The assessment of a prescribing protocol for pre-presbyopic computer users to relieve symptoms due to Computer Vision Syndrome (CVS): A pilot study

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The assessment of a prescribing protocol for pre-presbyopic computer users to relieve symptoms due to Computer Vision Syndrome (CVS): A pilot study

Abstract
The purpose of this study is to investigate the effectiveness of a prescribing method for pre-presbyopic computer users to relieve symptoms of Computer Vision Syndrome (CVS). As of now, no standard protocol exists to prescribe computer lenses for this population. Subjects were between 20-34 years of age, spent a minimum of 6 hours a day for 5 days a week working on a computer, and had visual symptoms of CVS. An initial exam was performed and subjects were randomly placed into one of three groups: habitual distance prescription, distance subjective prescription, or computer prescription. Symptom surveys were used to determine the severity of symptoms for the two month duration of the study. A follow-up examination was performed to determine if exam findings correlated with symptoms, and basic case analysis was used to analyze the exam data. Overall, the group receiving the computer prescription reported less frequent symptoms and normalized accommodative and vergence posture findings. A future study should involve a greater number of participants to show whether this conclusion can be made.

Degree Type
Thesis

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THE ASSESSMENT OF A PRESCRIBING PROTOCOL FOR PRE-PRESBYOPIC COMPUTER USERS TO RELIEVE SYMPTOMS DUE TO COMPUTER VISION SYNDROME (CVS): A PILOT STUDY

By

CODY S. BENGOA

NATANIEL D. SHILMAN

PAUL A. FILAR

A thesis submitted to the faculty of the
College of Optometry
Pacific University
Forest Grove, Oregon
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Advisors:

GRAHAM B. ERICKSON, OD

SCOTT C. COOPER, OD
Biographies

Cody Bengoa graduated from the University of Nevada, Reno, with a B.S. in Biochemistry and a Spanish minor. At Pacific University College of Optometry, he served as student liaison for the College of Optometrists in Vision Development, was Amigos President, and was a member of the Beta Sigma Kappa Optometric Honor Society. He was also nominated as a member of Who's Who Among Students in American Colleges and Universities. He and his wife, Tiffany, plan on residing in Reno, Nevada, where he plans to practice.

Nathaniel Shilman graduated from the University of Mary in Bismarck, North Dakota, with a B.S. in Biology and a Chemistry minor. At Pacific University College of Optometry he was a member of the American Optometric Student Association, the College of Optometrists in Vision Development, and the Beta Sigma Kappa Optometric Honor Society. He currently resides in Forest Grove with his wife Angie, and his son Jacob. They plan on returning to the Midwest in the future.

Paul Filar graduated from St. Norbert College in DePere, Wisconsin, with a B.S. in Biology and a minor in Psychology. At Pacific University College of Optometry he was a Student Optometric Association Equipment Representative, a member of the American Optometric Student Association, and in the Beta Sigma Kappa Optometric Honor Society. He and his wife, Trisha, will reside in Sturgeon Bay, Wisconsin, where Paul plans to practice.
Abstract

The purpose of this study is to investigate the effectiveness of a prescribing method for pre-presbyopic computer users to relieve symptoms of Computer Vision Syndrome (CVS). As of now, no standard protocol exists to prescribe computer lenses for this population. Subjects were between 20-34 years of age, spent a minimum of 6 hours a day for 5 days a week working on a computer, and had visual symptoms of CVS. An initial exam was performed and subjects were randomly placed into one of three groups: habitual distance prescription, distance subjective prescription, or computer prescription. Symptom surveys were used to determine the severity of symptoms for the two month duration of the study. A follow-up examination was performed to determine if exam findings correlated with symptoms, and basic case analysis was used to analyze the exam data. Overall, the group receiving the computer prescription reported less frequent symptoms and normalized accommodative and vergence posture findings. A future study should involve a greater number of participants to show whether this conclusion can be made.

