29	29	27	17	22.	27	33	20	22
8.	31	21	23	20	23.	16	26	28	13
9.	26	29	28	32	24.	27	11	15	12
10.	22	20	26	22	25.	20	21	24	12
11.	21	29	33	31	26.	20	24	16	13
12.	20	8	19	29	27.	14	23	25	16
13.	31	19	18	23	28.	20	19	24	27
14.	21	26	26	32	29.	8	30	22	10
15.	11	28	33	22	30.	21	15	26	22

An identical transformation was carried out on the posttest II (Y_2) comprehension scores presented in Table 24 and are presented as square roots in Table 26.

In applying Edwards' (3) analysis of covariance technique, the appropriate analysis of variance was computed for the posttest (Y_1) comprehension scores of all subjects as presented in Table 25. The summary of this analysis is given in Table 27. The obtained F value of .537 falls short of the F value of 2.70 required for a statistically significant difference at the .05 level of confidence for 3 and 116 degrees of freedom. Therefore, it can be concluded that the difference between the posttest (Y_1) means are only chance differences and not

TABLE 25

TRANSFORMED (\sqrt{X}) POSTTEST I (Y_1) COMPREHENSION SCORES MADE BY FOUR GROUPS OF TENTH GRADE STUDENTS ON THE SURVEY SECTION OF THE DIAGNOSTIC READING TEST*

Groups									
No.	A	B	C	D	No.	A	B	C	D
1.	4.123	4.690	5.477	5.196	16.	3.606	5.292	6.000	5.196
2.	5.477	6.164	5.568	5.916	17.	5.916	5.099	5.000	4.472
3.	5.196	4.583	4.796	5.196	18.	5.568	4.123	4.899	4.899
4.	5.916	3.873	4.123	5.000	19.	5.657	3.873	3.873	5.292
5.	5.745	4.583	5.196	5.385	20.	5.000	5.292	4.899	5.196
6.	5.477	5.292	5.292	5.385	21.	4.472	4.899	5.568	3.464
7.	5.745	4.359	5.568	4.796	22.	5.383	5.568	4.243	5.000
8.	5.745	4.796	4.899	4.359	23.	4.243	5.385	5.657	3.742
9.	4.899	4.243	5.000	5.477	24.	5.568	4.472	4.472	4.000
10.	4.796	3.606	5.477	4.472	25.	3.464	4.000	4.123	4.796
11.	4.359	5.568	4.796	5.477	26.	5.568	4.243	4.243	4.123
12.	5.477	3.000	5.568	5.099	27.	4.243	4.690	5.389	4.472
13.	4.899	4.899	3.873	4.690	28.	5.385	4.690	4.690	4.583
14.	5.745	5.745	4.472	5.831	29.	4.899	5.292	3.742	3.606
15.	3.000	5.196	6.000	5.196	30.	3.317	4.243	4.243	4.899

*Square roots of scores presented in Table 23.

"significant."

Continuing with Edwards' (3) computational model for the analysis of covariance, the analysis of variance was computed for the posttest II (Y_2) comprehension scores as presented in Table 24. The summary of this analysis is given in Table 28. From the table of F it was found that for 3 and 116 degrees of freedom, the obtained F value of .055 falls short of the F value of 2.70 required for statistically significant differences at the .05 level of confidence. It can, therefore, be concluded that the differences between the posttest II (Y_2) means are

TABLE 26

TRANSFORMED (\sqrt{X}) POSTTEST II (Y_2) COMPREHENSION SCORES MADE BY FOUR GROUPS OF TENTH GRADE STUDENTS ON THE SURVEY SECTION OF THE DIAGNOSTIC READING TEST*

Groups									
No.	A	B	C	D	No.	A	B	C	D
1.	4.000	5.292	5.477	5.196	16.	3.606	5.099	5.099	5.477
2.	4.899	5.568	5.292	5.657	17.	5.916	4.899	4.583	4.796
3.	5.745	5.000	5.292	5.000	18.	5.196	4.796	5.196	4.583
4.	5.745	4.123	3.606	5.657	19.	5.099	4.690	3.000	4.899
5.	5.196	4.796	4.690	5.477	20.	4.359	4.796	5.099	5.477
6.	5.657	5.099	5.568	4.690	21.	4.899	5.099	5.477	4.123
7.	5.385	5.385	5.196	4.123	22.	5.196	5.745	4.472	4.690
8.	5.568	4.583	4.796	4.472	23.	4.000	5.099	5.292	3.606
9.	5.099	5.385	5.292	5.657	24.	5.196	3.317	3.873	3.464
10.	5.690	4.472	5.099	4.690	25.	4.472	4.583	4.899	3.464
11.	4.583	5.385	5.745	5.568	26.	4.472	4.899	4.000	3.606
12.	4.472	2.828	4.359	5.385	27.	3.742	4.796	5.000	4.000
13.	5.568	4.359	4.243	4.796	28.	4.472	4.359	4.899	5.196
14.	4.583	5.099	5.099	5.657	29.	2.828	5.477	4.690	3.162
15.	3.317	5.292	5.745	4.690	30.	4.583	3.873	5.099	4.690

*Square roots of scores presented in Table 24.

only chance differences and are not "significant."

The next step in the covariance analysis was to analyze the total sum of cross products in exactly the same manner that the total sum of squares for Y_1 and Y_2 had been analyzed. Table 29 presents the sum of squares and cross products of Y_1 and Y_2 measure, posttest I and posttest II comprehension scores, as derived from data presented and summarized in Tables 23 through 28.

From Table 29 the necessary values were obtained for computing the required errors of estimate. The analysis of covariance was carried

TABLE 27

ANALYSIS OF VARIANCE OF TRANSFORMED (\sqrt{X}) POSTTEST I (Y_2) COMPREHENSION
SCORES MADE BY FOUR GROUPS OF TENTH GRADE STUDENTS ON THE
SURVEY SECTION OF THE DIAGNOSTIC READING TEST

Source of Variation	Sum of Squares	df	Mean Square	F
Between groups	.9392	3	.3131	
Within groups	<u>67.5699</u>	<u>116</u>	.5825	.537
Total	68.5091	119		

out between the posttest I (Y_1) comprehension scores and posttest II (Y_2) comprehension scores and presented in summary form in Table 30. It should be noted that the sum of squares of errors of estimate within groups now have 115 degrees of freedom, which is 1 less than the 116 degrees of freedom available for the within-groups sum of squares. The additional degree of freedom was lost in calculation of the regression coefficient. It will also be noted that the degrees of freedom for the

TABLE 28

ANALYSIS OF VARIANCE OF TRANSFORMED (\sqrt{X}) POSTTEST II (Y_2) COMPREHENSION
SCORES MADE BY FOUR GROUPS OF TENTH GRADE STUDENTS ON THE
SURVEY SECTION OF THE DIAGNOSTIC READING TEST

Source of Variation	Sum of Squares	df	Mean Square	F
Between groups	.1241	3	.0414	
Within groups	<u>87.9736</u>	<u>116</u>	.7584	.055
Total	88.0977	119		

TABLE 29

SUM OF SQUARES AND CROSS PRODUCTS OF TRANSFORMED (\sqrt{X}) POSTTEST I (Y_1)
AND POSTTEST II (Y_2) COMPREHENSION SCORES MADE BY FOUR GROUPS
OF TENTH GRADE STUDENTS ON THE SURVEY SECTION OF
THE DIAGNOSTIC READING TEST

Source of Variation	df	Σy_1^2	$\Sigma y_1 y_2$	Σy_2^2
Between groups	3	.9392	.2109	.1241
Within groups	<u>116</u>	<u>67.5699</u>	<u>59.3632</u>	<u>87.9736</u>
Total	119	68.5091	59.5741	88.0977

sum of squares of errors of estimate for the total is 1 less than the number of degrees of freedom for the total sum of squares. This loss was also attributed to the calculation of the regression coefficient for the total. Thus, the degrees of freedom for this sum of squares is equal to 118.

