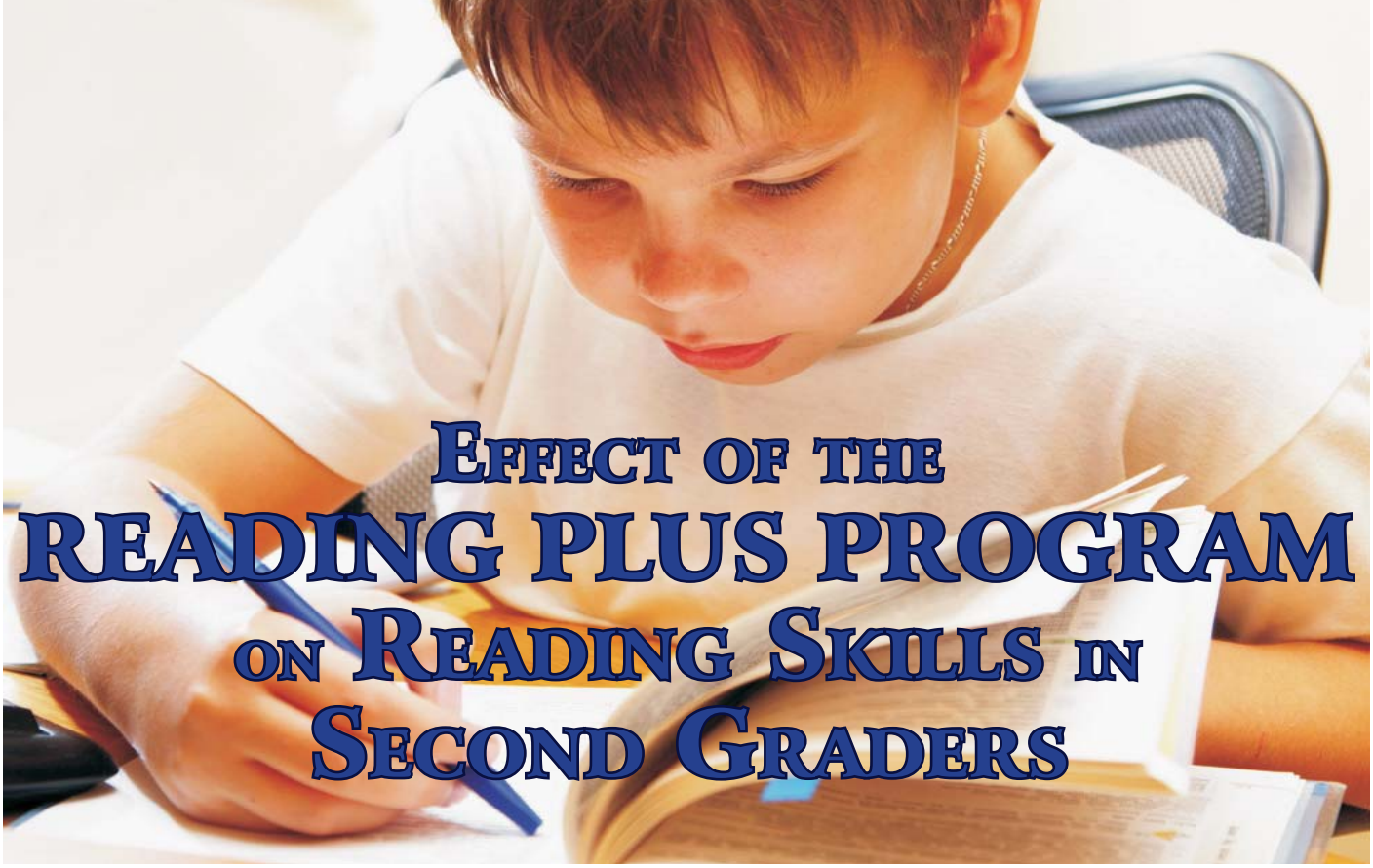

Effect of the Reading Plus Program on Reading Skills in Second Graders

- **John Shelley-Tremblay, Ph.D.**
- **Joshua Eyer, M.S.**

University of South Alabama
307 N. University Blvd.
Mobile, AL 36608-0002

Key Words

computer-based instruction, Gates-MacGinitie Reading Tests®, reading fluency, reading, Reading Plus Program, Visagraph III

Abstract

Previous research has evaluated the efficacy of the Reading Plus Program as a computer-based instructional program for developing reading skills and oculomotor efficiency. While many of these studies have found significant gains in reading skills and oculomotor efficiency, some have found gains only in the latter. The present study extends previous research by employing a true experimental design to assess gains in reading skills and oculomotor efficiency in 2nd graders in a public school. Students were randomly assigned to the Reading Plus Program or normal classroom instruction group at the beginning of the school year. Students were administered a standardized reading test, and Visagraph III to assess oculomotor efficiency before and after the training period. Interactions in the ANOVA model indicated significantly greater gains in reading comprehension, and word knowledge in the Reading Plus Program group compared to the control group. Analysis also revealed interactions showing greater gains in reading rate and reductions in the duration of fixation for the Reading Plus Program group compared to the control group. Furthermore, the pre-test Visagraph variable rate was a significant predictor of pre-test reading skill. Changes in duration of fixation were predictive of changes in reading skill, indicating the potential diagnostic utility of the Visagraph III.

