HOYA HOLDINGS N.V
Amsterdamseweg 29, The Netherlands
P.O. Box 250, 1420 AG Uithoorn, The Netherlands
Tel. +31 (0)297 514 350, Fax. +31 (0)297 569 666

Evaluating the efficiency of spectacle lenses with accommodative support and a blue light filter in reducing computer vision syndrome/digital eye strain symptoms in comparison with habitual glasses

Chris Ang[1], Prof. Dr. Dejan Dinevski[2], Dr. Natalia Vlasak[2] and Andria Kok[3]

1 CK Optometrist Consultant Centre, Malaysia
2 Maribor University, Maribor, Slovenia
3 Hoya Vision Care Asia Pacific, Singapore

Abstract

Background: The aim of this trial was to determine whether the use of spectacle lenses with accommodative and blue light filter reduced the symptoms of digital eye strain.

Methods: Thirty-one healthy volunteers were enrolled on this study according to the inclusion and exclusion criteria.

Inclusion criteria were 1) age 21-40 years; 2) wearing spectacles the last 6 months; 3) spending two or more hours per day using digital devices; 4) having digital eye-strain symptoms with the minimum score of six points in the CVS-Q; 3) not wearing single vision lenses with accommodative support 4) spherical power: +/- 5.00 and cylindrical power: minus cylinder ≤ 2.00; 5) giving written consent to participate in the study.

The primary outcome was reduction in in the severity of visual symptoms related to digital device use. Secondary outcomes were measures of visual performance, including a) visual acuity, b) amplitude of accommodation, c) MEM retinoscopy, d) visual experience score, e) satisfaction score.

Results: Thirteen (42%) subjects reported that they experienced eye-strain symptoms after one to two hours of digital device use. There was a significant reduction in the severity of visual symptoms related to digital device use ($p<0.01$). There was a significant improvement in the visual experience with the new spectacles after one month of wearing them ($p<0.01$).

Conclusion: The use of spectacle lenses with accommodative support and blue light filter may be advantageous for users of digital devices who suffer from CVS. The viewing distances measured were closer than those previously reported in the literature.

Key words: computer vision syndrome, digital eye strain, eye fatigue, digital device, viewing distance, lenses with accommodative support

Almost nine in ten adults (87%) use digital devices for more than two hours each day, while 52.2% report using two digital devices simultaneously[1]. A combination of factors, including the proximity at which digital screens are viewed, the frequency and length of time of use, and exposure to blue light emitted by backlit displays, can take a toll on the visual system and lead to computer vision syndrome (CVS) also known as digital eye strain.

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CVS is characterised by dry, irritated eyes, blurred vision, neck/shoulder and back pain due to poor posture and headaches from repeated eye strain.

Many people experience visual discomfort after two or more hours in front of digital screens, which include desktop and laptop computers, tablets, smartphones and televisions. The vision industry has identified CVS as a challenge for eye comfort and health. In recent years, special optimised lenses and innovative coatings have been developed to help alleviate CVS, eliminate glare and filter out harmful blue light. Furthermore, these solutions have been shown to improve visual acuity, visual comfort and precision.

Subjects and methods

Participants

Thirty-one healthy volunteers, 22 (71%) women and nine (29%) men with a mean age of 32.23 ± 5.45 years, were enrolled on this study according to the inclusion and exclusion criteria. Pre-screening was done online using a primary selection questionnaire, which included questions about the intensity of digital device use as well as a validated computer vision syndrome questionnaire (CVS-Q) [2]. Subjects who spent two or more hours per day using digital devices and had digital eye-strain symptoms with the minimum score of six points in the CVS-Q were invited for optometric screening. All the volunteers were spectacle wearers and had habitually worn single vision spectacles with the same correction for 11.1 ± 9.23 months (range 1-48 months) before being recruited. None of them had worn single vision lenses with accommodative support (e.g. Hoya Remark, Essilor Anti-fatigue/Eyezen, Zeiss digital lenses) in the past. Four (13%) subjects were hyperopes and 27 (87%) were myopes with mean distance spherical equivalent power for the right eye (-) 2.17 ± 1.63 and for the left eye (-) 2.31 ± 1.59. Subjects were excluded if they had any systemic or ocular disease (except for refractive error), prior eye surgery or trauma. Subjects who regularly used eye drops or contact lenses were also excluded. The study followed the tenets of the Declaration of Helsinki. After the protocol, had been fully explained, all subjects provided written informed consent to participate in the study.