Key Words: asthenopia, Video Display Terminal (VDT), occupational health, Computer Vision Syndrome (CVS)
Acknowledgments

We would like to express our gratitude to Dr. Erickson, Dr. Cooper, the Kikuchi College Research Fund, Dr. Ken Eakland, and Lowell Galambos. We would also like to thank the Merix Corporation, including John Schwan and Julie Hood.
Introduction

The number of people who use video display terminals (VDT’s) has increased tremendously over the past years. Many patients seen in optometric practices today spend more than three hours a day at their computer monitors. Computer Vision Syndrome (CVS) is a term that has been used to describe the visual complaints of a large percentage of computer users. The American Optometric Association (AOA) defines CVS as "the complex of eye and vision problems related to near work which are experienced during or related to computer use. CVS is characterized by visual symptoms that result from interaction with a computer display or its environment. In most cases, symptoms occur because the visual demands of the task exceed the visual abilities of the individual to comfortably perform the task." The most common symptoms of CVS include: asthenopia, headache, dry eyes, inability to maintain near focus, headache, tearing, and diplopia.

According to the American Optometric Association (AOA), an estimated 100 million people use computers daily, and 75% of them suffer from CVS. Thompson showed that CVS affects up to 93% of computer users, and with the number of VDT users growing, complaints of CVS are increasing rapidly. This indicates a significant health care issue that needs to be addressed by eyecare professionals.

The visual stimulus of computer screens may be a main factor contributing to CVS. Computer pixels of a VDT lack uniformity, and their luminance levels increase in the center and decrease towards the edges much like a bell-shaped or Gaussian plot. This type of luminance results in degraded images when compared to printed text. It is believed that the accommodative response decreases while viewing this type of Gaussian
image resulting in an increased lag of accommodation. A study of different tests of accommodation, including the positive and negative relative accommodation (PRA and NRA) midpoint, binocular crossed-cylinder (BCC), monocular estimate method (MEM) dynamic retinoscopy, subjective best-corrected nearpoint Snellen acuity, and dynamic retinoscopy using a Gaussian image as a target showed that the accommodative response to the Gaussian image resulted in approximately 0.50 D more plus than any of the aforementioned tests.

Ergonomic factors in the work place such as workstation design, placement, workplace lighting, and screen reflections may also contribute or cause vision-related symptoms. For instance, visual complaints of blurry vision, slow focusing and diplopia may occur due to such factors as viewing distance and prolonged viewing. Dry eye, itching, tearing and irritated eyes can be influenced by the air quality of the office and even screen height. Poor ergonomics and posture can lead to headaches, neck and shoulder tension, back pain, and pain in arms, wrists and shoulders. Butzon et. al. suggested that the use of an Ergonomic Self Assessment Tool (ESAT) be used to determine if computer vision problems were related to environmental conditions of the workplace, and suggested strategies to improve those symptoms.

One symptom computer users often encounter is dry eye. Reasons for this include decrease blink rate, lower workplace humidity, and incomplete blink due to higher viewing angle. Early studies have shown that during computer work, blink rates decrease dramatically. Patel et. al. demonstrated a five-fold decrease in blink rate when subjects used computers. A decrease from 18.4 blinks per minute during conversation to 3.6 blinks per minute during computer use was measured. Other studies have shown that
computer work requires a higher gaze angle. Sheedy stated that this higher gaze angle results in greater ocular aperture area and results in more rapid evaporation of tear film.

A recent study demonstrated that there is a direct correlation between an accurate spectacle prescription and productivity of employees. Daum et. al. showed that astigmatic corrections of computer users could increase productivity by 2.5%. They also indicated that these corrections increased visual comfort and resulted in a favorable cost-benefit ratio for employers. A recent study has shown that uncorrected vision problems can cause a 4-19% decrease in a worker's visual performance. A decrease in productivity by employees using computers for extended periods of time can become costly for employers. In fact, a Harris poll once identified computer eyestrain as the number one job-related complaint in the U.S. workforce. Due to the factors above, employers may be willing to provide computer spectacles to employees who suffer from CVS.

