5-1995

# The effects of plus lenses on eye movements

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## Abstract

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## Degree Type

Thesis

## Degree Name

Master of Science in Vision Science

## Committee Chair

Thomas Samson

## Subject Categories

Optometry

# THE EFFECTS OF PLUS LENSES ON EYE MOVEMENTS

By



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A thesis submitted to the faculty of the
College of Optometry
Pacific University
Forest Grove, Oregon
for the degree of
Doctor of Optometry
May, 1995

Advisor:

Thomas Samson, O.D.

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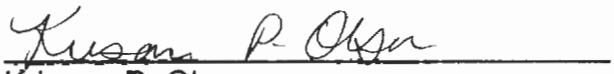

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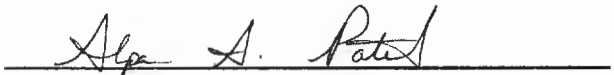

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# BIOGRAPHY

Krisann P. Olson is from Sherwood, Oregon. She graduated from Portland State University with a B.S. in Business/Human Resources and a B.S. in Psychology. She will receive her Doctor of Optometry from Pacific University in May, 1995.

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## ACKNOWLEDGMENTS

We would like to thank Laurel Gregory for her help with research, Dr. Hannu Laukkanen for assistance with the OBER2 eye movement analyzer, the Beta Sigma Kappa organization for their financial support, and Dr. Thomas Samson for his encouragement and guidance throughout this study.

## ABSTRACT

This study assessed eye movements of fourteen esophoric subjects at near utilizing the OBER2 digital eye movement registration system. The OBER2 has specialized goggles that monitor eye movements as a subject views a reading passage. Subjects read one passage with their habitual distance prescription and another passage with the plus amount required to shift their esophoric posture into exophoria. Our purpose was to quantify the eye movements with the near add to determine if the increased lens power would improve the subject's visual performance and eye movement ability. Statistical analysis was done on the eye movement data under both reading conditions and no significant difference was found.

## INTRODUCTION

The prescription of low plus lenses to alleviate the visual stress induced by near work is a basic tenet of functional optometry.[1,2] Often pre-presbyopes associate the need to wear lenses with visual acuity but not with visual efficiency. They are often unaccepting of a near add because they are able to obtain clear vision at near with few or no asthenopic complaints. We wanted to explore the idea that by bettering eye movements through the use of plus lenses, visual performance will be increased and rate of reading and comprehension abilities will be enhanced.

Many studies have examined the effects of plus lenses on eye movements and comprehension while reading. Perreault[3] in her 1992 study examined the effects of plano, +1.00D and -2.00D lenses as a subject read a passage for comprehension while their eye movements were recorded with an Eye-Trac. It was Perreault's thinking that the +1.00D lens would decrease the stimulus to accommodation, decrease accommodative effort, and increase reading comprehension. However, the time required to complete the reading passage and reading comprehension ability was not changed significantly under any of the three conditions.

Sohrab-Jam[4] in 1975 studied 4th and 5th grade males who were at least one year behind in their reading performance. The Eye-Trac was used to record subjects' eye movements while reading through plano and +0.50D lenses. Sohrab-Jam found that those who showed a need for plus lenses as determined by Book retinoscopy also showed fewer regressions, increased reading speed, and higher relative efficiency with the plus than without. The subjects indicating no need for plus lenses showed lower relative efficiency but better comprehension with the plus lenses.

Wildsoet and Foo[5] in their 1988 study compared the reading performance of 13 school children that had worn low plus lenses for at least six months to their reading performance when wearing plano lenses. The effects of the low plus lenses versus plano lenses were assessed using the Biometric Eye-Trac Recorder. No statistically

significant difference was found between the two sets of lenses when examining reading speed, frequencies of fixations and regressions, and comprehension.

Greenspan[6] in 1970 and Larrabee and Jones[7] in 1980 both studied the behavioral effects of nearpoint lenses on children performing pencil and paper tasks. Both found statistically significant improvements in performance of nearpoint tasks with prescribed near lenses. The above studies have shown varying results regarding the benefits of plus lenses while performing near tasks. Our study will assess the eye movements of esophoric subjects while wearing the amount of plus required to shift their esophoric posture to exophoria. It is our intent to demonstrate changes in visual performance associated with plus versus plano lenses. Visual performance will be analyzed utilizing the OBER2 computer system.

## METHODS

### Subjects

There were 14 subjects in the study, eight males and six females. All subjects were pre-presbyopic from 23 to 33 years of age. Subjects also had to demonstrate one prism diopter or more of esophoria at 40cm through their habitual distance prescription. The habitual phoric postures ranged from 1D esophoria to 15D esophoria. All subjects demonstrated 20/20 visual acuity OD, OS, OU at 40cm through their habitual distance prescription. A Snellen near point card was used to test visual acuity. The habitual refractive errors of the subjects ranged from -9.00D to +0.75D with a mean of -3.37D.