Design of the study

The subjects attended three appointments.

First appointment

During the first appointment, anamnesis, current spectacle analysis, preliminary investigation, subjective refraction, amplitude of accommodation (AA) and MEM retinoscopy were performed.

1. Visual acuity for far: 24 (77%) subjects had visual acuity 6/6; three (10%) subjects had 6/5; three (10%) subjects had 6/6 in one eye and 6/9 in the other; one (3%) subject had 6/9 in one eye and 6/12 in the other. After the subjective refraction, the prescription stayed the same for 17 subjects (55%), spherical power was increased by (-) 0.25D for 11 subjects (35%) and by (-) 0.5D for three subjects (10%).

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2. AA was measured using the push-up method with Royal Air Force (RAF) ruler. Average AA was 7.41 ± 2.02D in the range 4-11D: 4.0D – two subjects; 4.5D – three subjects; 4.75D – one subject; 5.0D – one subject; 5.5D – one subject; 6.0D – one subject; 6.5D – two subjects; 7.0D – one subject; 7.5D – two subjects; 8.0D – five subjects; 8.5D – two subjects; 9.0D – six subjects; 10.0D – three subjects; 11.0D – one subject.

3. Average MEM retinoscopy was 0.68D ± 0.20 in the range 0.25-1.0D: 0.25D in each eye – two subjects; 0.5D in each eye – eight subjects; 0.75D in each eye – 16 subjects; 1.0D in each eye – three subjects; one subject had 0.5D in one eye and 0.75D in the other; and one subject had 0.75D in one eye and 1.0D in the other; 26 (84%) subjects had an MEM retinoscopy score in the normal range.

Based on the results of the AA and MEM retinoscopy measurements, the functional power level of +0.53 was given to 19 (61%) subjects who had an AA and MEM retinoscopy score in the normal range; and +0.88D was given to 12 (39%) subjects who had AA of ≤ 7.0D and MEM retinoscopy of 0.75-1.0D.

The subjects were also asked to fill in detailed visual experience questionnaires. Spectacle frames were selected, adjusted and fitted and spectacle lenses with the chosen functional power level made from 1.6 material with blue light filter and anti-reflation coating were ordered.

Second appointment

During the second appointment, the spectacles were individually fitted and centration was checked. Visual acuity was measured, and after 15 minutes of wearing the new spectacles, subjects were asked to complete a first-impressions satisfaction questionnaire. Thereafter, the subjects were instructed to wear the spectacles every day for one month.

Third appointment

During the third and final appointment, after one month of wearing spectacle lenses with accommodative support and blue light filter, the subjects' visual functions were checked, e.g. visual acuity, AA, MEM retinoscopy.

1. Visual acuity for far: 28 (90%) subjects had 6/6 and three (10%) subjects had 6/5.

2. Average AA increased 7.88D ± 2.13 in the range 3.75-12D: 3.75D – one subject; 4.0D – one subject; 5.0D – three subjects; 6.0D – three subjects; 6.5D – one subject; 7.0D – two subjects; 7.5D – three subjects; 8.0D – three subjects; 8.5D – two subjects; 9.0D – five subjects; 10.0D – four subjects; 10.5D – one subject; 12.0D – two subjects.