There has been debate over specific types of computer lenses that are most efficient in reducing the symptoms of CVS. Sheedy has stated that single vision lenses used for beginning presbyopes with CVS work very well because of the wide field of view. The most common lens designs for computer use include bifocals, progressive addition lenses, trifocals, and single vision lenses. The placement of the near zone in bifocals and progressive addition lenses is often too low and may result in the inability to view the VDT terminal through the near portion of the lens with normal posture. Many practitioners intentionally increase the height of these lenses in order to minimize the effects of abnormal posture. Horgen showed that the postural loads of neck and shoulder muscles was increased in presbyopic computer users wearing occupational
progressive lenses over a three month period as compared with presbyopes wearing
single vision lenses. Selenow et al.\textsuperscript{14} showed that when compared to single vision
lenses, progressive lenses show slightly diminished performance in relieving symptoms.

As the use of computers increases, the need for specialized prescriptions also
increases. While presbyopes are at a greater risk of suffering from many of the CVS
symptoms, pre-presbyopes experience symptoms as well, and they too, may need a
special prescription for computer use. It has been documented that "computer glasses"
can be effective in decreasing symptoms of CVS\textsuperscript{7}. Although many computer prescribing
protocols have been proposed, there have been no controlled studies of prescribing
methods or inspecting their effectiveness.

As technology evolves and the need for special spectacle prescriptions increases,
prescribing methods may not address these special conditions. This study investigates
the effectiveness of a prescribing method for pre-presbyopic computer users to relieve
symptoms of CVS. The protocol utilizes measurements obtained with traditional vision
testing to determine the optimum prescription to reduce CVS symptoms in the pre-
presbyopic population. Our hypothesis is that CVS symptoms will decrease in subjects
using lenses prescribed specifically for computer tasks, employing a defined prescribing
protocol.

\textbf{Methods}

\textit{Subjects}

A total of 14 subjects were recruited by contacting local companies and by
advertising in news sources. Potential subjects needed to be 18-35 years of age, wear
glasses or contact lenses while at the computer, work at a computer a minimum of 6
hours a day for 5 days each week, and have visual symptoms related to computer use. A
subjective questionnaire was administered to potential subjects in order to determine
eligibility to participate in the study (see Appendix A). Any subject taking medication
that could affect accommodation was not accepted for participation. Based on this
preliminary questionnaire, eligible subjects were scheduled for an initial vision
evaluation. Of the fourteen potential subjects, only ten met qualifications for the initial
visual evaluation.

Vision evaluation

Habitual working distances were measured for each subject at their customary
computer station. This measurement was taken from the spectacle plane to the center of
the computer screen. Subjects completed the first symptom survey (see Appendix B). A
focused case history was elicited that consisted of twelve established questions (see
Appendix C).

Lensometry of each subject’s habitual spectacles was performed using a Marco
model 101 lensometer. This information was used to determine whether any changes in
refractive status existed that may affect eligibility for participation in the study (see
Experimental groups).

A Snellen chart was projected using a Marco CP-670 projector and was adjusted
to measure habitual monocular and binocular distance visual acuities at 16 feet (5m).
Monocular and binocular habitual near visual acuities were measured using a reduced
Snellen card held at 40cm. Equivalent Snellen fractions were recorded for both
distances.
The cover test was performed through the habitual spectacle correction with a threshold acuity target in primary gaze at 5m and 40cm. Cover testing at 40cm was also performed at approximately 10 degrees below primary gaze to simulate reading gaze position. The magnitude of any heterophoria was measured with a prism bar. Random dot stereopsis was assessed at 40cm with the Randot Stereotest (Stereo Optical Company, Inc.).

The near point of convergence (NPC) was measured using a standard push-up technique. Subjects were encouraged to keep the accommodative target single as the target was moved toward the nose of subjects at a rate of about 2cm/sec and maintained at approximately 10 degrees below primary gaze. Subjective break and recovery values were measured and recorded in centimeters. If the subject did not report a break, the location of the target was noted for where ocular alignment was objectively lost and regained, and these values were recorded as the break and recovery.

