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Effect of Yellow Filter on Contrast Sensitivity Function in High Myopes

Peeroo Azraa Beebee Sharfaa[1] and Fakhruddin Shamsheer Barodawala[2*]

[1,2]*Faculty of Optometry and Vision Sciences, SEGi University, No.9 Jalan Teknologi, Kota Damansara, Petaling Jaya, Selangor, Malaysia-47810*

[*]optom_fakhruddin@yahoo.com (Corresponding Author)

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ABSTRACT

Background: This study examines the influence of yellow filter on the contrast sensitivity function in individuals with high myopia. Through a comprehensive analysis, we explore the potential enhancement of visual perception and contrast sensitivity in this population. The findings contribute to our understanding of effective interventions to optimize visual outcomes for high myopes.

Purpose: A cross-sectional study was conducted where thirty-four (n=34) healthy young subjects (age range 17-25 years old) having high myopia (SER $\geq$ 6.00D) without any ocular pathology. Contrast Sensitivity Function (CSF) was assessed using the Functional Acuity Contrast Test (FACT). First, the CSF was measured without the filter (baseline) then immediately after using a yellow filter (50% transmittance) and then after five minutes of adaptation of the yellow filter. The room illumination was constant at 150lux across all the subjects.

Results: One-way repeated measure ANOVA showed that there was no statistically significant difference in contrast sensitivity function for spatial frequencies 1.5 cpd, and 12 cpd. However, there was a statistically significant difference in contrast sensitivity for spatial frequencies 3 cpd; $F(1.46, 48.20) = 28.80$, 6 cpd; $F(1.44, 47.43) = 39.99$ and 18 cpd; $F(1.53, 50.47) = 44.26$.

Conclusion: There was an improvement at the moderate and high spatial frequencies (3 cpd, 6 cpd and 18 cpd) but no changes were found at other spatial frequencies. This shows that yellow filter can help to improve the contrast sensitivity function in high myopes at moderate and high spatial frequencies.

1. Introduction

Vision plays an important role in our everyday life. Vision deterioration may cause some restrictions when we do our everyday activities. Most of the time spectacle lenses are being used to correct refractive power. Therefore, it is important to be well aware of how visual performance may be influenced by any ophthalmic device. In ophthalmic department not only spectacles lens that are being used but also tinted lenses are famous for their specific purpose. Tinted lenses are used to increase contrast and do not obstruct the visual performance of the person (Shaik *et al.*, 2013). Contrast sensitivity (CS) is defined as the noticeable significance in threshold between what can be seen and cannot be seen for basic and clinical vision science (Pelli & Bex, 2013). CS measures the visual capacity, particularly under low light, glare or haze, when the differentiation amongst objects and their experience frequently is lessened (Buhren *et al.*, 2006). Functional Acuity Contrast Test (FACT) provides a beneficial assessment of contrast sensitivity at a range of significant spatial frequencies. It comprises of five rows of nine grating patches. The spatial frequencies increase from row A through E. Row A which is the lowest spatial frequencies with 1.5 cpd, row B and C are moderate spatial frequencies with 3 cpd and 6 cpd and lastly row D and E are the high frequencies representing 12 cpd and 18 cpd (Onal *et al.*, 2008).

Optometrist prescribes tinted spectacles lenses due to many reasons. Refractive errors may have formed due to the disturbance of normal visual (Gilbert & van Dijk, 2012; Siegwart & Norton, 2012). Myopia is the visual state in which only near objects appear to be in focus in front of the retina instead of on the retina leading to distant object appearing blurred (Kerber, *et al.*, 2016). According to study done by Wallman & Winawer, (2012) the reduction in CS measured in high myopia is actually due to abnormality in the optical and neuro-retinal systems. Visual perception is upgraded when looking at objects with the help of green windshields, red visors, rose-shaded glasses and so on (Hammond, 2012). Colored spectacles and safety glasses are generally used in conditions where accurate eyesight is needed. Amber safety glasses are utilized by snipers to upgrade focusing on, tinted lenses are utilized the vast majority of the circumstances by

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skiers, and as for driving and enhancing driving execution around evening time, yellow exhibitions are used. Various new hued intraocular focal points have been made and are publicized for their capacity to ensure against blue-light harm, reduce glare, and enhance chromatic contrast (Mukai *et al.*, 2009; Tanito *et al.*, 2010). Regardless of the extensive advertisement for the colored lenses for better eyesight, the indication of their usefulness is widely diverse. A report suggested, "The use of yellow filters to enhance visual performance has been proposed for more than 75 years. Many users, including some military aircrew members, are absolutely convinced that the yellow filters improve target acquisition performance; yet others are just as certain that they provide no improvement or even degrade performance" (Provines *et al.*, 1992).

The human eye is known to be very sensitive, therefore the yellow color usually cuts the blue lights giving more brightness transmittance round a spatial period of a periodic wave of 550nm (Kohmura *et al.*, 2013). Studies have been done on impact of focal points on parts of visual performance including contrast sensitivity (CS) and has shown a change in CS (Wolffsohn *et al.*, 2000). The subjective impression of brightness perception with yellow lenses has been found to be mediated primarily by the contribution of the rod signals to the chromatic pathway (Kelly, 1990). Yellow lenses are known to improve visibility of an object if the object is viewed against a blue background (Kelly *et al.*, 1984). Even though yellow filter has many benefits but their use as night-driving glasses is fraught with danger as it decreases the ability to see and differentiate dark objects. A study also states that yellow lenses are more dangerous as they give drivers the impression that they can see clearer but instead they reduce the visual performance and delay glare recovery. Hence this research was conducted to study the CS function in high myopes with the use of yellow filter.