Shelley-Tremblay J, Eyer J. Effect of the Reading Plus Program on Reading Skills in Second Graders J Behav Optom 2009;20:59-66.

INTRODUCTION

The Reading Plus (RP) program[a] has been in existence in some form for over 30 years, and it has undergone numerous revisions and changes. In general, RP consists of a series of separate, computer-administered programs and exercises that are designed to develop silent reading fluency. Fluency is defined as an individual's ability to "…read quickly, efficiently, and with an appropriate degree of comprehension."[1] According to the National Reading Panel, out of the core reading competencies required by students, fluency was the one that was the most difficult to develop using traditional, commonly available classroom instructional techniques. Additionally, recent research describes a Fluency-Comprehension subtype of reading disability.[2] Since RP is a program developed to increase fluency it may have utility for regular and special educational instruction. The basic approach of the RP program is to begin with objective measurements of several aspects of reading using an infrared eye-tracker, the Visagraph III™ (Visagraph).[a] It provides data on reading rate and oculomotor characteristics while students read grade-normed passages.

Review of the RP Research Literature

Published studies regarding the ability of RP to improve some aspects of the reading process are largely favorable, although many inconsistencies exist in both the nature and the amount of change that occurs as a result of training. Marrs and Patrick published an evaluation of RP in which they concluded that their study yielded conflicting evidence with regards to the effectiveness of the RP.[3] These authors used a retrospective review of the records of 87, 6th through 8th graders in a Midwestern public middle school to assess gains in reading skills. It is unclear exactly which sub-programs within the RP program were utilized by the subjects in this study. They stated, "The sequence of exercises completed by each student varied depending

on the individual reading level and student and teacher preference. The RP does allow the student to choose from among the various components of the program." Yet, only one RP sub-program is described in the paper. Thus, while Marrs and Patrick claim to have evaluated the RP program, it is impossible to know how much, or indeed if, the different subcomponents of the program were used.

Marrs and Patrick also reported that the Visagraph measure of Reading Efficiency (words per minute/fixations per 100 words + regressions per 100 words) was correlated significantly with the students' starting level of reading skill on the Iowa Test of Basic Skills. However, Marrs and Patrick state that while functional eye movements may be correlated with reading skill, they are not the cause of good or poor reading, as stated by Rayner.[4] Nevertheless, eye movements recorded with the Visagraph successfully classified middle school students as either good or poor readers.[5]

In another study, the RP was used in a pilot study with a group of optometric graduate students.[6] The investigators sought to determine the effect of RP on eye movement variables. Five experimental and three control participants of 20 volunteers who began the study completed RP's online reading level assessment as well as Visagraph recordings. Experimental participants completed about 10 weeks of RP training, but the frequency and length of the session was not specified. Assignments were not random, but based on willingness to complete the RP sessions; thus the "control" group is clearly non-equivalent in motivation. Their findings suggested that fluency and oculomotor efficiency improved. The subjects also reported that they felt their reading ability improved.

A series of investigations by Solan and Shelley-Tremblay[7-9] used experimental designs, but selectively utilized aspects of the RP program as part of a novel training technique to specifically target the development of selective attention. In the first of such studies 31 6th graders who were achieving poorly in reading received either programs within RP that stressed development of oculomotor efficiency first, or those programs within RP that stressed development of comprehension and study skills first.[6] Following 12 weeks of training, all participants switched to the other parts of the program. Both aspects of training were found to be extremely beneficial. The students showed improvements in reading learning rate from an average of only 60% before treatment to 400% after treatment. Both aspects of RP produced significant gains in oculomotor efficiency, including gains in reading rate and reductions in fixations and regressions. Thus, RP was demonstrated to improve the fluency of below-average 6th grade readers, with objective increases in reading speed accompanied by objective increases in comprehension.

A follow-up study was conducted on an equivalent sample of children.[8] Only direct reading training consisting of attention training where several of the RP sub-programs that stressed development of selective and sustained attention were used. At the completion of attention therapy, the mean standard attention score of the experimental group improved one standard deviation from 95 to 113 (41st to 77th percentiles) on the attention tests. Mean reading comprehension scores of the experimental group improved significantly from grade equivalent (GE = 4.1 years to GE = 5.2 years, or from the 23rd to 35th percentile). Controls, however, showed no significant improvement in grade equivalent scores or percentiles in reading comprehension after 12 weeks. The study supported the notion that visual attention is malleable and that attention therapy has a significant effect on reading comprehension. The effectiveness of the RP programs, per se, was, however, confounded by the inclusion of other educational software.

Thus, despite the number of publications that have dealt with RP in some form, none have examined the effectiveness of the program as a whole as it is used in a normal school setting. Further, they have not employed a true experimental design with prospective, random assignment to experimental and control groups. The current study attempted to bridge this gap by using a recent version of RP to determine its ability to positively impact reading skill, using prospective random assignment to an experimental or control group.