Version testing was performed in the six cardinal positions of gaze using the broad H test with a fixation bead at approximately 40cm. Field-limits confrontational testing was performed to screen for any gross visual field deficits. Testing was performed under full illumination and subjects did not wear spectacles. Two stimulus presentations were performed in each quadrant under monocular conditions.

Direct and consensual pupil responses were evaluated while subjects viewed a threshold acuity target at 5m. Pupil assessment included size and shape in bright and dim room illumination and inspection for an afferent pupillary defect. Distance and near interpupillary distance (PD) was measured at 40cm with a millimeter ruler.
Static retinoscopy was performed to objectively estimate the refractive status of each subject. Monocular visual acuities at 5m were measured through the resultant retinoscopy lenses. A subjective refraction was performed both monocularly and binocularly. Spherical equalization was performed to achieve a binocular balance of accommodation. Monocular and binocular visual acuities were measured at 5m and 40cm through the subjective refraction.

Von Graefe horizontal heterophoria measurements were obtained at 5m and 40cm through the subjective refraction. To determine the gradient accommodative convergence/accommodation ratio, Von Graefe horizontal phorias were also performed through +1.00D and −1.00D addition lenses at 40cm. Horizontal vergence ranges were performed at 40cm through the subjective refraction using 20/20 (6/6) Snellen equivalent letters. Blur out, break, and recovery findings were obtained for positive and negative relative vergences.

To assess accommodative posture, the MEM dynamic retinoscopy was performed at each subject's habitual computer working distance through the subjective refraction using the Welch Allyn adult MEM card and Welch Allyn retinoscope. Trial lenses were used to neutralize any motion of the retinal reflex.

The binocular cross cylinder (BCC) test was performed by adding +2.00D to the subjective refraction. A cross-grid nearpoint card was used as a target, with lines set at 90 and 180 degrees. The subject was asked whether the vertical or horizontal lines were darker and/or clearer. If the vertical lines were darker, the examiner proceeded by decreasing plus power in −0.25D increments binocularly until the subject reported that the horizontal lines were darker. If initially the horizontal lines were darker, +0.25D was
added binocularly until the vertical lines appeared darker. If the subject perceived both
sets of lines as being equal, the lenses which produced the last "equal" response prior to
the vertical lines being darker was recorded. Otherwise, the first lenses that made the
horizontal lines appear darker were recorded. Monocular near visual acuities and
horizontal Von Graefe phorias were measured through the BCC lenses at 40cm.

Positive relative accommodation (PRA) and negative relative accommodation
(NRA) testing was performed at 40cm using 20/20 (6/6) Snellen equivalent letters. The
first lens power that made the letters too blurry to read was recorded as the blur out, and
the first lens power that allowed the subject to clearly view the target was noted as the
recovery.16

Experimental groups

Based on the results of the tests performed in the above vision evaluation, five
subjects were accepted. They exhibited no strabismus, no extra ocular muscle
restriction, no gross visual field defect, normal pupillary responses, best-corrected visual
acuity of 20/25 (6/7.5) or better in each eye, and were not taking medication that may
have an affect on accommodation or vergence. Subjects could not have more than a
1.50D change in cylinder power, or 15 degrees change in axis orientation comparing the
habitual prescription to the distance subjective prescription found during the vision
evaluation from their habitual prescription.

Subjects were randomly distributed into three groups: one into a control that
continued to wear their habitual prescription (Group 1), two into a group prescribed the
distance subjective refraction (Group 2), and a two into a group prescribed a computer
prescription based on the study protocol (Group 3). Following the first vision evaluation,
all subjects chose a spectacle frame, and lenses were generated for each of them. Therefore, even those in Group 1 were given a new pair of spectacles for the study. The "Informed Consent" form was the only source that explained that they would be assigned to one of three test groups, where they may or may not receive a change in prescription. The "Informed Consent" also explained that they would receive a voucher for a free comprehensive vision examination and the option to receive computer-specific glasses as needed at the end of study if they were not in the group who received them for the study. Subjects were not informed of their group assignment throughout the study until its conclusion, and were instructed to wear the study's spectacles at any time they worked at their computer.