3. Average MEM retinoscopy was 0.60D ± 0.16 in the range 0.25-1.0D: 0.25D – one subject; 0.5D – 17 subjects; 0.75D – 11 subjects; 1.0D – one subject; one subject had 0.5D in one eye and 0.75 in the other.

The subjects were also asked to fill in the CVS-Q, visual experience and satisfaction questionnaires.

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Data analysis

Data and statistical analyses were carried out using IBM SPSS Statistics software (version 22) and Microsoft Excel 2013. The differences between means were tested using a paired-samples t-test. Other tests were not employed, since the distribution of the differences between the scores of the two related groups were normally distributed. The significance level was set at $P < 0.05$.

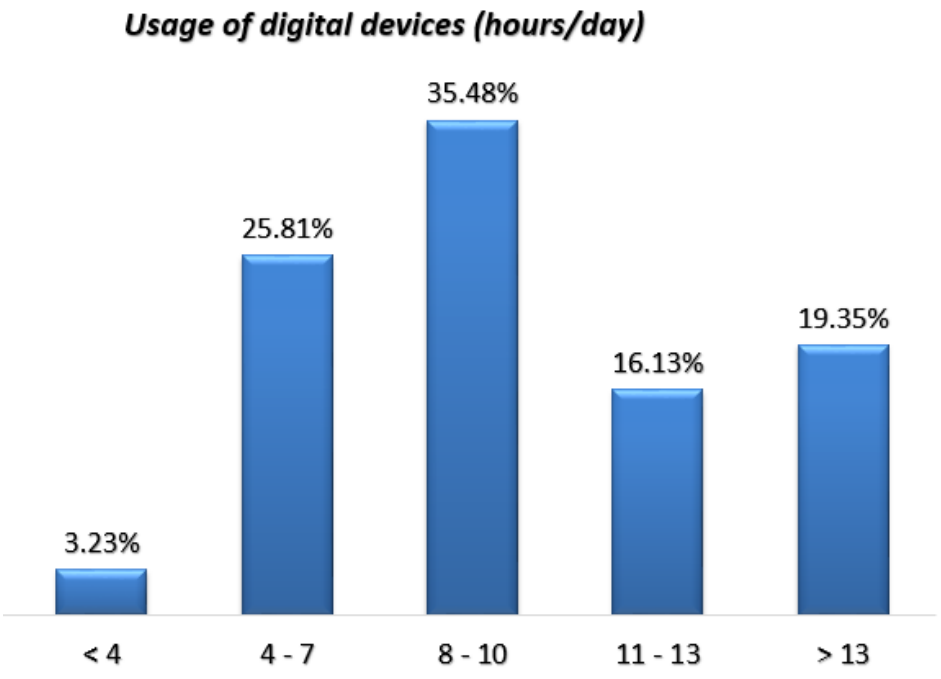
Results

I. Digital device use

Digital device use was evaluated using the data from the detailed questionnaire. All subjects (100%) answered that they used smartphones. The laptop was named as the second-most-used digital device. Tablets and desktop computers were used less often compared to smartphones and laptops. Laptops and desktops were usually used at work; at home, subjects preferred to use smartphones and tablets. Smartphones were used everywhere.

Only three (10%) subjects used one digital device (smartphone) and 28 (90%) subjects used two or more digital devices; 14 (45%) used two devices (in most cases smartphone and laptop); ten (32%) used three devices (smartphone, laptop, desktop or tablet); and four (13%) used all aforementioned devices.

Thirty (97%) subjects used digital devices for four or more hours per day; 11 (35%) used digital devices for 11-13 hours per day.



