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## Comparisons of eye movements pre/post and one year after a speed reading course

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*Pacific University*

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## **Comparisons of eye movements pre/post and one year after a speed reading course**

### **Abstract**

In 1995 a study on the effect of speed reading on eye movements showed a significant improvement for participants in a speed reading course. The purpose of this study is to determine if these are temporary or long-lasting benefits. By using the OBER2, an infrared monitoring device that accurately tracks eye movements, eye movements were monitored on 46 of the 59 original subjects of the 1995 study. Seventeen of the student subjects participated in a speed reading class (9 hours of speed reading instruction, with no out-of-class practice required). Twenty nine student subjects did not participate in the speed reading class. One year after the speed reading course, the speed reading group still showed the statistically significant changes in eye movements.

### **Degree Type**

Thesis

### **Degree Name**

Master of Science in Vision Science

### **Committee Chair**

Scott C. Cooper

### **Subject Categories**

Optometry

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COMPARISONS OF EYE MOVEMENTS PRE/POST AND  
ONE YEAR AFTER A SPEED READING COURSE

By

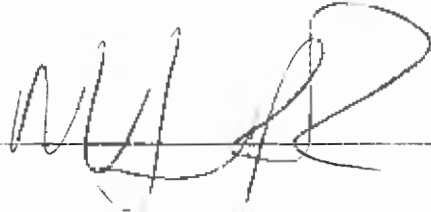
MARGARET PIATZ BENCK  
& AIMEE SCHULTE

A thesis submitted to the faculty of the  
College of Optometry  
Pacific University  
Forest Grove, Oregon  
in partial fulfillment of the requirements  
for the degree of  
Doctor of Optometry  
April, 1997

Advisory Committee:  
Scott C. Cooper, O.D., M.Ed.

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Margaret Piatz Benck

A handwritten signature in cursive script, appearing to read 'M. P. Benck', written over a horizontal line.

Aimee Schulte

A handwritten signature in cursive script, clearly legible as 'Aimee Schulte', written over a horizontal line.

Scott C. Cooper, O.D., M.Ed.

A handwritten signature in cursive script, appearing to read 'Scott C. Cooper', written over a horizontal line.

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Acknowledgments:

We would like to thank Dr. Scott Cooper for his willingness to help with this project and for his knowledge of the OBER2, also Dr. Bradley Coffey and Kevin Benck for their help in statistical analysis.

## ABOUT THE AUTHORS:

Peg Piatz Benck received her BA in English and Spanish from Northern State University. After spending several years overseas she returned to the states to pursue her goal of becoming an optometrist. She plans to return with her husband, Kevin, to the wide plains of South Dakota to practice.

Aimee Schulte did her undergraduate work at South Dakota State University. After three years she was accepted into the optometry program at Pacific University. She received her BS in Vision Science in 1994. She and her dentist husband plan on practicing in South Dakota.



## ABSTRACT

In 1995 a study on the effect of speed reading on eye movements showed a significant improvement for participants in a speed reading course. The purpose of this study is to determine if these are temporary or long-lasting benefits. By using the OBER2, an infrared monitoring device that accurately tracks eye movements, eye movements were monitored on 46 of the 59 original subjects of the 1995 study. Seventeen of the student subjects participated in a speed reading class (9 hours of speed reading instruction, with no out-of-class practice required). Twenty nine student subjects did not participate in the speed reading class. One year after the speed reading course, the speed reading group still showed the statistically significant changes in eye movements.

## INTRODUCTION

Although training and enhancement programs are often prescribed to improve performance skills such as reading, long-term benefits of these programs are not defined. The normal reading rate is from 200-300 words per minute (wpm).<sup>2,3</sup> Although speed reading courses (such as those popularized by Evelyn Wood in the 1960's) can improve reading rates for the average reader, these rates rarely exceed 1000 wpm.<sup>3</sup> Although impressive, claims of reading at the rate of as much as 123,000 wpm have never substantiated. Rubin and Turano<sup>8</sup> indicated that the limiting factor in reading speed is the time needed to prepare saccadic eye movements. They found that two thirds of fixation time was spent programming the next saccade and not used for comprehension. Therefore, even minor problems with eye movements can reduce reading speed.

More than reading rate, comprehension of material is a measure of reading success. At rates above 400-600 wpm, Carver's "Rauding theory" shows that comprehension decreases linearly as speed increases.<sup>4</sup>

Common visual elements discussed in speed reading texts, as found by Brozo and Johns<sup>6</sup>, include increasing span of recognition, reading three or more words per fixation and reducing the number of regressions. The authors suggested that the span of recognition is relatively fixed and limited. They found that 19-letter characters is the maximum span of recognition per fixation. Earlier they found that poor readers "make more fixations, have longer fixations, a greater number of regressions and generally more erratic eye movement patterns".<sup>6</sup> Jackson and McClelland<sup>7</sup> found that better readers have fewer fixations, but fixation durations of about the same length of time. They concluded that better readers extract more information per fixation.

A variety of literature supports the use of speed reading courses to improve reading rates. In 1995 a study by Pacific University optometry students Calef and Pieper analyzed eye movements before and after a speed reading course.<sup>1</sup> Their purpose was to identify how eye movements changed following a speed reading course. The test group participated in a five week speed reading course between October 11 - November 8, 1995 and were tested against a control group. The test group showed significant improvement in: reading speed, number of fixations per 100 words, span of recognition, number of regressions per 100 words and duration of fixation. Comprehension for the speed reading group showed an insignificant decrease. The goal of this study is to determine if these changes remain or have changed after one year in the original subjects.

## METHODS

### Subjects

Forty-six of 59 subjects were recruited from the original study by Calef and Pieper.<sup>1</sup> These subjects were required to read and sign an informed consent document prior to participating in this follow up study (appendix 1).

The "speed reading group" consisted of 17 subjects (9 females and 8 males) out of the original 25 participants. These subjects were undergraduate students, optometry students and non-students. Of the 17 subjects who participated in the follow-up study, 11 indicated that they utilized their speed reading skills "sometimes". The remaining six subjects hadn't used their speed reading skills since the conclusion of the original study.