### Methods and Materials

The habitual near lateral phoria was assessed using the Von Graefe technique utilizing a 20/30 vertical line target. All subjects had to show an initial esophoria in this condition through their distance prescription. Using the phoroptor, plus lenses were

added in quarter diopter increments to each subject's habitual distance prescription until a near phoria of three to five exophoria was produced. The maximum add necessary to achieve this range of exophoria was 2.25 diopters.

Horizontal eye movements for both eyes were recorded with the use of goggles attached to the OBER2 digital eye movement registration system.[A] One researcher performed the phoria test, and fit the patient with the OBER2 goggles. Using a randomization method, this researcher then selected either the subject's habitual distance prescription or the indicated near add, and placed them into a trial frame. Half of the subjects started with habitual lenses and the other half started with plus lenses.

A randomization technique was also used by the second researcher to establish a random order of presentation for the reading passages. The order of chosen lenses and passages was kept undisclosed between researchers to reduce researcher bias. A copy of the reading passages can be found in Appendix I.

Subjects were instructed to hold the appropriate flippers in front of their eyes and read the passage at a speed that was comfortable. The subject was instructed not to reread any portion of the passage and reminded that comprehension questions would be asked upon completion. To decrease subject anxiety about comprehension questions, a sample reading passage and questions (see Appendix I) was provided for the subjects when they signed the consent form. The room lights were kept dim and a 40cm working distance was maintained throughout testing.

The identical instructions were repeated for the second set of lenses and reading passage. Upon completion of testing, subjects were instructed not to discuss any portion of the test with other subjects.

## RESULTS

The plus adds given to subjects ranged from +0.50D to +2.25D with a mean of +1.25D. Regardless of the amount of plus given, some subjects could not be shifted into the 3-5 exophoria range. Due to the limited number of subjects available, the 3-5 exophoria criteria was expanded to 1-6 exophoria in order to include all subjects tested. The amount of exophoria elicited from the add ranged from 1D exo to 6D exo with a mean of 2.14D exophoria. The average shift in phoric posture was 7.85D in the exophoric direction. Table 1 summarizes the subjects' habitual phorias and the resulting phorias from the near add utilized during testing.

**TABLE ONE**

| SUBJECT | HABITUAL PHORIA | PLUS AMOUNT | PLUS PHORIA |
|---|---|---|---|
| 1 | 7 eso | 2.00 | 3 exo |
| 2 | 1 eso | 0.50 | 4 exo |
| 3 | 1 eso | 0.50 | 3 exo |
| 4 | 2 eso | 1.00 | 3 exo |
| 5 | 3 eso | 1.75 | 4 exo |
| 6 | 10 eso | 2.00 | 2 exo |
| 7 | 6 eso | 1.25 | 1 exo |
| 8 | 2 eso | 0.50 | 6 exo |
| 9 | 3 eso | 0.50 | 3 exo |
| 10 | 6 eso | 1.50 | 1 exo |
| 11 | 15 eso | 2.00 | 3 exo |
| 12 | 10 eso | 2.00 | 3 exo |
| 13 | 12 eso | 2.25 | 3 exo |
| 14 | 2 eso | 0.50 | 3 exo |

The OBER2 system evaluates eye movements by assessing seven areas: grade level, decoding, recognition span, regressions, duration of fixation, reading rate, and comprehension score.[8]

Duration of fixation measures the amount of time in seconds the eyes pause to take in information in a left to right direction. Regressions are reverse eye movements in the right to left direction. Regressions may aid in comprehension by allowing the re-examination of reading material. However, excessive regressions may prove to decrease efficiency and may indicate binocular dysfunction. Recognition span is the number of words taken in per fixation. It is determined by dividing the number of fixations into the number of words read. Decoding is the number of fixations per one hundred words or simply the inverse of recognition span. Reading rate is calculated as the number of words read per minute. The comprehension score is the number of true/false items answered correctly out of ten questions asked based on the appropriate reading passage. A minimum score of seven out of ten on each reading passage was required to participate in the study. All subjects met this criterion. The grade level is determined by comparing the above parameters with national norms from a study done by Taylor, Frackenpohl, and Pettee[9] in 1960. Table 2 summarizes the ranges and means of these areas while subjects wore their habitual lenses and also while wearing the amount of plus that gave them an exophoric posture.