Table 1. Characteristics of the initial pool of subjects participating in the study

Variable	Category	Statistic	
		N	**Percentage**
Ethnicity	White	70	90.9
	Asian/Pacific Islander	5	6.5
	Hispanic/Latino	2	2.6
	Total	77	100.0
	Gender	**Value**	**Percentage**
Control	Male	25.0	55.6
	Female	20.0	44.4
Reading Plus	Male	14.0	43.8
	Female	18.0	56.2
Age (years)		**Mean**	**Standard Deviation**
	Male	7.7	0.3
	Female	7.7	0.4

METHODS

Participants

The total pool of prospective subjects (n = 77) were students in grade 2 at a large, southwestern public elementary school. Table 1 displays the characteristics of the students who participated in the study. The subjects were drawn from six 2nd grade classrooms. Their classrooms were randomly assigned for the fall semester to be either in the RP (n = 45) or a control group (n=32) that received normal classroom instruction. Two of the students qualified for reduced price school lunch, while none qualified for free lunch, indicating a low level of poverty in the sample. All students who did not receive RP in the fall were allowed to take part in the spring to ensure equal access. Research was approved by the Institutional Review Board of the University of South Alabama. Participants' parents were informed of their right not to have their data included in the study; however initial participation was part of the required curriculum for all students. None refused to provide their data for research purposes.

Some participants were excluded from the final data analysis due to either being absent on either the pre-test or post-test dates, or in the case of the RP group, failure to complete the minimum number of training sessions. For the RP group, each participant was required to complete at least 40 total RP sessions, 40 or more Guided Reading lessons, and also to evidence growth greater than 0 on the second part (Part B) of Guided Reading. This last criterion was included to insure that teachers were properly advancing the program.

The assumption was that even struggling students should be expected to make gains in rate since students read passages that were at their comfort level. Thus, the final number of participants included was 20 for the RP group, and 29 for the control group.

MATERIALS

Reading Plus Program

The RP was administered on-line using a browser-based, JAVA application. Students are trained in their normal school computer lab, using PCs, as a part of their language arts instructional period. The RP program that was administered consisted of four sub-programs; PAVE, Guided Reading, Word Memory and Cloze-Plus. PAVE has two sub-programs and Guided Reading has four sub-programs.

1. Perceptual Accuracy-Visual Efficiency™ (PAVE)

The PAVE computer program consists of tachistoscopic exposure practice and oculomotor efficiency training. The participant experiences two programs in each PAVE session.

A. Flash Training

Perceptual Accuracy (Flash) Training: Numbers or letters are flashed in tachistoscopic exposures of 1/10th of a second; students call out (early reading stages) or type what they see. At this rate of exposure, students cannot move their eyes. Thus, they are experiencing a single visual impression during one fixation or eye-pause. Consequently, they can acquire more discrimination and spatial orderliness during these single visual impressions.

B. Scan Training

Visual Efficiency (Scan) Training: Numbers or letters, widely spaced across a line are scanned from left to right at progressively more rapid rates. Students respond or count each time a target element appears.

2. Guided Reading

This program was designed to integrate visual attention with oculomotor control during reading, using a four-part session.

A. Key Words

In this section, students are presented with two activities that provide practice with the key vocabulary words from the reading passage. The key word activity builds familiarity with vocabulary terms that are presented within the story that follows. Students see a sentence with a missing vocabulary word, and are prompted to press the space bar. When they press it, the term appears in the blank space in the sentence where it belongs for 250 msec. After one flash, students are to type in the term on the keyboard. Students may flash the word again as many times as they wish if they have difficulty correctly spelling it

B. Part A.

The first part of the key words in each lesson selection is divided into two section. In Part A the text builds on the screen line by line and then is removed line by line. Students press the spacebar as soon as they finish reading each screen and the reading rate is recorded.

C. Part B

The key words section requires students to read the second half of the short story from Part A. However, the computer program requires the children to read while a moving left-to-right horizontal aperture is exposed, approximately three words at a time.

D. Comprehension

Students then answer ten skill coded questions (observing 25 major skill categories), to determine the level of comprehension and understanding achieved. Students are placed on an automatic rate track that is appropriate for their grade level when they first achieve 70% comprehension on a lesson. The automatic rate track will then increase the rate of presentation of a selection in Guided Reading every time a student's comprehension is 70% or higher.

3. Word Memory

Each Word Memory session starts with a Word Introduction activity. A sentence is displayed and the student is asked to identify and click a highlighted target word. Next, a word scan activity is presented. It involves the scanning of three words from left to right across the screen not unlike what PAVE does with single characters. The program counts each time the spacebar is pressed during the activity. Each time a student completes a scan session correctly, the next scan session is presented at 10 words per minute faster. If a student's count is incorrect, the next session's scan rate remains the same. The minimum scan rate is 30 words per minute, and the maximum is 280 words per minute. After all the lesson words have been scanned, the student moves on to the Flash activity. The target words that were scanned previously are now flashed in sentences similar to the key words section in Guided Reading. The student is first asked to click the Flash button or press the spacebar to flash the omitted word and then type it in. All words are flashed for 1/6 second.