During the year between the two studies, two individuals of the speed reading group received vision therapy, one for plus lens acceptance and the other for convergence insufficiency. This was not considered a reason to exclude these subjects from participation.

The control group consisted of 29 subjects (17 females and 12 males) out of the original thirty-four. These subjects were optometry students and non-students.

### Instrumentation

The OBER2 is an infrared eye movement recording system used for clinical assessment of reading eye movements. Eye movement information detected by the goggle sensors was relayed to a 486 PC computer for analysis and display. Although the manufacturer of the OBER2 states that it is sensitive to less than 5 minutes of arc horizontally, it was tested by an end user at 9 minutes of arc. The "normal size" text character spans approximately 15 minutes of arc horizontally.<sup>5</sup> The information is analyzed by fixations per 100 words, regressions per 100 words, words per minute, span of recognition and duration of fixation.

## **Initial Testing**

All subjects were scheduled for a 20 minute session to retest entrance criteria and to test them on the OBER2. The initial testing and inclusion criteria included near monocular habitual visual acuity of 20/40 or better, no strabismus at near based on the near cover test, smooth and accurate ocular motility with no gaze limitations based on bead skills and test results from an initial test on the OBER2.

## **Testing protocol**

During eye movement testing, subjects wore their habitual correction underneath the OBER2 test goggles while reading hard copy text (appendix 3), printed in 14 point Times Bold with black print on white paper. They were instructed to read the passage for comprehension as quickly as they could. Each passage contained approximately 120 words. Depending on the subject, this took approximately 20-40 seconds to complete.

The program then analyzed fixations per 100 words, regressions per 100 words, words per minute, span of recognition and duration of fixation. The subjects were administered 10 standardized true/false questions concerning the passage they had just read. A comprehension score was determined for each subject and the results were recorded on a data form (appendix 2). All passages and questions used in this thesis were included in the OBER2 software. They were all college level passages and of the same difficulty. A copy of one of the passages and the true/false questions used to determine comprehension score can be found in appendix 3-1 and appendix 3-2.

## RESULTS

All data supplied by the OBER were analyzed using both one-way and two-way ANOVA tests. The two-way ANOVA post-hoc analysis method used in this study is the Fisher PLSD. This analysis was performed two ways: once with the original "speed readers" split into two categories, and once with all previous speed readers combined together. In both instances, these groups were compared against the control group at the end of the previous study and currently, one year later. Table 1 and 2 "Immediate post-trial" refers to the results obtained at the end of the speed reading course and "One year post-trial" refers to the results obtained on the same subjects one year later.

The data shown for "post data" will not exactly match the published values from the original study. For this study, these values are derived from the participants in this study only. The original subjects not participating in this follow up were eliminated from these statistics to allow a within subjects comparison.

### **ANOVA Analysis of Two Subject Groups:**

The two subject divisions made in this analysis were simply the control group and the subjects who participated in the original speed reading course. This allows direct comparison of the changes in one year in the original treatment and control groups. Each performance category for this analysis are itemized following table one.

**Table One: Original Subject Groups**

2-Way Anova, 2 Groups			Immediate Post-trial		One year Post-trial		Analysis		
Variable	Units	Group	Mean	Std. Dev.	Mean	Std. Dev.	Group	Repeated measure	Interaction
Fixations per 100 words	Number of Fixations	Speed	68.94	19.66	74.24	16.51	F=10.842 p=0.002	F=0.393 p=0.5339	F=1.6 p=0.2126
		Control	87.41	16.60	86.62	16.80			
Span of Recognition	Number of Characters	Speed	1.57	0.48	1.40	0.28	F=13.029 p=0.0008	F=2.086 p=0.1558	F=4.307 p=0.0438
		Control	1.19	0.25	1.19	0.22			
Regressions per 100 words	Number of Regressions	Speed	6.12	5.70	3.29	4.01	F=6.983 p=0.0114	F=34.276 p=0.0001	F=5.254 p=0.0267
		Control	12.37	8.08	4.86	4.00			
Duration of Fixation	Time in Seconds	Speed	0.23	0.02	0.24	0.03	F=1.137 p=0.292	F=9.233 p=0.004	F=0.013 p=0.9094
		Control	0.24	0.04	0.25	0.03			
Words per Minute	Number of WPM	Speed	404.29	125.89	347.82	94.38	F=11.601 p=0.0014	F=8.633 p=0.0052	F=4.283 p=0.0444
		Control	297.59	82.84	284.03	60.95			
Comprehension	Percentage	Speed	0.74	0.17	0.74	0.15	F=1.972 p=0.1673	F=0.609 p=0.4393	F=0.554 p=0.4605
		Control	0.803	0.148	0.762	0.127			

**Fixations per 100 Words:** See Figure 1

The speed reading and control groups are statistically delineated from each other at the end of the original study and again one year later. Although the speed readers have increased their number of fixations by 5.3 words per minute, the difference is insignificant.

**Span of Recognition:** See Figure 2

There is a statistically significant difference between the speed reading and control groups, with the speed readers taking in more characters than the control group. The measurements one year after the completion of the original study show that this difference is maintained and unchanged. The interaction of these measures statistically indicate that the insignificant changes from one year ago did not "shift" evenly for both groups...the speed readers had lost about 0.17 words per fixation while the control group remained essentially the same.

**Regressions per 100 words:** See Figure 3

Analysis of regressions showed statistical improvement for both groups, with the speed reading group always demonstrating fewer regressions than the control group. The speed group's regressions decreased by 2.83 and the control group's decreased by 7.51 regressions. Additionally, the two groups were shown to improve at different rates, with the control group having much more improvement in the last year than the speed reading group.

**Duration of Fixation:** See Figure 4

Although there is no statistical differentiation of these two groups by duration of fixation, an overall trend of increased fixation duration was significant.