TABLE 30

ANALYSIS OF COVARIANCE OF TRANSFORMED (\sqrt{X}) POSTTEST I (Y_1) AND POSTTEST II (Y_2) COMPREHENSION SCORES MADE BY FOUR GROUPS OF TENTH GRADE STUDENTS ON THE SURVEY SECTION OF THE DIAGNOSTIC READING TEST
(Group N = 30)

Source of Variation	Sum of Squares of Errors of Estimate	df	Mean Square	F
Total	36.2933	118		
Within groups	<u>35.8204</u>	<u>115</u>	.3115	
Adjusted means	.4729	3	.1576	.5059

The value of F for the test of significance of the adjusted means was obtained by dividing the mean square for the adjusted means .1576 by the mean square for the errors of estimate within groups .3115. The obtained value of F of .5059 for 3 and 115 degrees of freedom falls short of the F value of 2.70 required for a statistically significant difference at the .05 level of confidence. It can be concluded, therefore, that the differences between the means of the groups on the Y_2 variable are only chance differences and not "significant."

Steps 7 and 8 in Garrett's (5) analysis of covariance were carried out to compute the adjusted Y_2 means for comprehension scores. This analysis is presented in summary form in Table 31. In reference to Table 31 it is clear that the adjusted means of the groups failed to yield statistically significant differences, thus, it was not necessary to apply the t-test to check for any further specific group differences.

TABLE 31

ADJUSTED MEANS ON TRANSFORMED (\sqrt{X}) POSTTEST II (Y_2) COMPREHENSION SCORES
MADE BY FOUR GROUPS OF TENTH GRADE STUDENTS ON THE SURVEY SECTION
OF THE DIAGNOSTIC READING TEST

Groups	N	\bar{Y}_1	\bar{Y}_2	$\bar{Y}_1 \cdot \bar{Y}_2$
A	30	4.963	4.783	4.692
B	30	4.725	4.806	4.922
C	30	4.905	4.731	4.691
D	30	4.841	4.731	4.745
General Means		4.859	4.763	4.763

Analysis of Rate Scores on the Retention Check Nine Weeks
(Y₂) after "Acquisition" As Compared with
Initial Rate Scores (X)

In order to afford an additional check on retention of acquired gains or losses during "acquisition," an analysis was carried out on the retention check (Y₂) as against the initial measure (X).

This section deals with the rate performance measured by a variable which is designated as Y₂ as compared to the initial rate performance measured by the variable designated as X. It will be remembered that absentees during the retention check reduced the total N of each group to 30 cases. In order to determine which cases were eliminated the reader may compare the sequential order of subjects in Table 32 with the sequential order presented in Table 1.

TABLE 32

PRETEST (X) RATE SCORES MADE BY FOUR GROUPS OF TENTH GRADE STUDENTS
ON THE SURVEY SECTION OF THE DIAGNOSTIC READING TEST

Groups									
No.	A	B	C	D	No.	A	B	C	D
1.	368	520	347	299	16.	238	243	234	225
2.	338	355	347	295	17.	238	238	234	225
3.	325	342	329	273	18.	230	238	230	221
4.	321	325	321	269	19.	221	234	225	217
5.	308	325	303	260	20.	212	230	221	217
6.	290	321	277	256	21.	212	230	221	204
7.	290	286	260	256	22.	208	225	217	191
8.	282	286	260	247	23.	204	225	212	191
9.	277	282	260	243	24.	204	221	208	178
10.	273	282	243	234	25.	204	208	208	173
11.	269	269	243	234	26.	199	208	208	165
12.	264	269	243	230	27.	195	208	208	160
13.	260	264	243	230	28.	186	199	182	147
14.	256	256	238	225	29.	178	195	182	143
15.	238	243	238	225	30.	160	152	156	139

The rate scores of four groups of subjects on X , the pretest measure, are recorded in Table 32 from high to low in order of magnitude. The rate scores of the same four groups of subjects on Y_2 , the posttest II measure, are recorded in Table 17. The position of the scores in Table 32 corresponds directly with the position of the scores in Table 17. For example, the second subject in group A who has an initial score on X of 338 has a score on the retention measure Y_2 of 312. The other scores were paired in a similar fashion.

Again in referring to Edwards (3) for the initial step in computing the covariance analysis he suggests that an analysis of variance be carried out separately for both pretest and posttest scores. The appropriate analysis was computed for the pretest rate scores of all subjects as presented in Table 32. The summary of this analysis is given in Table 33. The obtained F value of 3.277 was statistically significant beyond the .05 level of confidence. It appears that the elimination of nine cases from the X measures in Table 1 included some atypical subjects which brought about a change in the differences between the groups on the pretest measure.

The computational model for the analysis of covariance continued to be followed in computing the analysis of variance for the posttest II (Y_2) rate scores presented in Table 17. The summary of the analysis is given in Table 19. From the table of F one finds that for 3 and 116 degrees of freedom the obtained F value of 10.419 is statistically significant beyond the .01 level of confidence. Hence, the hypothesis that the groups are random samples from a common population must be rejected. In effect, significant differences existed between the groups on the

TABLE 33

ANALYSIS OF VARIANCE OF PRETEST (X) RATE SCORES MADE BY FOUR GROUPS OF TENTH GRADE STUDENTS ON THE SURVEY SECTION OF THE DIAGNOSTIC READING TEST

Source of Variation	Sum of Squares	df	Mean Square	F
Between groups	29471.035	3	9823.678	
Within groups	<u>328879.557</u>	<u>116</u>	2835.169	3.277*
Total	358350.592	119		

*Significant beyond the .05 level of confidence.

posttest II (Y_2) measure.

The next step in the covariance analysis was to analyze the total sum of cross products in exactly the same manner that the total sums of squares for X and Y_2 have been analyzed. Table 34 presents the sums of squares and cross products of the X and Y_2 measures, pretest I and posttest II rate scores, as derived from data presented and summarized in Tables 17, 19, 32, and 33.