**TABLE TWO**

| | HABITUAL | | PLUS | |
|---|---|---|---|---|
| **AREAS** | **MEAN** | **RANGE** | **MEAN** | **RANGE** |
| **OBER2 Grade Level** | 10.96 | 6.5 - 13.5 | 10.32 | 5.5 - 13.5 |
| **Recognition Span** (Number of Words Seen Per Fixation) | 1.07 | .86 - 1.43 | 1.04 | .76 - 1.37 |
| **Decoding** (Number of Fixations Per 100 Words) | 95.14 | 70 - 116 | 99.14 | 73 - 131 |
| **Regressions** (Per Reading Passage) | 17.86 | 0 - 33 | 19.36 | 4 - 36 |
| **Duration of Fixation** (seconds) | 0.26 | 0.21 - 0.32 | 0.25 | 0.22 - 0.32 |
| **Reading Rate** (words/minute) | 251 | 163 - 322 | 241.07 | 190 - 312 |
| **Comprehension Score** (10 Possible Points) | 8.14 | 7 - 10 | 8.29 | 7 - 10 |

Statistical analysis was completed on the data utilizing a within-subjects, two-tailed t-test. No statistically significant changes were found in any of the seven areas when comparing habitual verses plus lenses. Reading passage order was also found to be non-significant when evaluating the seven categories. Finally, the subjects did not

perform significantly better on the second passage as compared to the first, regardless of the order of the reading passages or lens conditions.

## DISCUSSION

The saccadic eye movement ability of fourteen subjects did not improve with the use of the plus lenses. The subjects did show an exophoric shift with the use of plus lenses. Wearing the plus lenses for a longer period of time might have allowed the visual systems of the subjects to adjust to the plus, thereby relaxing accommodation and increasing visual performance. Although this study showed that the saccadic eye movement ability of pre-presbyopic esophores did not improve with the use of plus lenses, one cannot discount the use of plus lenses for the relief of accommodative and vergence stress in those patients who are symptomatic.

Given the opportunity to run a future study, certain procedures could be changed. A larger sample size and selection of a reading passage that is at a more appropriate level for the subjects would improve the quality of the statistical analysis. Consideration might also be given to the choosing of subjects that show asthenopia after prolonged near work. Finally, the wearing time of the plus lenses could be increased to allow a more accurate representation of the effects of plus on the visual system.

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A. OBER2 digital eye movement registration system: Permobil Meditech, Inc., Woburn, MA.

APPENDIX I

OBER2 reading passage.

Louis Braille was a French teacher of the blind. Braille's own sight was destroyed in an accident when he was three. He attended the Paris Institute for the Blind and became an instructor there at the age of nineteen. At that time, raised letters were used in teaching sightless people to read, but Braille devised a simpler method. He improved upon a system of writing with raised dots invented by a French army officer. Braille's alphabet was formed from varying combinations of six dots. His system applied to music as well as literature. Braille first published it in 1829, but his system was opposed because it was so radical. Widespread acceptance came only after Braille's death.

| | | |
|---|---|---|
| 1. | Louis Braille founded the Paris Institute for the Blind. | No |
| 2. | He lost his own sight at birth. | No |
| 3. | He became a teacher of the blind at the age of nineteen. | Yes |
| 4. | At that time raised letters were used in teaching the blind to read. | Yes |
| 5. | The idea of using dots was original with Braille. | No |
| 6. | His alphabet was formed of varying combination of six dots. | Yes |
| 7. | Braille's system could be used in music and literature. | Yes |
| 8. | Braille first published his system in 1829. | Yes |
| 9. | His system was initially opposed as being too radical. | Yes |
| 10. | The Braille system was accepted before Louis Braille died. | No |

## APPENDIX I

OBER2 reading passage.

John Roebling was a pioneer in building suspension bridges. Roebling was educated as a civil engineer in Germany, and emigrated to the United States as a young man. Believing that steel cable would make possible the construction of long-span suspension bridges, he established a factory to produce it. His fellow engineers predicted failure for his first long-span suspension bridge at Niagara Falls, but it proved to be a success. His most ambitious task was the Brooklyn Bridge, over fifteen hundred feet in length. In supervising this project, John Roebling received a fatal injury. The Brooklyn Bridge was finally completed in 1883 under the direction of his son. At that time it was the world's longest suspension bridge.

| | Answer Yes or No |
|---|---|
| 1. John Roebling was a pioneer in steel cable construction. | Yes |
| 2. Roebling was educated in Switzerland as an architect. | No |
| 3. He believed that steel cables would allow the building of longer bridges. | Yes |
| 4. He established his own steel cable manufacturing plant. | Yes |
| 5. His most ambitious project was the Niagara Falls Bridge. | No |
| 6. While building the Brooklyn Bridge, Roebling received a fatal injury. | Yes |
| 7. The Brooklyn Bridge was finally completed by Roebling's brother. | No |
| 8. The Brooklyn Bridge was completed in 1883. | Yes |
| 9. When completed, the Brooklyn Bridge was the longest suspension bridge. | Yes |
| 10. It was over eighteen hundred feet long. | No |

APPENDIX I

OBER2 sample reading passage.

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.

| | Answer Yes or No |
|---|---|
| 1. Paganini was born in 1784. | Yes |
| 2. He began violin lessons when he was eleven years old. | No |
| 3. Violin teachers finally 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 |