**Words per Minute:** See Figure 5

In both studies, the speed reading group statistically out performed the control group. Since the conclusion of the original study, the performance of the control group remained essentially unchanged (an insignificant loss of 13.56 wpm), but the the speed reading group's rate decreased significantly. So although the speed reading group lost much of their reading rate, they still read at a significantly faster rate than the control group. Because of this, a statistically significant interaction is demonstrated ( $f=4.283$ ,  $p=0.0444$ ).

**Comprehension:** See Figure 6

Comprehension was not statistically significant for differences between the two groups, overall changes or interaction.



### **ANOVA Analysis of Three Subject Groups:**

The three subject divisions made in this analysis were the control group, the treatment group who have utilized their speed reading skills over this last year (SS), and those who have not (SN). This allows differentiation between those who have practiced their new found skills to some extent and those who have not.

At first glance, analysis shows that after one year the entire group of speed reading subjects maintained their acquired skills. The control group after one year was relatively unchanged. Subdivision of the speed readers into those who utilized their skills over the last year (SS) and those who did not (SN), those who used their skills part of the time maintained their statistically significant improvement in eye movements, while those who did not use their skills regressed almost to the level of the control group. Specifications of each performance category follow table two.

**Table Two: Treatment Group Subdivided by Utilization**

2-Way Anova, 3 Groups			Immediate Post-trial		One year Post-trial		Significance		
Variable	Units	Group	Mean	Std. Dev.	Mean	Std. Dev.	Group	Repeated measure	Inter-action
Fixations per 100 words	Number of Fixations	Speed-Sometimes	66.36	19.70	68.64	13.07	F=6.718 p=0.0029	F=0.394 p=0.5333	F=1.377 p=0.2631
		Speed-Never	73.67	20.48	84.50	18.32			
		Control	87.41	16.60	86.62	16.80			
Span of Recognition	Number of Characters	Speed-Sometimes	1.65	0.53	1.50	0.26	F=8.565 p=0.0007	F=2.051 p=0.1594	F=2.25 p=0.1177
		Speed-Never	1.44	0.36	1.22	0.22			
		Control	1.19	0.25	1.19	0.22			
Regressions per 100 words	Number of Regressions	Speed-Sometimes	6.73	6.54	3.27	3.41	F=3.477 p=0.0398	F=33.71 p=0.0001	F=2.72 p=0.0772
		Speed-Never	5.00	4.00	3.33	5.32			
		Control	12.37	8.08	4.86	4.00			
Duration of Fixation	Time in Seconds	Speed-Sometimes	0.23	0.02	0.24	0.03	F=0.593 p=0.5572	F=9.073 p=0.0043	F=0.124 p=0.8835
		Speed-Never	0.23	0.03	0.25	0.03			
		Control	0.24	0.04	0.25	0.03			
Words per Minute	Number of WPM	Speed-Sometimes	426.91	136.10	374.00	93.60	F=7.489 p=0.0016	F=8.453 p=0.0057	F=2.139 p=0.1302
		Speed-Never	362.83	102.39	299.83	81.91			
		Control	297.59	82.84	284.03	60.95			
Comprehension	Percentage	Speed-Sometimes	0.72	0.16	0.76	0.16	F=0.804 p=0.4542	F=9.197 p=0.0041	F=0.33 p=0.7208
		Speed-Never	0.77	0.21	0.72	0.15			
		Control	0.80	0.15	0.76	0.13			

**Fixations per 100 words:** See Figure 1

After one year, the SS and control groups remained statistically unchanged after one year. However, the SN group regressed by 10.83 fixations, leaving them with approximately the same number of fixations per 100 words as the control group...just as if they had not made gains in the original study. The repeated measure did not improve significantly ( $f=0.394$ ,  $p=0.5333$ ). There was no significant interaction found in this category ( $f=1.377$ ,  $p=0.2631$ ).

**Span of recognition:** See Figure 2

Span of recognition is inversely related to the number of fixations one makes, therefore similar trends would be expected from analysis of these measurements. As expected, the SS and control groups retained essentially the same skill level, while the SN group regressed by 0.22 characters, almost reducing this skill to the level of the control group.

**Regressions per 100 words:** See Figure 3

All three groups showed statistically significant improvement. The SS group showed a decrease of 3.46, the SN group by 1.67 and the control group by 7.51 regressions per 100 words. The most recent means appear to be slightly better for those who have taken a speed reading course, but once attention is drawn to the standard deviation of these results, the three subject groups are insignificantly different.

**Duration of fixation:** See Figure 4

Although those who used their speed reading skills over the last year demonstrated a shorter duration of fixation currently and one year ago while the control group had the longest time, the differences of the three subject groups were insignificant. There is a statistically significant trend for slightly longer duration of fixations for all three groups since one year ago.

**Words per minute:** See Figure 5

All groups differed significantly, showing that each category's subjects had different performance levels. Over time, all groups have lost some of this ability to a statistically significant degree, with all groups reading at fewer words per minute. Once again, as in all performance categories, there were no inter-group interactions demonstrated, showing that there were no significantly confounding factors in this testing.

**Comprehension:** See Figure 6

Comprehension did not differentiate the individual groups, however, the tendency for the SS group to improved their comprehension, while both SN and control groups decreased in comprehension was significant.