4. Cloze-Plus

The Cloze-Plus™ lessons consist of the presentation of a reading selection in segments along with seven different types of contextual analysis activities. These require a student to choose an appropriate word or furnish a word of his/her choice to complete meaning. Cloze techniques are designed to build vocabulary competence and heighten comprehension.

DEPENDENT MEASURES

A. Visagraph

The Visagraph is an infrared eye-tracking system used for recording and evaluating students' eye movements while reading short passages. The Visagraph provides a comparison of measurements in relation to Taylor's National Grade Level Normative Data and Goals,[10] in addition to recommendations for Reading Plus programs that improve reading capability. The examiner places the goggles on a student's head and adjusts them in relation to the student's inter-pupillary distance. The student then reads a short selection from a test booklet and answers questions to determine his/her comprehension. Simulation of a student's eye-movements over text, multiple reports and data presentations are then auto-generated. The passages were selected by the classroom teachers to be slightly below grade level for that student, to permit normal, fluent reading without the need for excessive decoding. This level of difficulty, where a student can read, based primarily on sight word vocabulary, reflects the level of work that a student normally selects on their own. This level is referred to as the "independent reading level."

The Visagraph provides a number of dependent measures that quantify the oculomotor activity of the reader, including: fixations, regressions, duration of fixation, and rate. Fixations refers to the number of "eye-stops," or pauses between saccadic eye movements that occur per 100 words. Regressions refer to the number of times that the eyes move from right-to-left, against the normal progression of reading. It does not count end-of-line return sweeps, but represents typically more reflexive, short duration returns to text that was just read. Duration of fixation is the length of time that a fixation occurs, in msec. Finally, rate is the number of words read per minute, as estimated by an algorithm that divides the total time tak-

en to read a passage by the total number of words in that passage. For this study, only recordings where students achieved a 7/10 or greater on comprehension questions administered immediately after each passage were used. Students who failed to achieve this score on initial readings, were given an easier passage, and the recording was repeated.

B. Gates-MacGinitie Reading Tests-Fourth Edition[b]

The Gates-MacGinitie Reading Test-Fourth Edition (GMRT) is designed to measure silent reading skills in children in kindergarten through 12th grade.[11] The GMRT Level 2 was administered to all subjects. All students received form S at pre-test and form T at post-test. The GMRT Level 2 test was designed to provide a general assessment of early independent reading achievement. Students completed the testing for Word Decoding and Comprehension subtests in one session, and in an additional testing session for the Word Knowledge test.

Word Decoding

This test evaluates students' abilities to decode or recognize words.[11] Forty-three items are presented with a picture, and four answer choices. The correct answer identifies the picture, and the incorrect choices are phonologically and orthographically similar to the correct answer, thus necessitating that the participant make an appropriate phonemic/orthographic discrimination. For example, if the correct answer was "hat," then the incorrect answers would be: "hot," "hit," and "hut." Each of these incorrect choices shares two out of three phonemes with the right answer, thus requiring a careful consideration of the word sounds of each choice.

Comprehension

The passages in this test represent various kinds of extended text found in written English, including fiction and nonfiction, narrative and expository modes, and a variety of writing styles.[11] All but the last passages consist of four text segments; each segment is accompanied by a panel of three picture-answer choices. The students' task is to choose the picture in each panel that illustrates the text segment or answers a question about the segment.

Word Knowledge

This test evaluates beginning reading vocabulary.[11] It is structured identically to the Word Decoding test, with the exception that the incorrect choices are less frequent, and do not share orthographic/phonological features. The key discrimination in this task is semantic. For example, participants see a picture of a shack, and must choose between "ladder," "shack," "tent," and "apartment." Thus the test is a measure of the store of words that the student has available for reading independently with understanding.

Table 2. Average Usage of Reading Plus Exercises for Treatment Group

Reading Plus Exercise	Mean	SD
Guided Reading Total Lessons	75.38	16.48
Guided Reading Average Sessions/week	3.45	0.42
PAVE Maximun Scan Speed	73.28	31.77
PAVE Maximum Flash Characters	3.72	0.85
Cloze-Plus Total Lessons	42.97	25.18
Word Memory Maximum Speed	108.18	62.23

Table 3. Effect of Reading Plus on Reading Skill Measures for Reading Plus and Control Groups: Descriptive Statistics

Measure	Group	Mean Pre	SD	Mean Post	SD	Difference
GE	Control	3.1	0.9	3.8	1.3	0.7
	RP	3.0	1.2	4.4	1.6	1.4
NCE	Control	63.3	14.7	67.4	16.1	4.1
	RP	61.5	15.9	72.6	15.6	11.1
WD	Control	34.2	7.6	38.1	5.9	3.9
	RP	32.9	7.7	39.0	5.6	6.1
WK	Control	32.1	7.2	34.4	7.8	2.3
	RP	30.7	7.9	36.2	6.2	5.5

All scores are for the Gates-MacGinitie Reading Test. GE = Comprehension Grade-Equivalent, NCE = Normal Curve Equivalent, WD = Word Decoding, WK = Word Knowledge

PROCEDURES

Participants were assigned to either a control or treatment condition. Due to logistical constraints, within-classroom randomization was not possible, so each classroom was assigned to train in the fall, or to be in a wait-list control condition that received training in the spring semester. The pre-training GMRT and Visagraph were administered in the fall by the classroom teachers. They followed directions precisely and adhered to strict time limits for each part of the test. Teachers did not use the GMRT results as part of the classroom grade calculation, but instead as additional diagnostic information about students' reading ability.