TABLE 34

SUMS OF SQUARES AND CROSS PRODUCTS OF PRETEST (X) AND POSTTEST II (Y_2) RATE SCORES MADE BY FOUR GROUPS OF TENTH GRADE STUDENTS ON THE SURVEY SECTION OF THE DIAGNOSTIC READING TEST

Source of Variation	df	Σx^2	Σxy_2	Σy_2^2
Between groups	3	29471.035	39828.069	151723.700
Within groups	<u>116</u>	<u>328879.557</u>	<u>310411.340</u>	<u>563051.900</u>
Total	119	358350.592	350239.409	714775.600

From Table 34 the necessary values were obtained for computing the required errors of estimate. This led to the final step in the analysis of covariance. This analysis carried out between the pretest (X) and posttest II (Y_2) scores is summarized in Table 35. It will be remembered that the sums of squares of errors of estimate within groups now have 115 degrees of freedom, which is 1 less than 116 degrees of freedom available for the within-groups sum of squares. The additional degree of freedom was lost in calculation of the regression coefficient. It should be noted that the degrees of freedom for the sum of squares of errors of estimate for the total will be 1 less than the number of degrees of freedom for the total sum of squares. This loss was also attributed to the calculation of the regression coefficient for the total. Thus, the degrees of freedom for the sum of squares are equal to 118.

TABLE 35

ANALYSIS OF COVARIANCE OF PRETEST (X) AND POSTTEST II (Y_2) RATE SCORES
MADE BY FOUR GROUPS OF TENTH GRADE STUDENTS ON THE SURVEY SECTION
OF THE DIAGNOSTIC READING TEST
(Group N = 30)

Source of Variation	Sum of Squares of Errors of Estimate	df	Mean Square	F
Total	372463.780	118		
Within groups	<u>270071.700</u>	<u>115</u>	2348.450	
Adjusted means	102392.080	3	34130.693	14.533*

*Significant beyond the .01 level of confidence.

The value of F for the test of significance of the adjusted means was obtained by dividing the mean square for the adjusted means 32130.693 by the mean square for the errors of estimate within groups 2348.450. The obtained value of F which is equal to 14.533 is based on 3 and 115 degrees of freedom, and from the table of F one finds that this has a probability of less than .01 and is thus significant. The meaning of this significant value of F is that it indicates that the differences in the means of the groups on the Y_2 variable cannot be accounted for by differences in mean level of initial ability as measured by X , the pretest trial, since the means of the groups on the Y_2 variable have been "adjusted" by the analysis to a common mean initial level of performance on X .

The significant F value indicates pronounced differences between the adjusted Y_2 -means, but it does not reveal which Y_2 -means differ significantly from each other. In order to find these differences steps 7, 8, and 9 in Garrett's (5) analysis of covariance provided an adequate model for the required analysis. Garrett (5) recommends that the adjusted Y -means be computed and then tested for differences by the t -test. This was carried out and Table 36 presents the adjusted Y_2 -means for rate scores.

Following step 9, as presented by Garrett (5), it was found that the standard error of the difference between any two means is 18.066. For 116 degrees of freedom the difference required between the adjusted means of any two groups is 47.513 at the .01 level of confidence, 35.771 at the .05 level of confidence, and 29.990 at the .10 level of confidence. Table 37 presents the magnitude of difference on the adjusted means

TABLE 36

ADJUSTED MEANS ON POSTTEST II (Y_2) RATE SCORES MADE BY FOUR GROUPS OF TENTH GRADE STUDENTS ON THE SURVEY SECTION OF THE DIAGNOSTIC READING TEST

Groups	N	\bar{X}	\bar{Y}_2	$\bar{X} \cdot \bar{Y}_2$ (adjusted)
A	30	248.233	264.600	260.209
B	30	262.633	300.073	282.869
C	30	243.266	322.073	322.103
D	30	219.066	238.033	259.598
General Means		244.299	281.195	281.195

TABLE 37

DIFFERENCES BETWEEN THE ADJUSTED MEANS ON POSTTEST II (Y_2) RATE SCORES MADE BY FOUR GROUPS OF TENTH GRADE STUDENTS ON THE SURVEY SECTION OF THE DIAGNOSTIC READING TEST

Groups*	Magnitude of Difference Between Groups Taken Two at a Time	Levels of Significance		
		.10	.05	.01
A-B	22.46	No	No	No
A-C	61.89	Yes	Yes	Yes
A-D	.61	No	No	No
B-C	39.23	Yes	Yes	No
B-D	23.27	No	No	No
C-D	62.51	Yes	Yes	Yes

- *Group A--Tachistoscope without verbal "set" for speed
 " B--Tachistoscope with verbal "set" for speed
 " C--Verbal "set" for speed with rate-check without the tachistoscope
 " D--Control who received no special instruction in reading.

between groups, taken two at a time.

It is clear by reference to Table 37 that the adjusted mean for group C was significantly higher than the adjusted means for groups A and D at the .01 level of confidence and the adjusted mean for group B at the .05 level of confidence. Differences in the adjusted means for groups A and B, groups A and D, and groups B and D do not differ significantly at the .01, .05 or at the .10 level of confidence.

Analysis of Comprehension Scores on the Retention Check (Y_2)
Nine Weeks after "Acquisition" As Compared with
Initial (X) Comprehension Scores

This section deals with comprehension scores measured by a variable designated as Y_2 and compared with initial comprehension scores measured by a variable designated as X.

The comprehension scores of four groups of subjects on X, the pretest measure, are recorded in Table 38. The comprehension scores of the same four groups of subjects on the retention measure are recorded in Table 24. For example, the third subject in group A who has a pretest score X of 29 has a score on the retention measure Y_2 of 33. The other scores were paired in similar fashion.

As the initial step in the covariance analysis the analysis of variance was carried out separately for both the pretest (X) and the posttest II (Y_2) scores. The appropriate analysis of variance was computed for the pretest (X) comprehension scores of all subjects as presented in Table 38. The summary of this analysis is given in Table 39. The obtained F value of .0196 falls short of the F value of 2.70 required for a statistically significant difference at the .05 level of

TABLE 38

PRETEST (X) COMPREHENSION SCORES MADE BY FOUR GROUPS OF TENTH GRADE STUDENTS ON THE SURVEY SECTION OF THE DIAGNOSTIC READING TEST

Groups									
No.	A	B	C	D	No.	A	B	C	D
1.	14	26	31	20	16.	13	32	32	30
2.	31	29	29	37	17.	34	24	23	22
3.	29	19	22	29	18.	30	14	19	22
4.	28	15	11	28	19.	29	20	6	25
5.	23	22	28	28	20.	16	28	22	27
6.	30	31	29	27	21.	27	18	31	25
7.	29	27	31	27	22.	21	30	12	23
8.	31	24	24	21	23.	22	26	26	18
9.	25	25	33	29	24.	25	23	18	13
10.	22	19	29	16	25.	15	14	14	12
11.	25	33	33	29	26.	27	22	19	16
12.	33	10	34	29	27.	9	18	23	19
13.	25	18	24	24	28.	21	26	22	26
14.	26	32	27	33	29.	24	26	12	7
15.	11	29	34	24	30.	9	21	15	21

confidence for 3 and 116 degrees of freedom. It can, therefore, be concluded that the differences between the pretest means are only chance differences and not "significant."

The next step in the analysis of covariance was to compute an analysis of variance for the posttest II (Y_2) comprehension scores as presented in Table 24. The summary of this analysis is given in Table 40.