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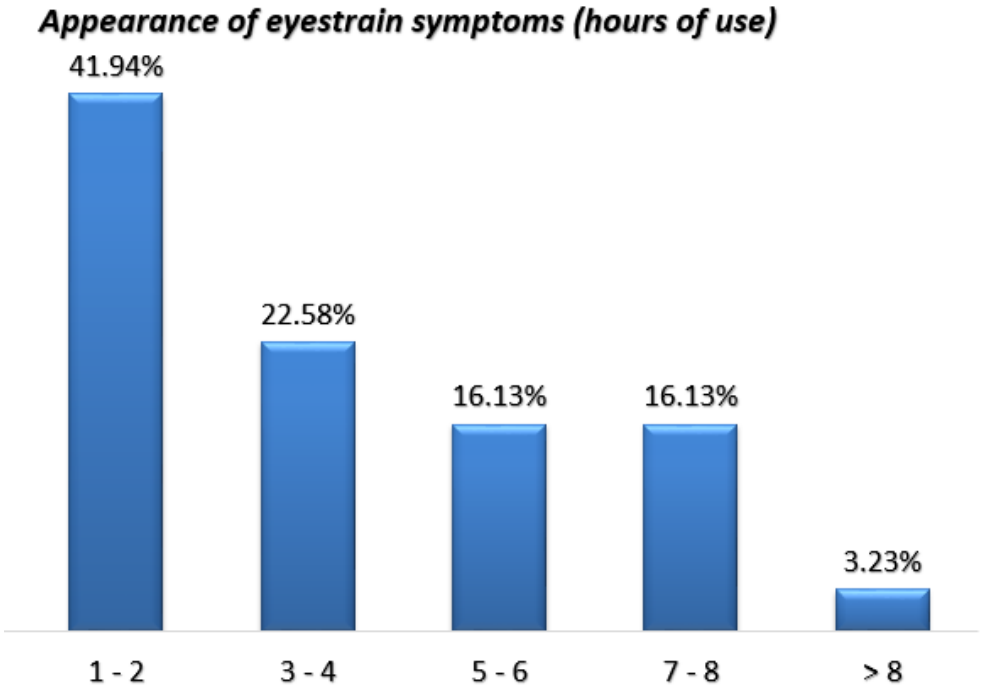
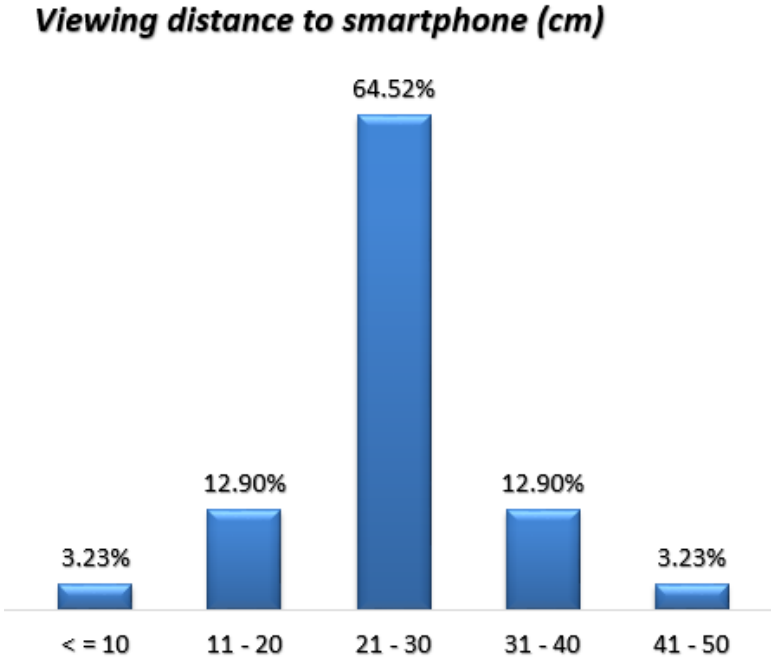
Thirteen (42%) subjects reported that they experienced eye-strain symptoms after one to two hours of digital device use.



Smartphones were used for two-five hours per day. Twenty-eight (90%) subjects used their smartphones at a distance of 11-40cm, 20 (64.5%) at a distance of 20-30cm.