Each RP training session occurred during the normal reading time, in place of the standard curriculum that was in place at the school. The RP was administered online using a browser-based, JAVA application. All of the teachers involved in the study had at least two years of experience with RP and the Visagraph, with their initial training being provided directly by the regional representative from RP. Students trained in their normal school computer lab. The control group used various forms of reading instruction for periods of time equal to the treatment group. These included small, ability-grouped guided reading using leveled books, whole group lessons, lessons in phonics and in fluency. Instruction included the basal reading series *Rigby Literacy* by Harcourt Rigby Education,[12] and *Wright Group Literacy* by Wright Group/McGraw Hill.[13]

Taylor Associates recommend a minimum of 40 RP sessions for a normal student. The actual frequency of usage of the students in the current study was a critical issue. Thus, for the current investigation only students who completed 40 or more RP sessions were included. As a further check of usage quality, only those students who completed at least one Guided Reading lesson per RP session were included, as this program is central to the proposed mechanism of instruction for RP. Students were post-tested at the completion of the training by the same educational staff that performed pretest assessments.

Table 4-a. Effect of Treatment on Reading Measures for RP and Control Groups: Inferential Statistics

	Time Main Effect		Interaction x Group	
	F	p	F	p
GM NCE	53.0	< 0.001	11.2	0.001
GM WD	74.5	< 0.001	3.5	0.065
GM WK	27.6	< 0.001	4.5	0.036

F = ANOVA Value, GM = Gates-MacGinitie, NCE = Normal Curve Equivalent, WD = Word Decoding, WK = Word Knowledge, Degrees of Freedom = 1, 72

Table 4-b. Reading Plus Measures with Gates MacGinitie Normal Curve Equivalence Change

	Time	Sessions	Lessons
r	0.414	0.404	0.315
p	0.004	0.005	0.007

r = Pearson's correlation coefficient

RESULTS

Usage Analysis

Students completed an average of 47 (SD = 3.93) RP sessions during the training period. Other usage statistics for the individual exercises are displayed in Table 2.

Effectiveness of RP

Our primary hypothesis was that participants in the RP condition would demonstrate a higher level of growth in reading skills than those in the control group. To test this hypothesis, means and standard deviations were computed separately for the two groups on the GMRT Comprehension subtest, for scores before and after training. These data are displayed in Table 3, which indicates that the control and RP groups began with equivalent reading levels on the GMRT Comprehension scores (Grade Equivalent, GE) of 3.1 and 3.0 years, respectively. These groups both demonstrated growth (Control = 0.7 years, RP = 1.4 years). In order to correct for the non-normal distribution of grade equivalence and allow for a parametric analysis of these changes, the data were converted to Normal Curve Equivalents and subjected to an ANOVA with the within subjects factor of Time (Pre, Post) and between subjects factor of Group (Controls, RP). The inferential results that are displayed in Table 4-a reveal a significant main effect of Time, showing that both groups made significant gains during the training period. In support of the primary hypothesis, a significant interaction between time and training group emerged at the p=<.001 level. This confirms that the rate

Figure 1. Mean Duration of Fixation for RP and Control Groups

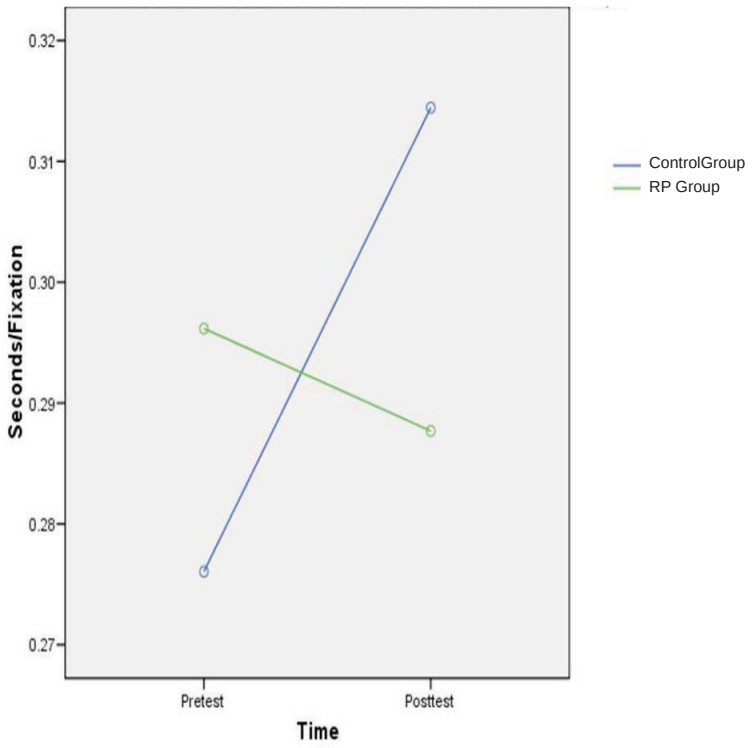

Figure 1. Durations of fixation for the RP and Control groups before and after the treatment period. Note how the control group spends significantly more time on each fixation, while the RP group spends less time.