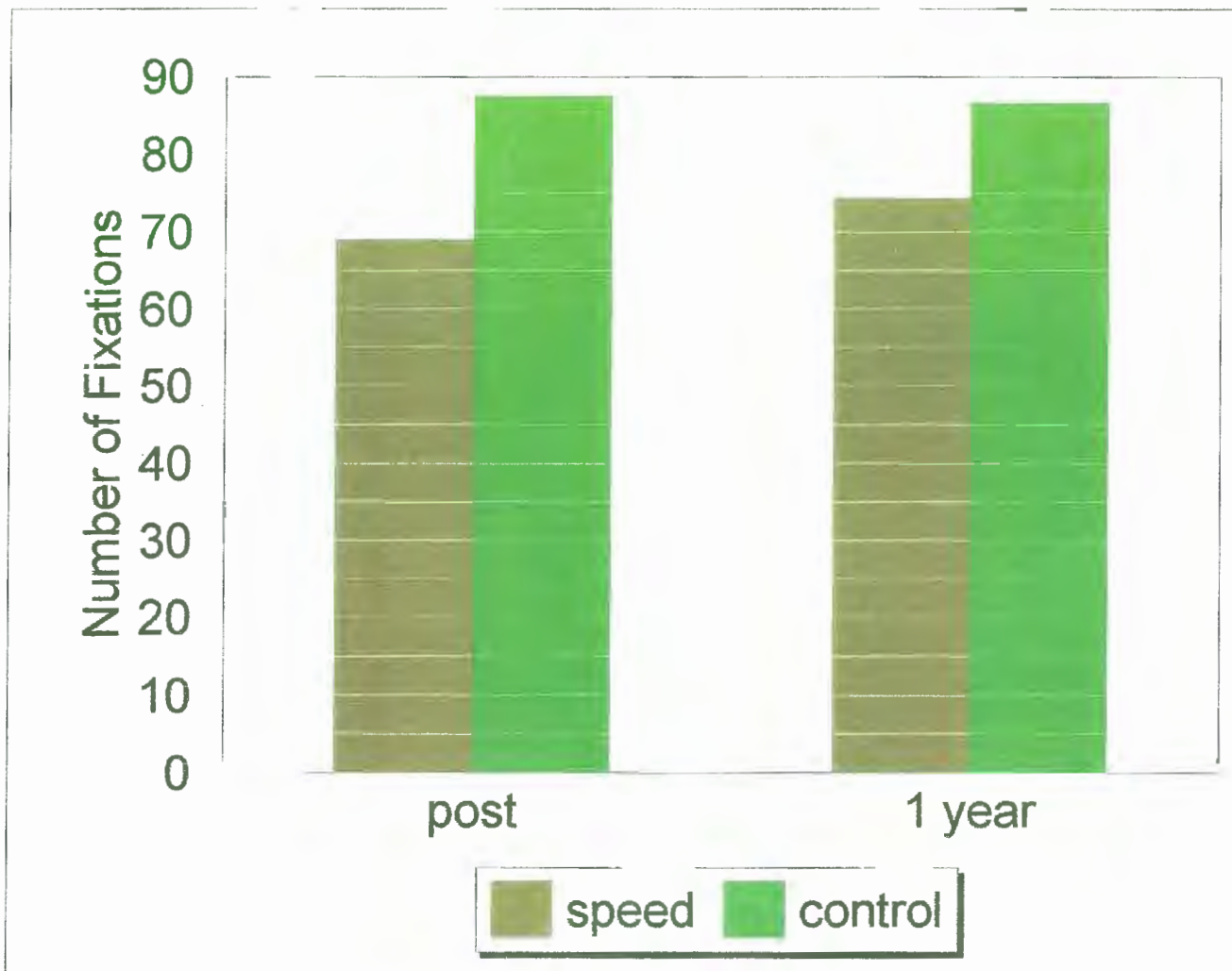


Figure 1. Number of Fixations per hundred words. Changes in fixations for each group post and 1 year after.