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Laptops were the second-most-used digital device. Subjects used a laptop for between three and 13 hours a day. Nine subjects (29%) did not use a laptop. Eighteen (58%) subjects used a laptop at a distance of between 30-60cm.

Seventeen (55%) subjects used a desktop computer at a distance of between 40-70cm. Nine (29%) subjects did not use a desktop.

Tablets are mostly used (by 14 or 45% of the subjects) at a distance of 21-40cm. This is similar to the distance to smartphones. Thirteen (42%) subjects did not use a tablet.

II. Visual functions

1. Visual acuity: Visual acuity increased due to the new correction.

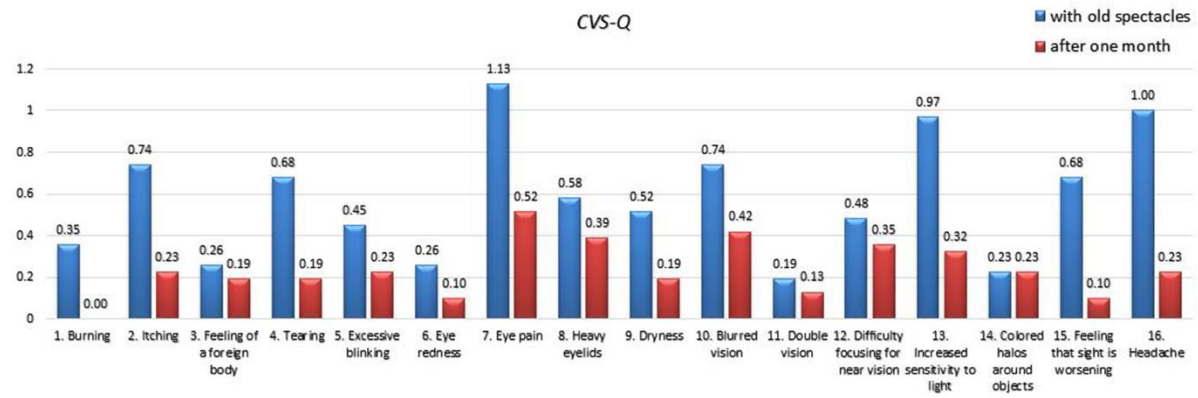
2. AA: Comparing the result from the first appointment with the result after wearing Remark lenses for one month, AA increased in 17 (55%) cases, stayed the same in nine (29%) cases and decreased in five (16%) cases.

3. MEM retinoscopy: Comparing the result from the first appointment with the result after wearing Remark lenses for one month, 29 (93.5 %) subjects had MEM in the normal range, and there was a slight improvement in the score.

III. Questionnaire score analysis

1. Computer vision syndrome score analysis

The computer vision syndrome questionnaire (CVS-Q)[1] was used to estimate the severity of visual symptoms related to the use of digital devices. All subjects filled in the CVS-Q twice: before the trial wearing their old glasses, when the score was 9.32 ± 3.25, and after one month of wearing the new spectacle lenses with accommodative support, when the score was 3.81 ± 3.33. Comparing the CVS-Q scores before and after the trial, the severity of the symptoms reduced in 26 (84%) of the cases, stayed the same in two (6.5%) and increased in three (10 %). There was a significant reduction in the severity of visual symptoms related to digital device use ($p<0.01$).