**Computer prescription protocol**

The BCC lens value was used as a tentative computer prescription. The BCC lens was trial framed for 5 minutes while the subject read a computer productivity article (Times New Roman, font size 12) from a laptop computer at their habitual computer working distance. After reading for 5 minutes, MEM retinoscopy was performed at their habitual computer working distance. If a lag of accommodation was found to be greater than or equal to 0.50D, the BCC lenses were increased in +0.25D steps until the lag was found to be less than 0.50D. If a lead of accommodation was found, minus was added to the BCC lenses in 0.25D steps until the desired lag of less than 0.50D was obtained. The near cover test was performed at the subject's habitual computer working distance with the computer lenses. This data was used to ensure that the computer lenses would not create a high exophoria or exotropia. Subjects were also asked about comfort and clarity while reading the text at the laptop with the computer lenses.
Follow-up evaluation

The vision evaluation was repeated on each subject following 2 months of spectacle wear. In addition to the symptom survey completed on the day of the initial vision evaluation, each subject completed a symptom survey (Appendix B) the day spectacles were dispensed for the study, then 1 week, 1 month, and 2 months following the dispensing date. All subjects received a complimentary vision examination at Pacific University College of Optometry and those who were not selected for Group 3 were given the option to receive a complimentary pair of computer glasses at the conclusion of the study, with lens powers determined as described following the Computer prescription protocol above. Those who were in Group 3 were given the option of retaining their spectacles.

Results

Symptom surveys were analyzed to quantify the frequency that components of CVS occurred in each group throughout the study. If the symptom was never experienced, it was rated as a level 0, rarely as a level 1, sometimes as a level 2, frequently as a level 3, and always as a level 4. Duration of spectacle wear was measured in days, with the survey administered during the first vision evaluation plotted as day 0. Immediately prior to receiving spectacles for the study, another survey was given and plotted as day 1. Surveys were then administered at 1 week, 1 month, and 2 months following spectacle prescription use.

Changes were noted to be significant if the frequency of CVS symptoms were increased or decreased by at least 1 level. If averaging levels within a group resulted in a
fraction, the level was rounded up to the next integer (e.g., 2.5 would be rounded up to a level 3, or always being experienced).

Group 1

Group 1 (see Fig. 1), wearing the habitual spectacle prescription, showed an overall decrease in eyestrain throughout the study. This group dropped two levels, from eyestrain always being experienced to eyestrain only sometimes occurring. Headaches diminished over time as well. Initially headaches occurred sometimes, but this symptom ceased to occur by the end of the study. The symptom of pain in and/or around the eyes was low in this group at the beginning of the study and showed no significant change in severity after two months. Dry eye occurred frequently in this group throughout the duration of the study. Group 1 reported having watery eyes and itchy eyes almost always throughout the study, and showed no significant change. Lighting or glare discomfort had a frequent incidence initially, but only occurred rarely after two months time. The symptoms of blurred distance vision and worse vision at the end of the day showed a decrease in frequency from always occurring to only sometimes taking place. Blurred intermediate vision showed a significant change over two months time, beginning with being experienced sometimes, then frequently, but then never after wearing the lenses for 1 week. Blurred near vision happened sometimes, but lessened and was never experienced by the end of the study.