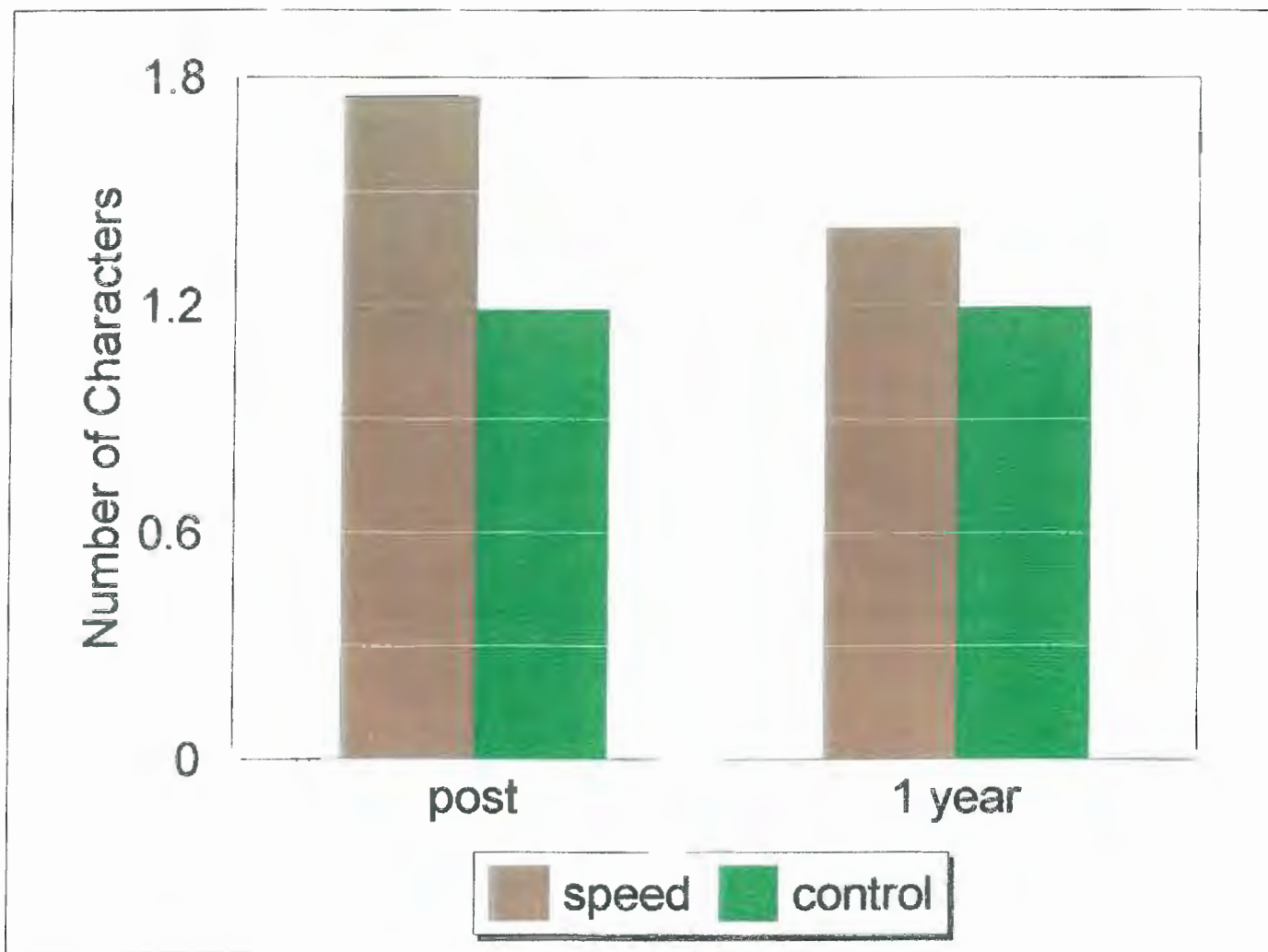


Figure 2. Span of recognition for each group post and 1 year after.

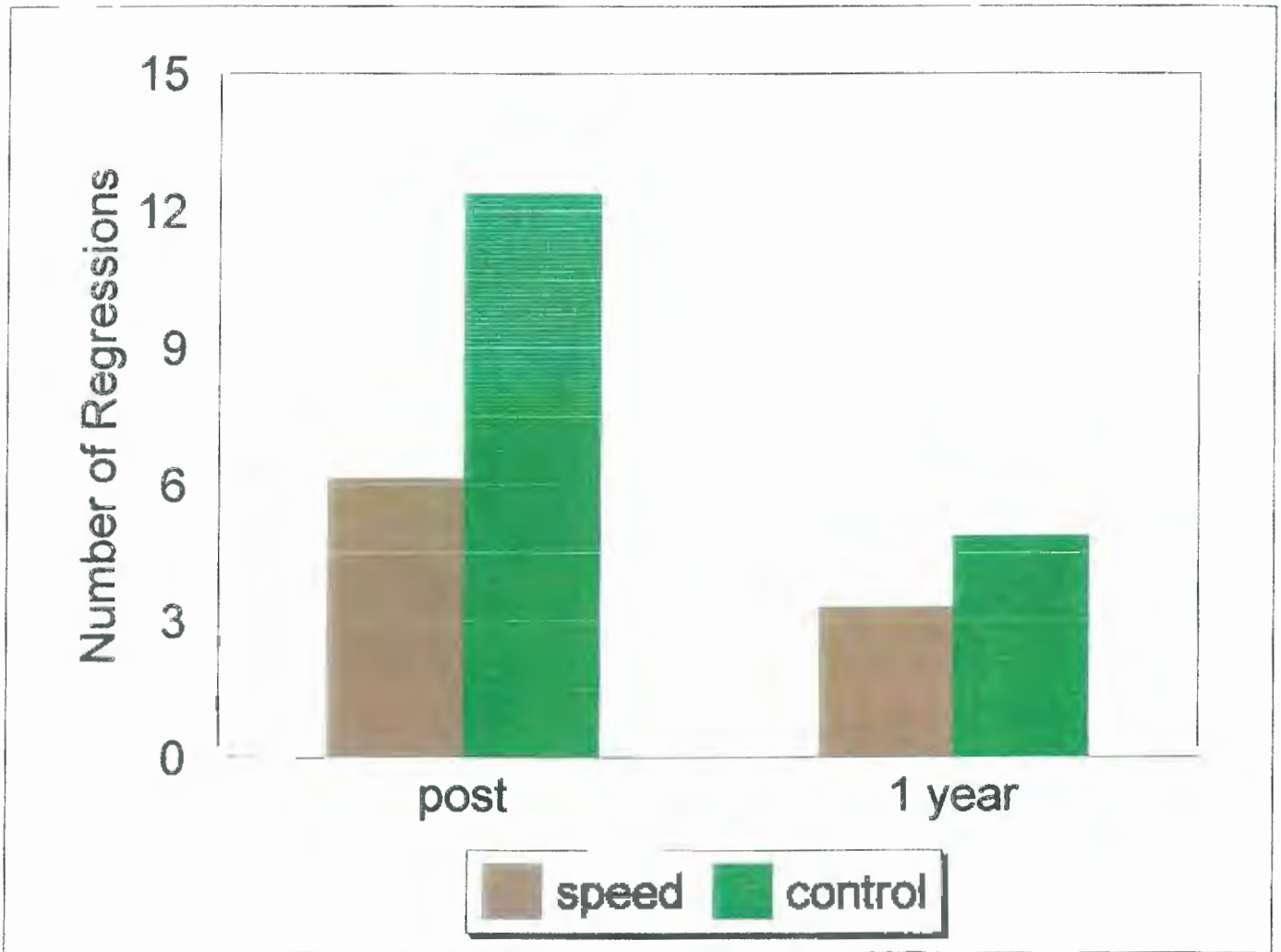


Figure 3. Number of regressions per hundred words for each group post and 1 year after.