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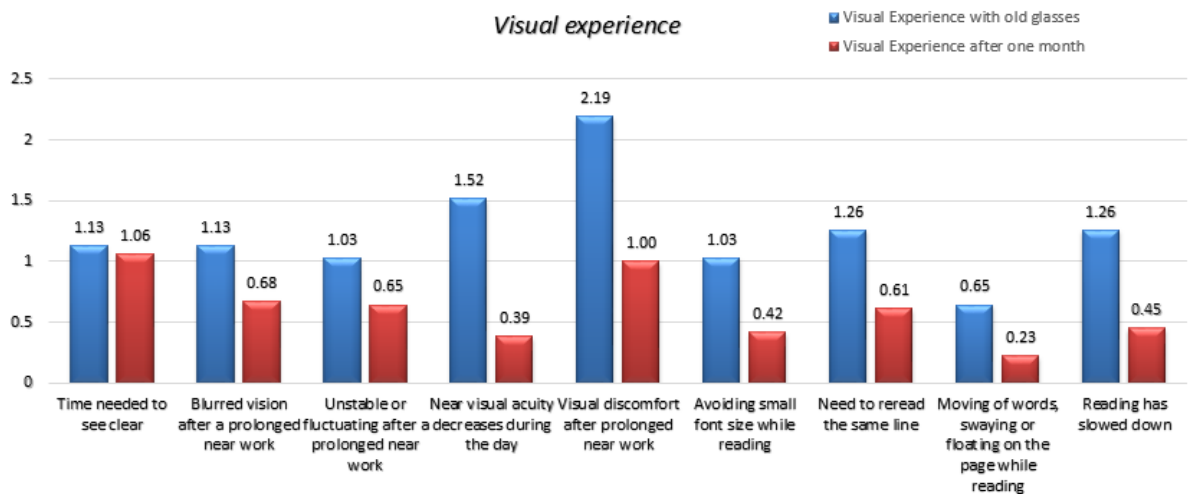
Graph 1. Comparison of severity of computer vision syndrome symptoms before and after one month of wearing the spectacle lenses with accommodative support and blue light filter.

More detailed analysis of specific answers to the 16 questions was done in order to outline their values. Every question in the CVS-Q had two values, one for frequency (never = 0, occasionally = 1, often or always = 2) and the other for intensity (moderate = 1, intense = 2) of the symptom. The combined value is called 'severity' and is calculated by multiplying frequency by intensity. Severity values are all the multiplication combinations of their respective scores: 0 x 0, 0 x 1 and 1 x 0 = 0; 1 x 1, 2 x 1 and 1 x 2 = 1; and 2 x 2 = 2.

2. Visual experience score analysis

All subjects also filled in the visual experience questionnaire twice: during the first appointment wearing their old spectacles and again during the third appointment wearing the new spectacles. The first score was 11.19 ± 6.23 and the second was 5.48 ± 4.09. There were nine symptom-related questions, and the frequency of each symptom was given a value (never = 0, rarely = 1, sometimes = 2, often = 3, always = 4). There was a significant improvement in the visual experience with the new spectacles after one month of wearing them ($p<0.01$). A comparison of all nine answers (mean values of the answers) to the visual experience questions with the old and new spectacles is presented in the following graph.



Graph 2. Comparison of severity of symptoms related to near work before and after one month of wearing the spectacle lenses with accommodative support and blue light filter.

3. Satisfaction score analysis

All subjects filled in the satisfaction questionnaire after 15 minutes and after one month of wearing the new spectacle lenses with accommodative support. The first satisfaction score was already quite high – 37.29 ± 4.96 (max. 52) – and increased at the end of the one-month trial to 39.52 ± 7.47. The activity with the highest improvement was reading.

Conclusion

The use of spectacle lenses with accommodative support with one of two functional power levels +0.53D/+0.88D, made from 1.6 material with blue light filter and anti-reflection coating, led to an improved AA score, a significant reduction of visual symptoms related to digital device use and increased satisfaction. These findings provide evidence that the use of spectacle lenses with accommodation support and a blue light filter may be advantageous for users of digital devices who suffer from CVS.

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Author Contributions

Author CA is considered co-first author, co-designed and conducted the study, co-analysed the data. Author DD co-analysed the data and co-write the manuscript. Author NV co-designed the study, co-analysed the data and co-wrote the manuscript. AK is an employee of Hoya Vision Care Asia Pacific, co-designed the study and provided spectacles.

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