Figure 2. Mean Reading Rate for RP and Control Groups

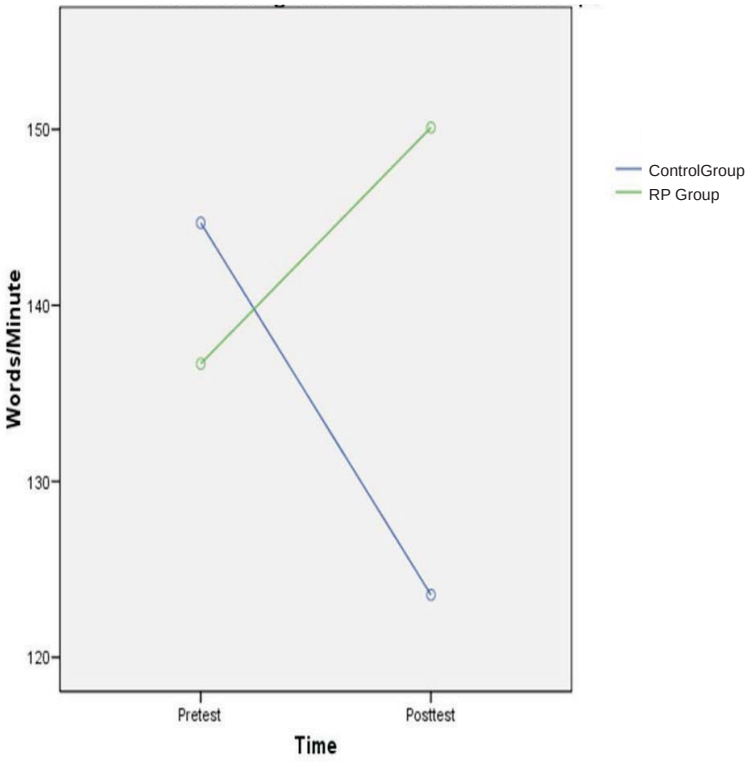

Figure 2. Mean Reading Rate for the RP and Control groups before and after the treatment period. The significant interaction indicates a pattern of increased reading speed for the RP group, but decreased reading speed for the Control group.

of growth in the RP group was significantly larger than that of the control group.

Another way to examine the question of RP's effectiveness is whether using it more is associated with higher levels of gain. Pearson correlations were computed between the changed scores on the GMRT Normal Curve Equivalents for comprehension and three primary indicators of usage that are automatically tracked by RP: Total amount of time using the program (Time), total number of sessions (Sessions), and total number of Guided Reading lessons completed (Lessons). The results displayed in Table 4-b show significant, positive correlations between these variables and the amount of progress made on GMRT scores.

Next, the other two sub-tests within the GMRT; Word Decoding and Word Knowledge were evaluated for change between groups over time. The means and standard deviations for these tests for both groups at pre and post-training are displayed in the bottom portion of Table 3. Inspection of these values reveals a positive growth in the skill areas for both groups, with the RP group demonstrating about twice the rate of gain post-training for both measures. In order to determine whether these gains were significant, the scores were entered into separate ANOVAs with the same factors described immediately above. Table 4-a displays that both groups made significant gains overall, but that the RP gained significantly more on the Word Knowledge measure only (Interaction x Group, p = .036).

The next analysis was undertaken to determine the extent to which RP training affected Visagraph measurements of ocular efficiency. Means and standard deviations were computed for the RP and control groups before and after the training interval for each of the four eye movement variables: Fixations, Regressions, Duration, and Rate. These data are displayed in Table 5. This table shows an increase in fixations and regressions for the control group, and a decrease in the RP group. Duration showed an interactive pattern of change from pre to post training, with the control group spending longer on each fixation, and the RP group spending somewhat less. Rate also showed opposite effects for each group, with the control group actually reading more slowly, and the RP group reading about 10 words per minute (WPM) faster.

Separate ANOVAs were conducted using the same factors as described above on each of the eye movement measures, with the result that only duration showed a significant main effect (p = .045: Table 6). Duration also showed an interaction between groups (p = .002), indicating that the rates of change between the control and RP groups were significantly different. Post-hoc t-tests indicated that only the control group's duration lengthened significantly from pre to post test (p < 0.001), while the RP group did not (p = .054) (See Figure 1). The control group is associated with students spending longer on each fixation while reading, while the RP group is *not* spending significantly less, but the statistical trend is suggestive.