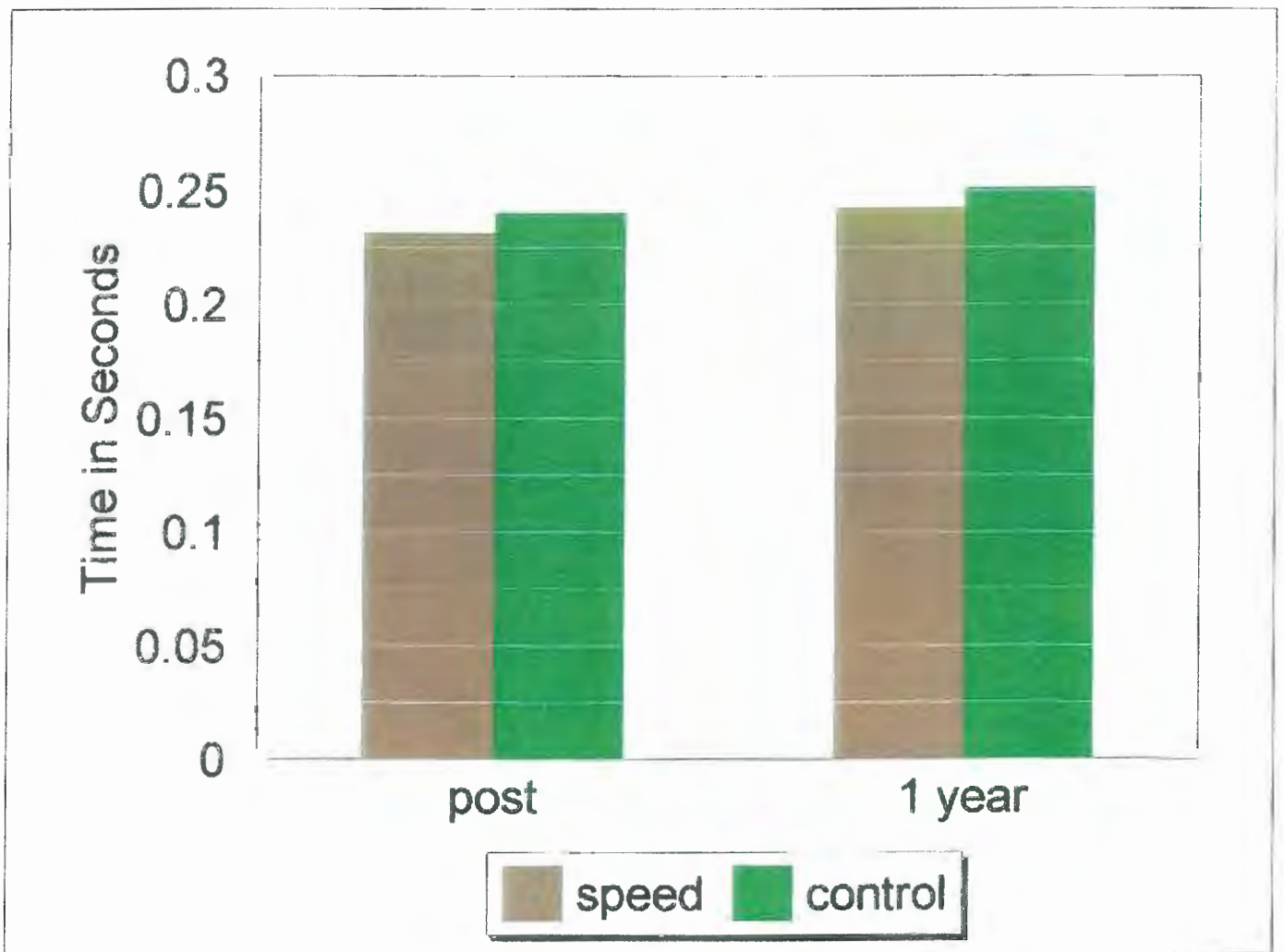


Figure 4. Duration of fixation for each group post and 1 year after.



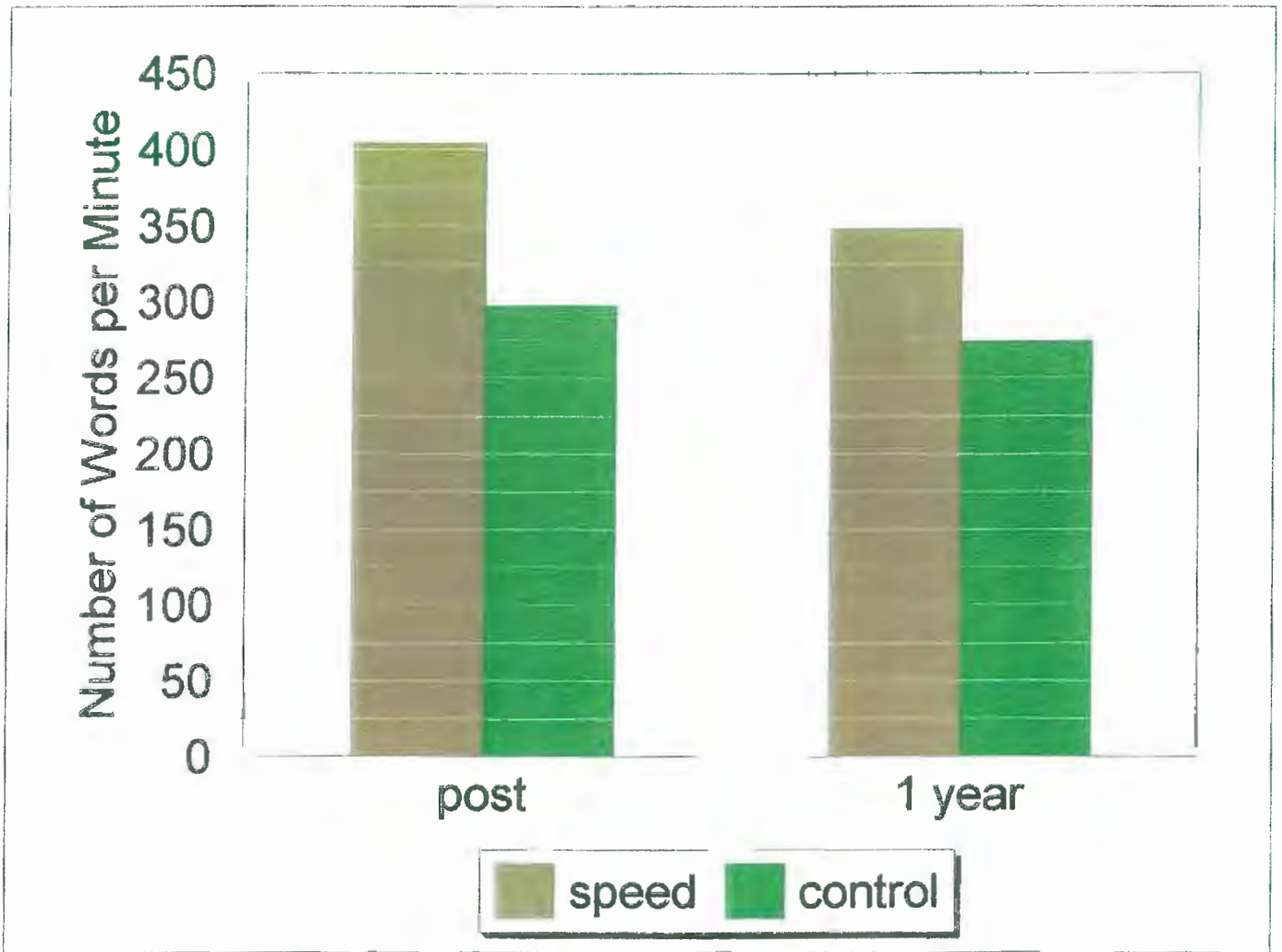


Figure 5. Number of words per minute for each group post and 1 year after.