From the table of F it was found that for 3 and 116 degrees of freedom, the obtained F value of .2082 falls short of the F value of 2.70 required for statistically significant differences at the .05 level of confidence. It can, therefore, be concluded that the

TABLE 39

ANALYSIS OF VARIANCE OF PRETEST (X) COMPREHENSION SCORES MADE BY FOUR GROUPS OF TENTH GRADE STUDENTS ON THE SURVEY SECTION OF THE DIAGNOSTIC READING TEST

Source of Variation	Sum of Squares	df	Mean Square	F
Between groups	2.800	3	.933	
Within groups	<u>5530.067</u>	<u>116</u>	47.673	.0196
Total	5532.867	119		

differences between the posttest II (Y_2) means are only chance differences and are not "significant" in any statistical sense.

TABLE 40

ANALYSIS OF VARIANCE OF POSTTEST II (Y_2) COMPREHENSION SCORES MADE BY FOUR GROUPS OF TENTH GRADE STUDENTS ON THE SURVEY SECTION OF THE DIAGNOSTIC READING TEST

Source of Variation	Sum of Squares	df	Mean Square	F
Between groups	25.025	3	8.342	
Within groups	<u>4648.300</u>	<u>116</u>	40.072	.2082
Total	4673.325	119		

The next step in the covariance analysis was to analyze the total sum of cross products in exactly the same manner that the total sum of squares for X and Y_2 have been analyzed. Table 41 presents the sum of squares and cross products of the X and Y_2 measure, pretest and posttest II comprehension scores, as derived from data presented and summarized in Tables 26, 38, 39, and 40.

TABLE 41

SUMS OF SQUARES AND CROSS PRODUCTS OF PRETEST (X) AND POSTTEST II (Y_2)
COMPREHENSION SCORES MADE BY FOUR GROUPS OF TENTH GRADE
STUDENTS ON THE SURVEY SECTION OF THE
DIAGNOSTIC READING TEST

Source of Variation	df	$\sum x^2$	$\sum xy_2$	$\sum y_2^2$
Between groups	3	2.800	4.966	25.025
Within groups	<u>116</u>	<u>5530.067</u>	<u>3567.834</u>	<u>4648.300</u>
Total	119	5532.867	3572.800	4673.325

From Table 41 the necessary values were obtained for computing the required errors of estimate. As a concluding step the analysis of covariance was carried out between the pretest (X) comprehension scores and the posttest II (Y_2) comprehension scores. The results are presented in summary form in Table 42. It should be remembered that the sum of squares of errors of estimate within groups now has 115 degrees of freedom, which is 1 less than the 116 degrees of freedom available

TABLE 42

ANALYSIS OF COVARIANCE OF PRETEST (X) AND POSTTEST II (Y_2) COMPREHENSION
SCORES MADE BY FOUR GROUPS OF TENTH GRADE STUDENTS ON THE
SURVEY SECTION OF THE DIAGNOSTIC READING TEST
(Group N = 30)

Source of Variation	Sum of Squares of Errors of Estimate	df	Mean Square	F
Total	2366.221	118		
Within groups	<u>2346.458</u>	<u>115</u>	20.406	
Adjusted means	9.763	3	3.254	.1594

for the within-groups sum of squares. The additional degree of freedom was lost in calculation of the regression coefficient. It will also be noted that the degrees of freedom for the sum of squares of errors of estimate for the total are 1 less than the number of degrees of freedom for the total sum of squares. This loss was attributed to the calculation of the regression coefficient for the total. Thus, the degree of freedom for this sum of squares is 118.

The value of F for the test of significance of the adjusted means was obtained by dividing the mean square for the adjusted means 3.254 by the mean square for the errors of estimate within groups 20.406. The obtained F value of .1594 based on 3 and 115 degrees of freedom falls short of the F value of 2.70 required for a statistically significant difference at the .05 level of confidence. It can be concluded, therefore, that the differences between the means of the groups on the Y_2 variable are only chance differences and not "significant."

Steps 7 and 8 in Garrett's (5) analysis of covariance were carried out to compute the adjusted Y_2 means for comprehension scores. Since the adjusted means of the groups failed to yield statistically significant differences it was not necessary to apply the t -test to check for any specific group differences. Table 43 presents the adjusted Y_2 means for comprehension scores.

A recapitulation of the analysis of the data reveals these salient findings:

1. In analyzing the rate data comparing the initial measure (X) with the posttest I measure (Y_1), as presented in Table 8, it was found that group C (verbal "set" and rate check without the tachistoscope)

TABLE 43

ADJUSTED MEANS ON POSTTEST II (Y_2) COMPREHENSION SCORES MADE BY FOUR GROUPS OF TENTH GRADE STUDENTS ON THE SURVEY SECTION OF THE DIAGNOSTIC READING TEST

Groups	N	\bar{X}	\bar{Y}_2	$\bar{X} \cdot \bar{Y}_2$
A	30	23.433	23.133	23.198
B	30	23.366	23.500	23.607
C	30	23.766	24.133	23.982
D	30	23.566	22.933	22.912
General Means		23.526	23.050	23.050

differed significantly from groups A (tachistoscope without verbal "set" for speed) and D (control) beyond the .01 level of confidence. In this same analysis group B (tachistoscope with verbal "set" for speed) differed significantly from groups A and D at the .10 level of confidence.

2. In analyzing the rate data comparing the initial measure (X) with the posttest II measure (Y_2), as presented in Table 37, it was found that group C differed significantly from groups A and D beyond the .01 level of confidence and from group B at the .05 level of confidence.

3. No significant differences were found among any of the analyses of the comprehension data.

CHAPTER IV

DISCUSSION AND INTERPRETATION OF RESULTS

This section was incorporated for the express purpose of interpreting the several statistical differences found between groups with respect to the preceding quantitative analysis.

An inspection of Table 6 shows that the calculations for rate scores resulted in an F value of 107.83 which reached significance beyond the .01 level of confidence. Reference is made here, of course, to a two-tail-test of significance. As indicated in Chapter II, this result indicates that differences between means of the groups on the posttest I (Y_1) variable regarding rate scores could not be accounted for by differences in mean level of initial ability as measured by the pretest (X) trial. In effect, one or more of the four groups was contributing to this "significant" value. By referring to Table 7 which presents the adjusted means for the pretest (X) and posttest I (Y_1) rate scores, it is possible to evaluate the differences between the teaching methods as they were related to reading rate scores. This evaluation is made in Table 8 where the significance of the difference between groups is presented.

It is clear from Table 8 that group A, the group exposed to tachistoscopic training without verbal "set" for speed, did not achieve

a change in reading rate significantly different beyond the .10 level of confidence from that achieved by group B, the group exposed to tachistoscopic training with verbal "set" for speed. More concisely, the slight statistical significance reveals that these two groups read at approximately the same rate. Correspondingly, group B and group D, the control group who received no special instruction in reading, displayed relatively similar rates of reading. The reading rates of group A and group D approached even closer proximity than those of groups B and D.