The inferential analysis of the rate data showed a significant interaction, confirming that the pattern of change between the groups was different. In the same pattern as duration, post-hoc t-tests for rate showed that the control group slowed down significantly (p = .003), while the RP group increased, but not to a significant degree (p = .504) (See Figure 2). Thus, the trend for this data is that control group is associated with decreasing reading rate, and RP produced no statistically significant simple main effect. It must be noted that the interaction *was* significant, which shows that the decline in rate observed in the control group did not occur in the RP group.

The previous analyses lead us to examine whether any eye movement variables were associated with participants' initial reading skills, and additionally if changes in eye movements were associated with changes in reading skills. The means for the pre-training eye movement variables (fixations, regressions, duration, rate) served as the independent measures that were regressed onto the dependent variable of the pre-training GMRT Normal Curve Equivalence in a multiple linear regression, with the result that only rate was a significant predictor of Normal Curve Equivalence, $r^2 = .109$, F_{change} (1,55) = 6.734, p = .012. The r^2 value indicates that reading rate accounted for a significant 10.9% of the variance in the pre-training scores for all subjects combined.

The next question addressed was whether the changes in eye movements from pre-test to post-test would correlate with changes in any of the GMRT scores. Put another way, the data was tested to determine which of the eye movement variable change scores could predict a change in the GMRT scores. First, the eye movement variable change scores were regressed onto a GMRT Normal Curve Equivalence change score, with the result being that only the duration change score was a significant predictor of GMRT Normal Curve Equivalence change, $r^2 = .104$, $r^2_{change} = .104$, F_{change} (1,45) = 5.223, p = .027. The r^2 value indicates that changes in duration of fixation

Table 5. Effect of Treatment on Eye Movement Measures for RP and Control Groups: Descriptive Statistics

Measure	Group	Mean Pre	SD	Mean Post	SD	Difference
Fixations	Control	166.84	50.44	176.78	44.05	9.94
	RP	163.68	48.27	159.32	39.50	-4.36
Regressions	Control	30.43	19.50	30.62	16.08	0.19
	RP	27.50	20.54	26.02	13.09	-1.48
Duration	Control	0.28	0.05	0.32	0.06	0.04
	RP	0.29	0.05	0.28	0.05	-0.01
Rate	Control	144.68	46.99	123.55	54.44	-21.13
	RP	136.68	43.25	150.11	71.61	13.43

Table 6. Effect of Treatment on Eye Movement Measures for RP and Control Groups: Inferential Statistics

	Time Main Effect		Interaction x Group	
	F	p	F	p
Fixations	0.126	0.725	0.829	0.367
Regressions	0.043	0.837	0.072	0.789
Duration	4.229	0.045	10.378	0.002

Degrees of Freedom = 1, 46

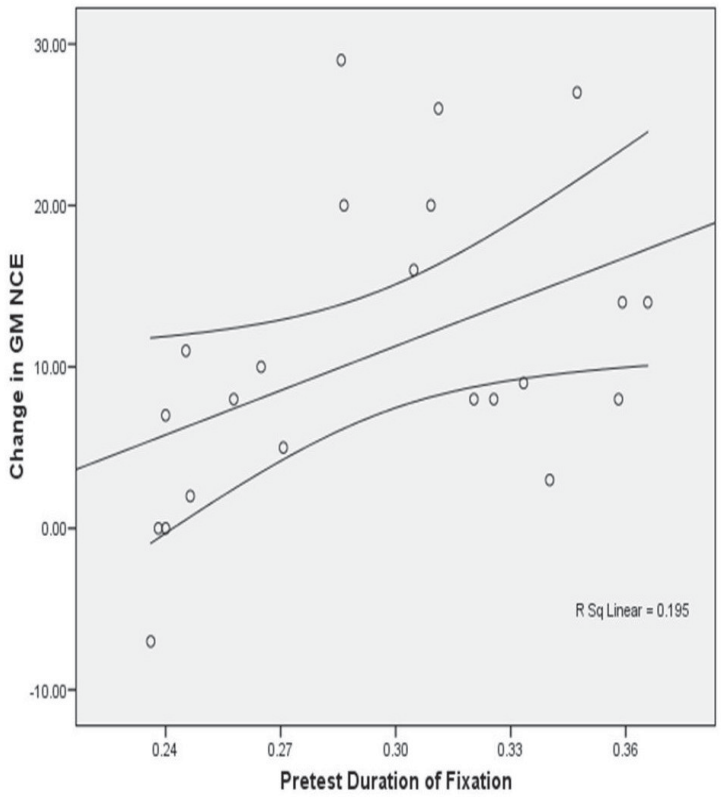

Figure 3. Plot of the regression of duration of fixation, before the treatment period, onto response to intervention, as measured by change in the Gates-MacGinite Normal Curve Equivalence for the overall score.

accounted for 10.4% of the variance in the change scores in GMRT Normal Curve Equivalence for all subjects combined. As a follow up to this analysis, the pre-training duration score was used to predict the change in GMRT normal curve equivalence score for the RP participants in a linear regression (See Figure 3). It was found that Duration did predict change in GMRT Normal Curve Equivalence, $r^2 = .195$, beta = .441, $F(1,20) = 4.842$, $p = .040$.