Group 2

The group designated to use their distance subjective refraction, or Group 2 (see Fig. 2), began reporting symptoms of eyestrain or tired eyes always on the first day they received the prescription. Thereafter these symptoms were reported as being experienced
frequently. This group reported the least change in headache symptoms, initially with headaches noted frequently, then decreasing to sometimes after the first week and remaining at this severity level. Pain in and/or around the eyes was initially reported as being experienced frequently to always, but this symptom subsided and was only experienced sometimes after two months. Dry eyes and watery eyes were not reported to have been significantly affected by the distance subjective refraction. Group 2 began frequently experiencing itchy eyes, as well as lighting/glare discomfort. These symptoms then diminished to rarely by the end of the study. The symptoms of blurred distance vision was first experienced sometimes, then frequently after one week, diminished to rarely, but returned to sometimes by the end of the study. Vision was experienced worse at the end of the day, frequently at the beginning, but then was only felt sometimes by the termination of the study. Blurred intermediate vision was initially reported as occurring frequently, blurred near vision as frequently to always, but after two months both symptoms were only sometimes experienced.

Group 3

The group wearing the computer prescription (see Fig. 3), had symptoms of eyestrain or tired eyes frequently but these symptoms consistently subsided throughout the study until symptoms were rare. Group 3 began with frequent headaches, but rarely encountered such symptoms after the first week. The symptom of pain in and/or around the eyes did not show a significant change over time. The computer Rx group reported no significant change in dry eye symptoms or watery eyes during the study, reporting these symptoms from sometimes to rarely. Group 3 did not show a large change in itchy eye symptoms, reporting this symptom between sometimes and rarely. They did,
however, experience fewer symptoms than the group wearing their habitual Rx. This group reported suffering from lighting or glare discomfort CVS symptoms, but these symptoms decreased in frequency to *sometimes*. The symptom of worse vision at the end of the day showed a steady decrease in frequency in those wearing the computer prescription from *frequently* at the beginning of the study to *rarely* by the end. The computer prescription group initially reported *sometimes* experiencing blurred near vision, then this symptom was encountered *rarely* for the remainder of the study, although this was not a substantial change. Blurred intermediate vision did not show a major change for the duration of the study. The computer prescription group displayed a steady decrease in experiencing blurred distance vision, from *frequent* episodes prior to using the computer prescription, until by the end of the study it was *rarely* reported.

In addition to symptom surveys, basic case analysis (Table 1) was used to determine whether changes in symptoms compare accurately to accommodative and vergence posture. Sheard's and Percival's Criterion was used to estimate the amount of prism necessary to help the patient cope with vergence related stress (if necessary). When comparing the following two tables, it should be noted that only those in the Distance Subjective Group Prescriptions failed Percival's Criterion on the second visit, which could lead to symptoms of CVS.

Sheard's Criterion was calculated by multiplying the horizontal phoria through the subjective refraction at 40cm (near) by 2 and comparing it to the blur of the compensating horizontal vergence range at near. The near phoria must be at least twice the blur of the compensating horizontal range to pass. To determine the appropriate prism compensation upon failing, the difference between the doubled phoria and
compensating blur was calculated, divided by 3, and recommended prism applied in the necessary direction. In order to pass Percival’s Criterion, the greater break of the horizontal vergence ranges at near should be smaller than the lesser break multiplied by 2. The appropriate prism added when failing Percival’s Criterion is determined by taking the difference between the doubled lesser and greater breaks, dividing by 3, and adding the resulting prism in direction of greater break.

Changes in accommodative posture were noted by comparing results of the MEM through the subjective refraction obtained from each vision evaluation. Accommodative posture changes in Groups 1 and 2 showed decreased lag while Group 3 showed a slightly increased lag. The small changes in accommodative posture or the tendency to decrease lag or increase lead correlate with the continued symptoms of Groups 1 and 2.

The changes in vergence posture were noted by comparing the near phoria through the subjective refraction of the initial vision evaluation to the phoria at near through the test lens at the follow-up evaluation. Groups 1 and 2 displayed an eso shift, which demonstrated continued near point stress, potentially leading to continued CVS symptomology. Conversely, Group 3 exhibited a tendency toward a more appropriate exo posture at near. Some decreased symptoms reported by Group 3 may be a direct result of the exo shift.