Table 8 indicates that when group C, the group exposed to verbal "set" for speed without the tachistoscope, was compared with group B it was found that their reading rates were approximately the same. It should be noted, however, that Table 8 also indicates a significant difference in reading rate between groups C and D. Referral to Table 7, presenting adjusted means, shows group C to have the highest adjusted mean reading rate. Thus, the results shown in Table 8 are interpreted as meaning that group C, the group exposed to verbal "set" for speed without the tachistoscope, attained a greater speed in reading than did groups A and D. While no essential difference in reading rates was found between groups B and C the existence of superiority of group C to all other groups, which group B did not display, can permit the inference that verbal "set" for speed without the tachistoscope produced greater reading speed. Even inclusion of the rapid flash technique used in conjunction with the tachistoscopic projection for the increase of reading speed did not, in this experiment, increase the speed of reading any more than did verbal "set" for speed alone.

The data might tentatively be summarized as indicating that in

itself the tachistoscope did not improve reading rate performance. Moreover, verbal "set" appeared to be the more significant manipulable variable in this investigation; it seemed to engender reading rate more uniformly than did the tachistoscope.

Examination of Table 35 reveals that the calculation for the retention of rate scores resulted in an F value of 14.533, which is significant beyond the .01 level of confidence. This denotes that differences between means of the groups on the posttest II (Y_2) variable regarding rate scores cannot be accounted for by the differences of mean level of initial ability as measured by the pretest (X) trial. By referring to Table 36, which presents the adjusted means for pretest (X) and posttest II (Y_2), it is possible to evaluate the difference between the teaching methods as they affect rate scores. This evaluation is made in Table 37 where the significance of the difference between groups is presented. The posttest II (Y_2) results are mean scores attained 17 weeks after pretest (X) and 9 weeks after posttest I (Y_1). Thus, these scores may be taken as indices of retention of reading speed following instruction or the "acquisition period."¹

It is clear from Table 37 that group A, the group exposed to tachistoscopic training without verbal "set" for speed, did not differ significantly in reading rate even at the .10 level of confidence from that of group B, the group exposed to tachistoscopic training with verbal

¹A similar comparison of posttest I (Y_1) with posttest II (Y_2) indicated no significant difference between reading rate immediately following the "acquisition period" and the retention check 9 weeks later. The reader is referred to Tables 21 and 22 for a presentation of the F values and the adjusted means.

"set" for speed. The retention check revealed that the slight statistically significant difference in reading rate performance on posttest I (Y_1) failed to exist on posttest II (Y_2). Correspondingly group B and group D, the control who received no special instruction in reading, failed to differ significantly in reading rate performance at the .10 level of confidence which existed at the end of "acquisition" (Y_1).

Table 37 also indicates that when group B was compared to group C, the group exposed to verbal "set" for speed without the tachistoscope, there was a statistically significant difference at the .05 level of confidence which did not exist at the end of "acquisition" (Y_1). Table 37 further indicates a statistically significant difference in reading rate when groups C and D were compared. Referral to Table 36 which presents adjusted means shows group C to have the highest adjusted mean reading rate. Thus, the results shown in Table 37 can be interpreted as meaning that group C, the group exposed to verbal "set" without the tachistoscope, attained a greater speed in reading than did groups A and D. While the difference in reading rate between groups C and B is not as highly significant as the difference between groups C and A and groups C and D, the superiority of group C over all groups permits the conclusion that gains made in reading rate performance were retained to a greater degree by group C than by groups A, B, and D.

In summary it might be concluded that group C which was exposed to only verbal "set" for speed not only attained a greater rate of reading but retained more of that particular proficiency than did either of the remaining trio of groups. However, no statistically significant change was affected for comprehension performance by any of the

experimental methods employed. Although a change in comprehension did not accompany the change in rate performance, it should be noted that there was no loss in comprehension scores among the groups who showed superiority in rate.

The foregoing discussion in itself would not constitute an adequate discussion of this research since a comparative evaluation between this investigation and previous studies would be lacking. Therefore, only those studies that are more pertinent to the scope of this problem will be assessed and discussed in relation to the results of the present study. Divergencies will be resolved in so far as they can be determined.

As previously discussed in Chapter I, some tachistoscopic studies reported in the literature suffer from inadequate analysis in view of the fact that other devices and materials were used with the tachistoscope and no effort was made to determine the effectiveness of each. Rust (48) perhaps utilized some of the gains due to Dr. Osburn's "Types of Thinking" and "Dynamic Vocabulary Exercises," and Norman Lewis' list of "Five Hundred Most Important Words for Your Reading Vocabulary." He treated this investigation as if the gains were due to tachistoscopic presentation without consideration of the possible influence of other materials which may have promoted part of the gains. In isolating some factors which undoubtedly underlie the procedures used by Rust (48) and utilizing these as experimental variables, the results of the present study cannot be used to support the findings of Rust (48). Thus, confounding the experimental procedures by injection of an uncontrolled and unaccounted for variety of materials has led several investigators to

attribute their results to the efficacy of the tachistoscope. Witness the work of MacLatchy (21) and the U. S. Air University (44).

This investigation does not substantiate Renshaw's (25,26) enthusiastic claims for the value of visual form training in aiding the process of learning to read. Such optimistic results as reported by Renshaw (25,26) may be attributable to the 10.8 I.Q. difference in favor of the experimental group over the control group rather than his experimental manipulation. That the present study does not support his findings is not to be viewed with alarm in as much as individual difference which apparently caused some bias in his results does not operate in a similar fashion in the present study.

In much the same fashion Melcer and Brown (23) credited rapid gains in reading to the tachistoscope. However, the difference in experiential background with language in their experimental and so called control group were not properly equated. One would expect that the experimental group which included forty-five essentially Spanish-speaking individuals could advantageously use instruction of any kind in reading English, whereas the control group made up entirely of English-speaking individuals might easily have required more intensive training than they received before their facility would have increased. It is felt that such lack of consideration for the nature of control groups precludes any "crucial" comparison of the results of works such as those just cited and the results of the present study.

Even more questionable than the work of Melcer and Brown (23) just cited was that of Brown (9) and also Schwarzbek (41). Brown reported the results of an adult extension class without a control group.

In addition he used a multitude of materials in conjunction with the tachistoscopic training. Schwarzbek's (41) experimental group is suspect because of the multitude of fears, motivation, status, requirements, et cetera to be found in the human relations aspect of industry (4) all of which he seems to neglect in his results of the efficacy of the tachistoscope among employees.

Articles (25,26,37,41) and books (1,2) have been written encouraging the use of this device, and schools are purchasing the tachistoscope. However, this study concludes that there is no evidence that its value is significantly greater than other methods of reading improvement which do not employ this device. It is interesting to note that Weber (38), Freeburne (14), Sutherland (34), Allen (7), Manolakes (22), and Goins (46) also support this theory by reporting that when compared to another method, tachistoscopic training did not produce superior results. The present investigation further produces results that favor another method over tachistoscopic training, a method which does not make use of any mechanical device.

The results of this study agree with investigators such as Dearborn (12), O'Brien (24), Sommerfeld (43), Glock (17), Springsteed (32), and Sisson (28) who made strong inferences and conclusions that quick exposure training in and of itself does not bring about an improvement in reading unless accompanied by a secondary factor such as motivation. This study is in agreement with those statements by Springsteed (32) in which she reported that outstanding improvement in a school wide training program was largely due to verbal motivation. This study further agrees with Sisson's (28) conclusion that motivated rapid reading is the

most salutary single medium for the attainment of reading proficiency.