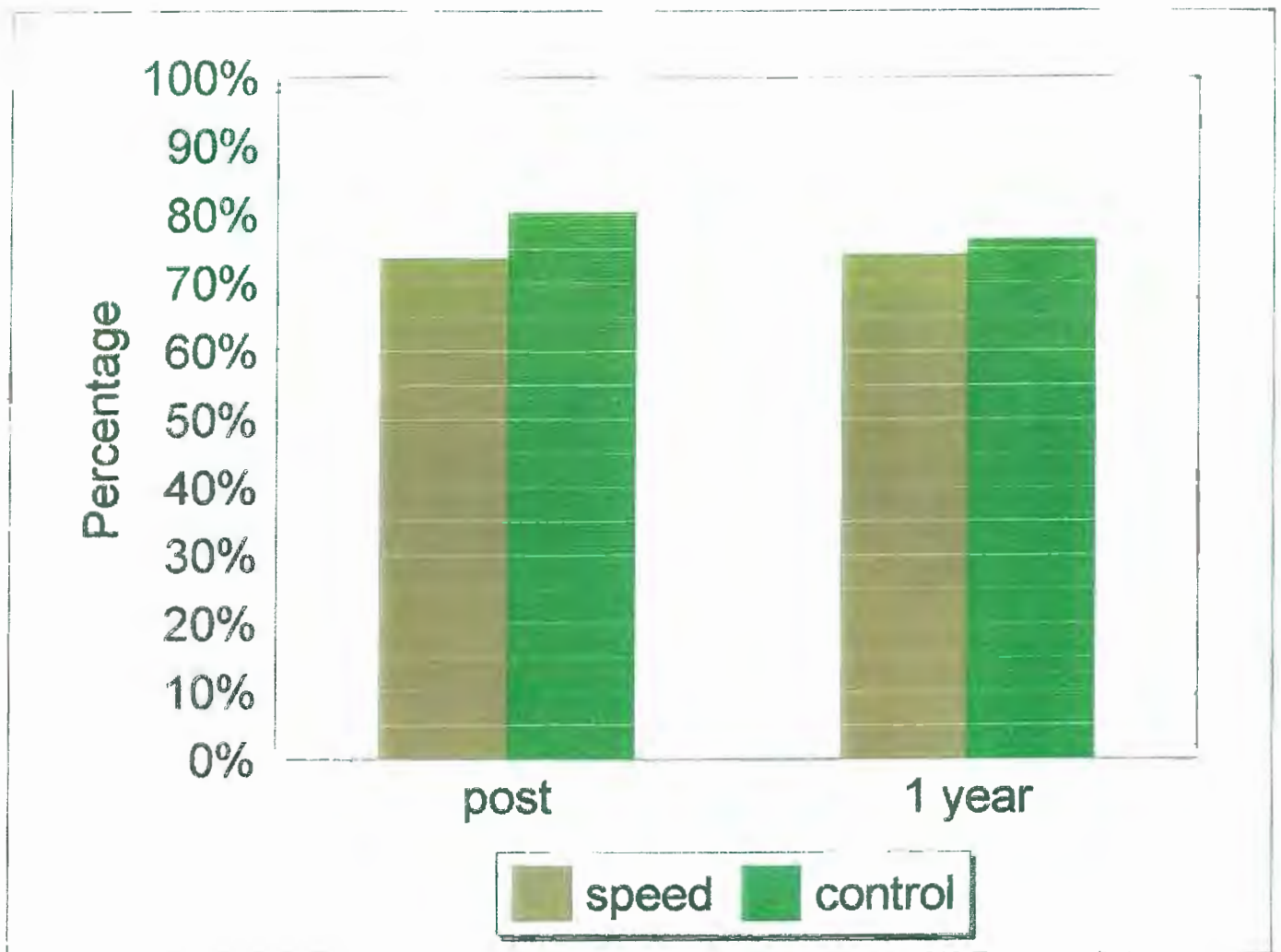


Figure 6. Changes in comprehension for each group post and 1 year after.

## DISCUSSION

Considering the speed reading group as a whole (not subdivided), the improvements found after the speed reading course were retained over time. Analysis of the two original groups provided less information, however, than analysis of the control group, those who have used their speed reading skills over the past year and those who have not. Even though the SN group was small ( $n=6$ ), there were identifiable differences in these two subgroups. Results specified that most of the eye movement skill improvements gained through using speed reading skills will remain after one year, especially if these skills are practiced periodically. Those who had made gains with the speed reading course, but didn't utilize them since the end of the original study, showed several areas of regression to control group levels. This underscores the importance of reinforcement found only through practice and utilization of newly learned skills.

The only skill showing significant change for the control group was the number of regressions per one hundred words. While there is no clear cut way to account for the great improvements demonstrated by the control group, it is good to note that improvement was seen in the treatment group as well. One possible explanation for this finding is that the first study tested mostly first and second year optometry students. One year later these same students are now second and third year students and perhaps the immersion in difficult reading material or experience with experimental testing has equalized this variable somewhat.

The subjects who had not used their speed reading skills in the past year showed gains in number of regressions (as did all groups), essentially no change in comprehension, slight decrements in span of recognition, and moderate decrements in reading rate, duration of fixation and number of fixations per 100 words.