Table 2 indicates how the computer prescription seems to have alleviated stress from the accommodative and vergence systems for the subjects in Group 3. Only these subjects had slightly increased lag and exo posture possibly indicating a relief in CVS symptoms. The subjects in the other groups demonstrated continued near point stress with decreased lags and esoward shifts.
Discussion

The purpose of this study was to investigate the effectiveness of a prescribing method to determine a compensating lens which would reduce symptoms of CVS in pre-presbyopic computer users. Symptom surveys and basic case analysis were employed to determine changes in symptoms, and whether changes were expected.

For the purpose of this study, a change of greater than one level in frequency of CVS symptoms was considered significant. A reduction in symptoms to a level at which they occurred rarely to never would most likely be beneficial to the patient. According to the symptom surveys, Group 1 showed a significant decrease in most symptoms, however a reduction in the frequency to rare occurred in only five areas. Group 2 showed a noteworthy decrease in nine symptoms but only two symptoms decreased to a level at which they occurred rarely. Nine symptoms were also demonstrated to have a significant reduction in Group 3. It is worth mentioning however, that eight of these symptoms were reduced to a level at which they rarely occurred.

Group 1 passed both Sheard's and Percival's Criterion at the initial and follow-up vision evaluations, but showed a decreased lag of accommodation on MEM and an eso shift at near. These results seem to relate to with the symptom surveys in that there was a decrease in symptoms, but only five symptoms decreased to rare. Group 2 passed Sheard's and Percival's Criterion during the initial vision evaluation, but was the only group to fail Percival's Criterion on the follow-up vision evaluation. Group 2 also demonstrated a decreased lag on MEM and an eso shift at near. Symptom surveys showed that this group had significant decreases in most symptoms but only two symptoms occurred rarely during the last survey. These results correspond to the case
analysis. The third group passed both Sheard's and Percival's Criterion at the initial and follow-up vision evaluations. This group also established a very small increased lag on MEM and exhibited a shift to a more normal exo posture at near. These findings seem to parallel the symptom surveys which show that eight symptoms were reduced to rare at the conclusion of the study.

Based on the findings above, the prescribing method proposed is shown to decrease symptoms of CVS in pre-presbyopic computer users. However, a more thorough study with a greater number of participants is needed to show whether this conclusion can be made.

The study was designed to incorporate a control for the placebo effect. The habitual prescription (Group 1) was used for this purpose. Since this group was wearing their habitual prescription, it was anticipated that their symptoms would remain unchanged. A minimal placebo effect was shown in this group by a slight decrease of symptomology. This group demonstrated the lowest reduction in symptoms of all three groups.

One problem that arose during this study was with subject recruitment. Many candidates were excluded due to habitual wear of a current near lens, the use of accommodation altering medications, and unwillingness for the cessation of contact lens wear. Some potential subjects failed our entrance tests due to accommodative and vergence problems. Minus projection, or lead of accommodation, as well other forms of accommodative dysfunction and binocular vision disorders such as strabismus and amblyopia occur in the general population and would be excluded by the strict criterion of this study. These problems are bound to occur in individuals who work on computer
for several hours a day. For these patients, it may be necessary to employ certain forms
of vision therapy or other lens compensation before the computer glasses are prescribed
to the patient.
References

3. Anderson L. CVS: The Causes are Real...So are These Cures. Review of Optometry 2000 Feb 15:51-54.
### Tables

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
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<td>Initial Vision Evaluation</td>
<td>A</td>
<td>B</td>
<td>C</td>
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<td>Gradient AC/A</td>
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<td>2.75</td>
<td>5.25</td>
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<tr>
<td>Near Far AC/A</td>
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<td>3</td>
<td>5.5</td>
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<tr>
<td>Sheard's</td>
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<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td>Percival's</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td>Follow-up Vision Evaluation</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Gradient AC/A</td>
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<td>3.38</td>
<td>5</td>
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<tr>
<td>Near Far AC/A</td>
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<td>3.8</td>
<td>5.75</td>
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<tr>
<td>Sheard's</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td>Percival's</td>
<td>Pass</td>
<td>Fail: 0.67^BO</td>
<td>Fail: 6^BI</td>
</tr>
</tbody>
</table>

**Table 1.** Case analysis of each subject, including AC/A calculations, Sheard's, and Percival's criteria recommendations, and accommodative and vergence posture shifts.