The present investigation concurs with investigations conducted by Weber (38), Imus, Rothney, and Bear (58), and Deal (11) which found high degrees of retention of reading rate are to be expected from intensified training in reading improvement. This study is not in accord with Blayne (8) in that his study supported the conclusion that retention of gains in rate was actually enhanced over post-training scores. However, his conclusion might be questioned since the number of cases reported in his study were not sufficient to warrant definite conclusions.

This study refutes Barnette's (2) theory that only superlative teaching with long hours of preparation can achieve gains equivalent to tachistoscopic training. A brief but meaningful period of verbal motivation seemed sufficient; yet arduous hours of preparation were not needed in order to promote remarkable improvement in reading rate.

The tachistoscope was not seen as the core of a successful reading program when the results of the present study were interpreted. Success in reading is probably more completely enhanced by an attitudinal change in the subject. In as much as the tachistoscope produces such change it is of value, but the results obtained indicate, in this experiment at least, that the "set" the subject undertakes, the willingness of the subject to learn to read faster seems a far more important and sufficient cause for improvement. The major implication of the study is clear: reading ability can be improved by increasing the motivation of the pupil and in turn he will evolve a technique suitable to himself by means of which his reading will improve. Therefore, the

classroom teacher of normal pupil groups who can encourage motivation or a "mind-set" for speed in his pupils can promote reading improvement without the expenditures attendant upon the use of a tachistoscope.

The study did not specifically attempt to influence comprehension, and thus it cannot be claimed to have evolved a most superior method for teaching reading. It does suggest, however, that verbal "set" may well be incorporated in a more efficient method for teaching reading.

It is not felt that any method or device which enhances motivation on the part of the student or the instructor should be neglected. However, a variety of methods and devices may supply motivation and one should be cautioned against sole dependence on one method or device which seems popular or novel.

Within probability the requisite skills for improving reading rate lie in the ability of the teacher to motivate the students for an increase in reading rate and expensive apparatus are not essential to release these potentialities.

CHAPTER V

SUMMARY AND CONCLUSIONS

The ability to read is tremendously important for scholastic achievement, therefore the teaching of reading constitutes one of the most crucial responsibilities of the public school today. In view of the imperative need for developing reading abilities many educators have incorporated mechanical devices in their reading improvement programs. Among these devices the tachistoscope has been used extensively. However, there is lack of agreement as to whether improvement should be accredited to the tachistoscopic technique or to a secondary factor, "set." The present study was conducted to ascertain the effects of the tachistoscope and "set" on reading rate and comprehension.

The purposes of the study were: (1) to determine the effect of the tachistoscope with verbal "set" for speed on reading rate and comprehension; (2) to determine the effect of the tachistoscope without verbal "set" for speed on reading rate and comprehension; (3) to determine the effect of verbal "set" for speed without the tachistoscope on reading rate and comprehension; (4) to compare the results of these three procedures of teaching reading; and (5) to check the retention of gains in reading rate and comprehension produced by these three methods.

Four groups were used in the study: Group A, the group exposed

to tachistoscopic training without verbal "set" for speed; group B, the group exposed to tachistoscopic training with verbal "set" for speed; group C which was instructed in methods for improving reading and given verbal "set" for speed without the use of any mechanical device or training manual; and group D, the control group who was given no instruction in reading improvement. The subjects were 396 sophomore English students from Capitol Hill High School, Oklahoma City, Oklahoma. It was assumed that these students represented the "typical" sophomore English students in the school system. The investigation was conducted under regular classroom conditions, each class having its own English teacher as the instructor in reading improvement sessions. Classes with their respective teacher were assigned to the experimental and control groups on a random basis. Prior to the instructional period each group was given, as a pretest, the Survey Section of the Diagnostic Reading Test, Form A. Each group was given sixteen 20 minute periods of instruction, two days a week over an interval of eight weeks. The Survey Section of the Diagnostic Reading Test, Form B was given as the post-training test. Nine weeks after the termination of reading instruction the Survey Section of the Diagnostic Reading Test, Form C was administered as a retention check.

The null hypotheses tested in this study were: (1) there is no significant difference between the three experimental groups and the control group in reading rate and comprehension; and (2) there is no significant difference in the retention of gains between the three experimental groups and the control group.

On the basis of a series of single classification covariance

analyses it was necessary to reject both null hypotheses regarding reading rate performance. Conversely, the analysis indicated that both hypotheses be accepted regarding comprehension performance.

From the results of this investigation the following conclusions are offered:

1. Verbal "set" emerged as the most significant manipulable variable; it seemed to engender reading rate more uniformly than did the tachistoscope. The groups receiving only verbal "set" not only attained a greater rate of reading but retained more of that particular proficiency than did either of the remaining three groups.

2. The tachistoscope with or without verbal "set" was ineffective as a means of producing statistically significant gains in reading rate and comprehension. However, the tachistoscope with verbal "set" for speed did produce greater gains than the tachistoscope without verbal "set" for speed.

3. Comprehension performance was not affected by any of the methods employed. Although a change in comprehension did not accompany the change in rate performance, it can be concluded that there was no loss in comprehension scores among the groups who showed superiority in rate.

The conclusions above seem to support the following implications:

1. Reading ability can be improved by increasing the motivation of the pupil and in turn he will evolve a technique suitable to himself by means of which his reading will improve. Therefore, the classroom teacher of normal pupil groups who can encourage motivation or a mind-set for speed in his pupils can promote reading improvement without the

expenditures attendant upon the use of a tachistoscope.

2. The superior technique of verbal "set" for speed without the tachistoscope did not promote an increase in comprehension. Therefore, the investigation cannot be claimed to have evolved a most superior method for teaching reading. It does suggest, however, that verbal "set" may well be incorporated in a more efficient method for teaching reading.

3. Any method or device which enhances motivation on the part of the student or the instructor should not be neglected. However, a variety of methods and devices may supply motivation and one should be cautioned against sole dependence on one method or device which seems popular or novel for the moment.

4. Within probability the requisite skills for improving reading rate lie in the ability of the teacher to motivate the students for an increase in reading rate and expensive apparatus are not essential to release these potentialities.

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APPENDIX A

SAMPLES OF INSTRUCTIONAL MATERIAL

LESSON VII

Teacher _____ (Group A)

October 25, 1954

Resource Material for Introductory Remarks (Five minutes)

During the past two weeks we have been studying skills in the mechanics of reading. Let us review these very briefly:

1. Read with a minimum number of fixations, or stops, to the printed line.
2. Develop a wide eye-span which absorbs phrases and thoughts, rather than isolated words.
3. Break any habits of moving your lips or vocalizing when you read silently.
4. Eliminate the tendency "to look back" and reread words. There must be no regressions if you expect to become a smoother reader.

Improvement in your reading depends to a great extent on how much you have been applying these rules to the reading you do all day long. When you read English, science, a novel, or a newspaper, force yourself to read efficiently.

RHYTHM is another skill we need to develop for efficient reading. The fixations or pauses made by good readers come at about the same place on successive lines of print and there are generally the same number of fixations to each line. This regularity is called reading rhythm. Today we have a slide for the tachistoscope that is designed to help you achieve this rhythm which will in turn help you become a smoother, better reader.