The subjects who had utilized their speed reading skills in the past year showed similar improvements in number of regressions, essentially no change in

comprehension, and only very slight, insignificant decrements in fixations per 100 words and span of recognition. This group showed moderate losses in duration of fixation and reading rate. Therefore, although their losses were statistically not as drastic as those who did not practice their skills, this treatment subgroup did not perform up to the same level as at the end of the original study. This either means that these subjects did not practice enough to maintain these skills, or these skills naturally regress when the subjects are not immersed in the original learning setting.

This study shows that improved eye movement skills can be maintained over a period of time as long as these skills are utilized regularly. Learning, but not reinforcing speed reading skills will result in almost total loss of those skills to pre-learning levels.

This study has shown that benefits to eye movement and reading skills gained through a speed reading course can be maintained through practice and use of these new-found skills. Furthermore, if these skills are not reinforced through practice, these improvements cannot be expected to remain. To fully understand the long-term effects of speed reading skills, more testing needs to be done in this area. A logical follow-up study would be to retest this same population in a few more years to compare with present data or to define how long those who have lost their skills would need to return them to optimum levels with practice.

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**Appendix One:**

**Informed Consent Form**

## Informed Consent Form

Institution: Pacific University College of Optometry

- A. Title of project: Comparisons of Eye Movements Pre/Post and One Year After a Speed Reading Course.
- B. Principal investigators:  
Margaret Piatz Benck: 357-4408  
Aimee Schulte: 648-8128
- C. Advisor: Scott Cooper: 848-9580
- D. Location: Pacific University College of Optometry  
Forest Grove, OR 97116  
Office location (presently unknown)
- E. Date: 1995-1996

1. Description of Project

Previous research has shown that significant changes in eye movements were measured after a speed reading course was taken by the subjects. In these studies the OBER2 was used to measure eye movements. The OBER2 is a computer program for measuring eye movements. The patient wears goggles over their eyes and reads computer text. The computer measures the patient's eye movements. The previous study showed a significant change in eye movements for those who took the speed reading course.

In the proposed project we will again use the OBER2 to test the same subjects to measure if the eye movement changes stayed the same one year after the speed reading course. The goal of this project is to determine how permanent are the learned eye movements.

2. Description of Risks

Some tests involve placing equipment near the eyes. These tests are used safely and routinely by optometrists and their patients; however, a remote possibility exists of receiving mild trauma to the eyes and or/face. The goggles are kept in place with a Velcro strap. There is very little risk associated with the use of the OBER2.

3. Description of Benefits

This study will serve to increase the basic understanding of eye movement skills one year after a speed reading course.

4. Alternatives Advantageous to subjects

Not applicable.

5. Confidentiality of Records

Records of this project will be maintained in a confidential manner and no name-identifiable information will be released.

6. Compensation and medical care

If you are injured in this experiment it is possible that you will not receive compensation or medical care from Pacific University, the experimenters, or any organization associated with the experiment. All responsible care will be used to prevent injury, however.

7. Offer to Answer Any Inquiries

The experimenters will be happy to answer any questions that you may have at any time during the course of the study. If you are not satisfied with the answers you receive, please call Dr. James Peterson at 357-0442. During your participation in the project you are not a Pacific University clinic patient. All questions should be directed to the researchers and/or the faculty advisor who will be solely responsible for any treatment (except for an emergency). You will not be receiving complete eye, vision, or health care as a result of participation in the project; therefore you will need to maintain your regular program of eye, vision, and health care.

8. Freedom to Withdraw

You are free to withdraw your consent and to discontinue participation in this project or activity at any time without prejudice to you.

I have read and understand the above. I am 18 years of age or over (or this form is signed for me by my parent or guardian).

Printed Name \_\_\_\_\_

Signed \_\_\_\_\_ Date \_\_\_\_\_

Address \_\_\_\_\_ Phone \_\_\_\_\_

City \_\_\_\_\_ State/Zip \_\_\_\_\_

Name and address of a person not living with you who will always know your address.

\_\_\_\_\_  
\_\_\_\_\_



**Appendix Two:**

**Data Recording Form**

NAME: \_\_\_\_\_

DATE: \_\_\_\_\_

ENTRANCE CRITERIA

Near VA \_\_\_\_\_

Ocular Motility \_\_\_\_\_

Cover Test \_\_\_\_\_

OPER DATA

Fixations/100 words \_\_\_\_\_

Span of Recognition \_\_\_\_\_

Regressions/100 Words \_\_\_\_\_

Duration of Fixation \_\_\_\_\_

Words/Minute \_\_\_\_\_

Comprehension Score \_\_\_\_\_

Have you gone through a V.T. course during the past year? \_\_\_\_\_

Have you used your speed reading skills always, sometimes or not at all? \_\_\_\_\_

**Appendix Three:**

**Reading Passage and  
Standardized Question Samples**



Paganini was one of the world's greatest violinists. Born in 1784, Paganini began violin lessons early in life. When he was eleven years old, violin teachers told him they could do no more to improve his technique. Paganini began to study strenuously on his own, practicing passages for ten hours at a time. He began professional tours when he was thirteen. Audiences were moved to tears by his rendition of quiet melodies and astonished by his force and speed. To show his virtuosity, he played entire selections on the fourth string alone. He took great delight in composing music so technically difficult that he alone could play it. His later life was a series of triumphant tours.

Questions:

1. Paganini was born in 1784. (Yes)
2. He began violin lessons when he was eleven years old. (No)
3. Violin teachers told Paganini they could not improve his technique. (Yes)
4. Paganini began to give violin lessons. (No)
5. He often practiced passages for fifteen hours at a time. (No)
6. He began touring professionally at the age of thirteen. (Yes)
7. Audiences were astonished by his force and speed. (Yes)
8. He could play whole compositions on one string alone. (Yes)
9. He composed violin music so difficult that he alone could play it. (Yes)
10. It was not until after his death that his music was appreciated. (No)