DISCUSSION

Both groups showed an educationally meaningful amount of growth in their overall reading skill, as indexed by their improvements in grade equivalent level. One way of thinking about the amount of growth would be to convert the grade equivalence to a percent growth measure, such that the percent growth = (Post GE – Pre GE) / Number of Months between Pre and Post. According to this formula, thus, for the control group the time elapsed between tests was about 5 months, the growth was 1.2 years, or 120%. This is indicative of a reading curriculum that, on its own, is producing gains above the level expected by national norms. Given this high ceiling, it is particularly interesting that the RP showed a percent growth score of 2.8, or 280%, more than doubling the growth of the unsupplemented control group.

In terms of changes in ocular efficiency, the picture was more complex. Rate showed opposite effects for each group. The control group actually read at a slower rate after the course of normal instruction. The slower reading rate can be accounted for in terms of a significantly longer duration of fixation for the control group than the RP group. While the RP students were scanning the text relatively more rapidly, pausing at each eye-stop for less time, the control group was actually spending longer on each fixation by the end of their normal one semester course of instruction. This type of finding suggests that one of the outcomes of more conventional, group-based classroom instruction may be to make students slower readers.

This was a surprising finding, and is initially difficult to explain, given that reading rate does naturally increase with grade level. It is possible that within the context of this class room, the teachers stressed that students should read "carefully," and avoid making mistakes as they prepared for standardized tests. One speculation is that while teachers may want to improve fluency, there is little that a traditional reading instruction program can do to boost fluency directly. Verbal exhortations to read more quickly would likely have an opposite effect: the students' level of anxiety would increase under pressure, and this would paradoxically rob students of cognitive resources necessary to execute more fluent scanning and processing of text. RP offers one type of solution to this problem. The rate increased gradually, often without the students' awareness, and rate is only increased for material that students are comfortable reading. This was in terms of vocabulary and comprehension difficulty level.

The Visagraph measure of Reading Efficiency correlated significantly with the students pretest reading skills.[6] The current study is in agreement that the Visagraph can provide valuable information about students' pre-training reading level. The reading skills level was predicted significantly by the Visagraph variable of rate, accounting for 10.9% of the variance in the pre-training scores for all subjects combined. Rate is one of the most important factors in reading efficiency, and the two are highly correlated. Marrs and Patrick[6] did not examine whether changes in eye movement would predict changes in reading skills, as was done in the current investigation. The current study demonstrated that changes in duration were associated with changes in comprehension normal curve equivalent scores, predicting 19.5 % of the response to intervention in a classroom setting. This suggests support for the idea that an eye movement variable can provide assistance in determining how well students may respond to a classroom intervention. This finding may help educators select individuals who may be in need of additional resources in order to meet national standards for reading achievement. Thus it seems that rate predicts reading at pretest, but duration of fixation predicts response to treatment.

CONCLUSION

The current study demonstrated that RP produced significantly larger gains than randomly assigned controls in comprehension and word knowledge in normally achieving 2nd graders. These results suggest that, in addition to the findings of Solan and collaborators[7] using poor readers, normal and above-average readers in a normal classroom setting can benefit significantly from the addition of RP to their school curriculum. Further research needs to be done to elucidate and isolate the

mechanisms of action behind the effects of RP. Nevertheless, this study suggests that it can produce substantial supplemental gains. Furthermore, analysis of the Visagraph data demonstrated that measures of ocular efficiency were significant predictors of changes in reading skills. These results, taken in total, suggest that the model of reading improvement utilized may be important for educators.

The authors have no financial or other interest in the instruments or tests listed herein.

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EDITORIAL continued

we can take. Foremost is to provide the indicated eye and vision care for these tense and discouraged children. In many instances this will alleviate significant obstacles to academic achievement. And, we can seek to ally with other professionals who feel that sooner isn't always better. A potential source is the teachers, psychologists and occupational therapists to whom you refer, and who make referrals to you. This type of alliance may eventually influence those who frame public policy. Perhaps the most effective action we can take is to educate the parents; an example is providing the mother and father with scientific evidence that it is expected for a kindergartener to reverse letters and numbers in spite of a school report identifying these reversals as a problem. A printed sheet of expected visual and visual perceptual skills in kindergarten and the early grades can be a very effective device in this regard.

This developmental perspective might be hard for parents and other professionals to understand because it differs from current educational guidelines. Further, it may seem counter-intuitive because of the current educational philosophy: Isn't sooner always better than later? Isn't trying harder always better? Don't children get to be better readers by reading difficult material? Shouldn't we stop reading to our child once they start to read on their own so that they can become more proficient and develop a love of reading? Won't using something to help them keep their place make them lazy? These are some of the assumptions that can be counterproductive to academic performance and whose application for all children needs to be questioned.

We share with parents and educators the goals of happy, healthy, successful children in their academic endeavors but also with a degree of balance and realistic expectations in their lives. I hope that we can help more people understand that some of the changes made in education to achieve these goals are not optimal for many children.

Gary J. Williams, OD
Owego, NY

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Corresponding Author:
John Shelley-Tremblay, Ph.D.
Department of Psychology
University of South Alabama
Mobile, AL 36608-0002
jstremblay@usouthal.edu

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