The ability to read efficiently is a skill which can be developed only by analyzing present reading habits, rooting out bad ones and substituting good ones.

Slide	Target	Timer	Response	Notes and Comments
43	Paragraph for demonstrating reading rhythm	Open		Remove cover plate and expose the entire paragraph. With your pencil on the slide, have students follow its rhythmic sweep with their eyes. Instruct students to re-read paragraph. Tap a steady rhythm and let students match the rhythm with their eye-movements.
44	Two-word phrases	1/100	Oral	This slide will serve as a "warm-up" to the more difficult exercises that are to follow.

Slide	Target	Timer	Response	Notes and Comments
45	Three-word phrases	1/100	Oral	By now students should not have to concentrate so heavily on focus. They should merely try to catch a mental image of the flash. Their minds can be compared to an unexposed film in a camera.
46	Three-word phrases	1/100	Written & checked	
47	Three-word phrases	1/100	Oral	If these seem too easy for some students remind them that the slides become progressively more difficult. Mastery at each level will bring best results.
48	Three-word phrases	1/100	Written & checked	Reading these phrases as they are presented should transfer to rhythmic phrase reading on the printed page.
49	Four-word phrases	1/100	Oral	
50	Four-word phrases	1/100	Written & checked	

Stress that students use the skill of rhythmic phrase reading in their everyday reading, and urge them to practice other newly acquired skills.

LESSON VII

Teacher _____ (Group B)

October 25, 1954

Resource Material for Introductory Remarks (Five minutes)

During the past two weeks we have been studying skills in the mechanics of reading. Let us review these very briefly:

1. Read with a minimum number of fixations, or stops, to the printed line.
2. Develop a wide eye-span which absorbs phrases and thoughts, rather than isolated words.
3. Break any habits of moving your lips or vocalizing when you read silently.
4. Eliminate the tendency "to look back" and reread words. There must be no regressions if you expect to become a faster reader.

The purpose of this reading period is to increase your reading speed and improve your comprehension. The greater your skill in these four mechanics the greater your normal speed. The greater your speed, the more accurate your comprehension is likely to be.

RHYTHM is another skill we need to develop for smooth, fast reading. The fixations or pauses made by good readers come at about the same places on successive lines of print, and there are, generally, the same number of fixations to each line. This regularity is known as reading RHYTHM. Today we have a slide for the tachistoscope that is designed to help you achieve this rhythm which will in turn increase your speed and smooth out your reading. Thus you become faster and better readers.

The ability to read faster is a skill which can be developed only by analyzing your present reading habits, rooting out bad ones and substituting good ones.

Remember faster reading can come to anyone who wants to improve and this is a wonderful opportunity for you to do so. Being a good reader means time in the "bank."

Slide	Target	Timer	Response	Notes and Comments
43	Paragraph for demonstrating rhythm	Open		Remove cover plate and expose the entire paragraph. With your pencil on the slide, have students follow its rhythmic sweep with their eyes. Instruct students to read paragraph. Tap a steady rhythm and let students match the rhythm with their eye movements.

Slide	Target	Timer	Response	Notes and Comments
44	Two-word phrases	1/100	Oral	This slide will serve as a "warm-up" to the more difficult exercises that are to follow.
45	Three-word phrases	1/100	Oral	By now students should not have to concentrate so heavily on focus. They should merely try to catch a mental image of the flash. Their minds can be compared to an unexposed film in a camera.
46	Three-word phrases	1/100	Written & checked	
47	Three-word phrases	1/100	Oral	If these seem too easy for some students remind them that slides become progressively more difficult. Mastery at each speed will bring best results.
48	Three-word phrases	1/100	Written & checked	Reading these phrases at a high rate of speed should transfer to rhythmic phrase reading on the printed page.
49	Four-word phrases	1/100	Oral	
50	Four-word phrases	1/100	Written & checked	

Encourage students to use the skill of rhythmic phrase reading in their everyday reading and strive to become SPEED READERS.

READ AT A LITTLE FASTER RATE THAN IS COMFORTABLE!

LESSON VII

Teacher _____ (Group C)

October 25, 1954

Materials

Student: Prose and Poetry for Appreciation
Graph
Pencil

Teacher: Prose and Poetry for Appreciation
Stop watch

Resource Material for Instructor

During the past two weeks we have been studying skills in the mechanics of reading. Let us review these briefly:

1. Read with a minimum number of fixations, or stops, to the printed line.
2. Develop a wide eye-span which absorbs phrases and thoughts, rather than isolated words.
3. Break any habits of moving your lips or vocalizing when you read silently.
4. Eliminate the tendency "to look back" and reread words. There must be no regressions if you expect to become a faster reader.

The purpose of this reading period is to increase your reading speed and improve your comprehension. The greater your skill in these four mechanics the greater your normal speed. The greater your speed, the more accurate your comprehension is likely to be.

Improvement in your reading depends to a great extent on how much you have been applying these rules to the reading you do all day long. When you read English, science, a novel, or a newspaper, force yourself to read efficiently.

Today, let's do some additional practice on expanding your eye-span. Your eyes should pick up a number of words at one glance instead of one or two. This automatically reduces the number of pauses or fixations per line.

In efficient reading, the fixations come at about the same places on successive lines of print, and there are generally the same number of fixations on each line. This regularity is known as rhythm.

Let's turn to page 493* and as we read this selection silently, let's make our eye move across the line with rhythmic sweeps, pausing

*Read silently with students and tap a slow, steady rhythm to set speed for eye movements. Gradually increase rhythm as they read.

to pick up several words at each fixation. Try making three fixations per line, keeping a steady rhythm. (Use the first 27 lines of the poem "Daniel")

Now we will reread this selection with two fixations per line. Keep a steady reading rhythm.*

Remember to read forward to overcome the habit of regression or back-tracking over words. Do your reading with your eyes and mind only--no lip or throat movements.

Rate check--For today's 1000 word reading rate check, turn to page 547. Read The Tell-Tale Heart beginning with "True...nervous very, very..." Read to paragraph 4, page 549. Record your words per minute on your graph. (Follow standard procedures for initiating the rate check.)

*Continue to tap rhythm as students reread the selection.

REMIND STUDENTS TO PRACTICE NEWLY ACQUIRED SKILLS IN ALL THEIR READING!

LESSON VIII

Teacher _____ (Group A)

October 27, 1954

Resource Material for Introductory Remarks (Five minutes)

We have been discussing how reading is still in the "horse and buggy" stage when we read word for word. Here is another suggestion to take us off the cobblestones to smoother sailing along the printed page. Reading every "and," "if," and "but" on the page can get you so bogged down in details that you will fail to concentrate on the main ideas. The KEY WORDS in a sentence are the ones that carry the meaning. A small child uses key words when he says "want drink water" instead of "I want a drink of water." Actually you can get the meaning without the "I," "a," and "of." So it is with reading--look for KEY WORDS and these unimportant words will automatically play their small part as you read in phrases or thought units. Nouns and verbs carry the essential thought, aided sometimes by adjectives and adverbs.