<table>
<thead>
<tr>
<th>Group Trends:</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decreased Lag</td>
<td>Eso posture shift</td>
<td>Eso posture shift</td>
<td>Exo posture shift</td>
</tr>
<tr>
<td>Slightly increased lag</td>
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<td></td>
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</tbody>
</table>

**Table 2.** Overall accommodative and vergence posture shift trends for each group.
Figures

Figure 1. Frequency of each component of CVS symptom reported by Group 1 over 2 months.

Figure 2. Frequency of each component of CVS symptom reported by Group 2 over 2 months.
Figure 3. Frequency of each component of CVS symptom reported by Group 3 over 2 months.
Appendix A

Today's Date: __________________________

Name: __________________________________ Date of Birth: ____________

Tasks performed at computer:

Hours/Day of computer work: ______
Days/Week of computer work: ______
How often are breaks taken from computer work during the day: ______

Approximate percentage of time performing the following tasks:

  Viewing computer monitor: ______%
  Viewing hard copy: ______%

Circle one response for each question:
Do you have symptoms of eyestrain or tired eyes, headaches, pain in & around the eyes, dry eyes, or other vision problems while working at the computer? Y N

Do you currently wear glasses?: Y N

To be eligible to participate in this study, you must work at the computer for a minimum of 6 hours each day, 5 days a week for the 3 month duration of the study (excluding holidays). Will you be able to fulfill this obligation? Y N

Sometimes medication can affect our vision. Please list ALL medications you are currently taking (including prescription and non-prescription remedies):

Please place this form in the envelope provided, seal it, and sign across the seal.

THANK YOU!!!
Appendix B

SYMPTOM SURVEY

Please circle the corresponding number that best describes how often you experience each symptom, with a 0 being Never and a 4 being Always.

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Never</th>
<th>Rarely</th>
<th>Sometimes</th>
<th>Frequently</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eyestrain or tired eyes</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Headaches</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Pain in &amp;/or around eyes</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Dry eyes</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Watery eyes</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Itchy eyes</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Lighting or glare discomfort</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Constant blurred distance vision</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Vision worse at end of day</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Blurred intermediate vision (computer distance)</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Blurred near vision</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

Which of the above is most significant or bothersome to you?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

Please list all medication (prescription and non-prescription) that you are currently taking:

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
Appendix C

<table>
<thead>
<tr>
<th>Name:</th>
<th>DOB:</th>
<th>Age:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time:</td>
<td>Computer Working Distance: cm</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LEE Date:</th>
<th>Reasons for LEE:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal or Family Hx of:</td>
<td></td>
</tr>
<tr>
<td>Glaucoma:</td>
<td></td>
</tr>
<tr>
<td>Eye Turn:</td>
<td></td>
</tr>
<tr>
<td>Diplopia:</td>
<td></td>
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<tr>
<td>Injur:</td>
<td></td>
</tr>
<tr>
<td>Blindness:</td>
<td></td>
</tr>
<tr>
<td>Surgery:</td>
<td></td>
</tr>
<tr>
<td>Infection:</td>
<td></td>
</tr>
<tr>
<td>DM:</td>
<td></td>
</tr>
<tr>
<td>HTN:</td>
<td></td>
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<tr>
<td>Heart:</td>
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<tr>
<td>Lung:</td>
<td></td>
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<tr>
<td>Thyroid:</td>
<td></td>
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<td>Cancer:</td>
<td></td>
</tr>
<tr>
<td>LME:</td>
<td>Reason for LME:</td>
</tr>
<tr>
<td>Meds:</td>
<td></td>
</tr>
<tr>
<td>Allergies:</td>
<td></td>
</tr>
</tbody>
</table>

DOB: date of birth, LEE: last eye examination, DM: diabetes mellitus, HTN: hypertension, LME: last medical examination, Meds: medication currently taking