The reader who pays excessive attention to every word and detail is likely to lose a lot of the impact of the main theme of a story, and the slow, detailed reader may actually not result in as good comprehension as you might think.

Note these first two slides. Do you see how the main idea is evident without going into the details of conjunctions, prepositions and articles?

Slide	Target	Timer	Response	Notes and Comments
51 & 52	Demonstration of KEY WORDS	Open		KEY WORD reading is the KEY to smooth reading. Ask the students if they can make sense from reading the skeleton paragraph. You might ask some alert student to supply the missing words, and then move on to slide #52 for comparison.
(When you change slides be sure you always give one example for the students to locate the target)				
53	Four-word phrases	1/100	Oral	These are short and students should master most of them.
54	Information signs	1/100	Written & checked	Ask students to keep a complete record of all written responses and check each wrong response carefully. Inform them that you want the responses at the end of the session today.
55	Four-word phrases	1/100	Oral	

Slide	Target	Timer	Response	Notes and Comments
56	Four-word phrases	1/100	Written & checked	Continue on same response sheet
57	Four-word phrases	1/100	Oral	
58	Four-word sentences & one five word sentence	1/100	Written & checked	Tell the students not to be discouraged if they missed a few. There will be more practice in subsequent lessons before mastery can be expected.

LESSON VIII

Teacher _____ (Group B)

October 27, 1954

Resource Material for Introductory Remarks (Five minutes)

We have discussed how your reading time is slowed to a "horse and buggy" speed by reading a word at a time. As we practice rapid reading by seeing groups of words, let us also include this helpful hint: READ FOR KEY WORDS. As you progress in reading ability you'll find it isn't necessary to read every word. Reading every "and," "if," and "but" on a page will get you so bogged down in separate words that you will fail to concentrate on main ideas. Look for KEY WORDS, and these unimportant words will automatically play their small part as you read in phrases and thought units. Nouns and verbs carry the essential thought, aided sometimes by adjectives and adverbs.

How is your speed? If you're reading 225 words per minute, your rate is about the national average, or the rate of a sixth-grade child who masters most of his reading assignments. High school students have difficulty if they cannot read over 300 words a minute. The college student who reads less than 350 words a minute will find the going tough. It is encouraging to know you can improve your reading rate up to 50% by your own efforts. Tachistoscopic training is designed to help you reach that doubled speed, which many students have attained.

Notice these first two slides and see how reading KEY WORDS can increase your speed.

Slide	Target	Timer	Response	Notes and Comments
51 & 52	Demonstration of KEY WORDS	Open		KEY WORD reading is the KEY TO RAPID READING. Ask the students if they can make sense from reading the skeleton paragraph. You might ask some alert student to fill in the missing words then move on to slide #52 for comparison.
(When you change slides be sure you always flash one example for the students to locate the target)				
53	Four-word phrases	1/100	Oral	These are short and students should master most of them.
54	Information signs	1/100	Written & checked	Ask students to keep a complete record of all written responses and check each wrong response carefully. Inform them that you want the responses at the end of the session today.
55	Four-word phrases	1/100	Oral	

Slide	Target	Timer	Response	Notes and Comments
56	Four-word phrases	1/100	Written & checked	Continue on same response sheet
57	Four-word phrases	1/100	Oral	
58	Four-word sentences & one five-word sentence	1/100	Written & checked	If some of the students feel that they missed a number of these sentences, tell them that they will have more practice in subsequent sessions before mastery will be expected.

LESSON VIII

Teacher _____ (Group C)

October 27, 1954

Materials

Student: Prose and Poetry for Appreciation
 Graph
 Pencil

Teacher: Prose and Poetry for Appreciation
 Stop watch

Resource Material for Instructor

We have discussed how your reading time is slowed to a "horse and buggy" speed by reading a word at a time. As we practice reading more rapidly by seeing larger groups of words this new suggestion will be helpful: READ FOR KEY WORDS. You have been trained in elementary school to "read every word." As you progress in reading ability, you'll find that not every word should be read. Reading every "and," "if," and "but" on the page can get you so bogged down with separate words that you will fail to concentrate on the main ideas. The KEY WORDS in a sentence are the ones that carry the meaning. A small child uses them when he says "want drink water" instead of "I want a drink of water." Actually you can get this meaning without the I, a, and of. The same is true with reading, it is not necessary for the reader to give attention to the unimportant words. He looks for the KEY WORDS as he reads in phrases or thought units. Nouns and verbs carry the essential thought, aided sometimes by adjectives and adverbs.

To better demonstrate what has just been said, let's direct our attention to the board:* Only KEY WORDS are used in this paragraph.

- - - red squirrel - - - - - traits - - - - - offensive.
 - - - - - quarrelsome, - - - - - "light-fingered" - - -
 steals - - - - - industrious neighbors, - - - chipmunks - - - mice.
 - - - - - not all. Sometimes, - - - - - daring murderer - - -
 - - - songbirds. - - - - curiosity reminds - - - - - Paul Pry, - - -
 blue jay. - - - - - gossipy - - - - talks - - - - loud, harsh voice,
 snickering, chattering, - - - whistling.

*Before class or at most convenient time write the skeleton paragraph which contains only KEY WORDS on the board. After students have read it ask someone to try to fill in the blanks, or you may desire to fill it in by group discussion.

The unimportant words are included in this paragraph:

The red squirrel has some traits that are most offensive. Besides being quarrelsome, he is "light-fingered" and steals from his more industrious neighbors, the chipmunks and mice. But that is not all. Sometimes, he is a daring murder of our songbirds. His curiosity reminds you of Paul Pry, the blue jay. He is gossipy and talks in a loud, harsh voice, snickering, chattering, or whistling.

As you read the 1000 word selection today read a little faster than is comfortable. Read for key words. If you are reading 225 words a minute, you are reading at about the national average, or the rate of a sixth-grade child who masters most of his reading assignments. That is not fast enough to make newspaper or magazine reading enjoyable. High school students have difficulty with their studies if they cannot read 300 words per minute or faster, and college students who read below 350 words will find the going tough. In some jobs even 600 words per minute is too low.

Rate check---For today's 1000 word reading rate check, turn to page 358. Read Mountains and Men beginning with "In the afternoon. . ." Read to the bottom of page 360. Record your words per minute on your graph. (Follow standard procedures for initiating the rate check.)

KEY WORDS THE KEY TO FASTER READING:

APPENDIX B

SAMPLES OF TACHISTOSCOPIC EXPOSURES

SAMPLES OF PHRASES AND SENTENCES USED IN
TACHISTOSCOPIC TRAINING
(Lessons VII and VIII)

(Slide 44)

Two-word phrases

grow tall

his head

floor lamp

his tail

ask him

be good

before long

can buy

(Slide 47)

Three-word phrases

around the circle

beyond the light

beside our house

go toward home

spill black ink

iron your shirt

beneath the oak

will have taken

(Slide 54)

Sentences

Follow the arrow.

Pavement slippery.

Please close the window.

Turn to the right.

Keep off soft shoulder.

Go to the store.

Sign on the dotted line.

Men working.

Read efficiently.

(Slide 56)

Four-word phrases

aids to good reading

this is good training

to improve your reading

you learn by doing

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