2. Methodology

A cross-sectional study was conducted where a total of thirty-four healthy high myopic subjects with a mean SER of ≥ 6.00D without any ocular disease with the age group between 17 to 25 years were recruited for this study. Subjects recruited had the best correction visual acuity of BCVA 0.00 LogMAR. Subjects who are soft contact lens wearers were included only after washout period of 24 hours. Subjects with any binocular vision abnormality, ocular pathology such as glaucoma, diabetic retinopathy, retinal or macular pathology, media opacities such as cataract, corneal opacity and vitreous hemorrhage, ocular surgery, major systemic disease, and neurological disorders were excluded. Subjects having dry eye (Schirmer's test < 10mm, TBUT < 4-5sec) were also excluded.

The research compiled with the tenants of the Declaration of Helsinki. Written consent was obtained from all the subjects. Contrast sensitivity function was measured using the Functional Acuity Contrast Test (FACT) first without the filter (baseline) then immediately after using a yellow filter with 50% transmittance and after five minutes of adaptation. The room illumination was kept constant at 150lux. The yellow filter that was used for the research was the HOYA eyeveil2. Data was analyzed using the IBM SPSS Statistics Version 25 (Chicago, IL, USA). Repeated measure ANOVA was carried out. A p-value of less than 0.5 was considered to be statistically significant.

3. Results

A total number of thirty-four subjects were enrolled in the study. These included 23 (68%) females and 11 (32%) males. The mean age of the subjects was 21.53 ± 1.34 years. The mean spherical equivalent refraction (SER) was -7.75 ± 1.24D. The mean log contrast sensitivity values are shown in Table 1 below. Figure 1 shows the mean contrast sensitivity function at baseline, with filter and after adaptation for all spacial frequencies.

Table 1: Mean and SD for spatial frequencies baseline, with filter and after adaptation.

	Baseline	**With filter**	**After adaptation**
Row A (1.5 cpd)	74.24 ± 21.82	82.64 ± 19.98	94.50 ± 14.03
Row B (3 cpd)	106.70 ± 20.58	118.29 ± 21.97	144.47 ± 25.54
Row C (6 cpd)	117.09 ± 43.37	129.76 ± 41.39	172.41 ± 26.00
Row D (12 cpd)	63.65 ± 29.44	68.97 ± 29.70	98.76 ± 22.14
Row E (18 cpd)	20.79 ± 10.88	28.62 ± 16.71	47.68 ± 17.42

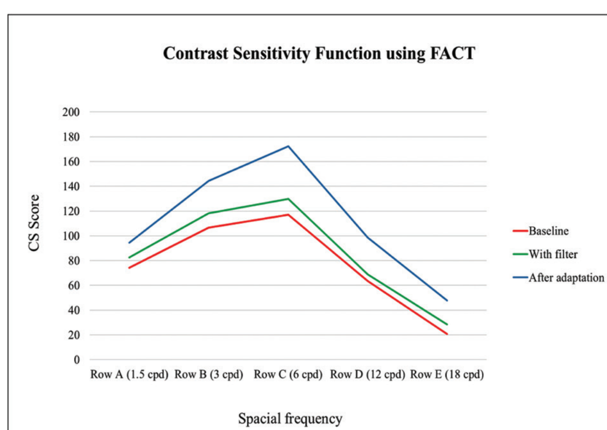

Figure 1: Contrast Sensitivity Function

Repeated measure ANOVA showed statistically significant difference between without and with yellow filter for row B (3 cpd), row C (6 cpd) and row E (18 cpd). However no statistical difference seen in row A (1.5 cpd) and D (12 cpd). Post hoc Bonferroni test was done to further check on the data which was statically significant. Row B (3 cpd) showed equally significant difference between baseline, with filter and with adaptation. Row C (6 cpd), baseline with filter shows a lower significant difference as compared to baseline with adaptation and filter with adaptation. Row E (18 cpd) baseline with filter shows a lower significant difference as compared to baseline with adaptation and filter with adaptation.

4. Discussion

Contrast sensitivity is known to have a better useful result rather than measuring visual acuity, which is preferred for visual function measurement (Dorr *et al.*, 2017). In the present study, we compared contrast sensitivity with normal refractive error, with yellow filter and after five minutes' adaptation in high myopes subjects. A study concluded that contrast shows a decrease after the age of 45 years old, especially in the middle and high frequencies therefore the age group for the present subjects were chosen to be between 17 to 25 years old (Sieiro *et al.*, 2016). According to De Fez *et al.* (2002), if illumination changes, this leads to a change in contrast sensitivity therefore Further Investigation Room was kept approximately to 150lux during the course of the study. Only high myopic subjects with SER ≥ -6.00D were included in the study. A study states that contrast sensitivity is affected by degree of myopia. It was stated that contrast sensitivity was low for high spatial frequency, and this was due to the axial length of the nearsightedness. The contrast sensitivity was measured using Monituer Ophtalmologique. For the present study FACT chart was used. Even though FACT chart and Vistech have same cpd value, but research did by Pesudovs *et al.* (2004) shows a significant difference between FACT and Vistech for post LASIK. They found that at 1.5 cpd for post-LASIK subjects FACT have a greater score as compared to 1.5 and 3.0 cpd for Vistech but have the same score for other spatial frequency.

Another study reported that there was a significant improvement at lower spatial frequencies at 2.0 cycles per degree with yellow filter and a significant improvement at 0.5 and 1.0 cycles per degree with orange filter in contrast to the present study that shows a significant different at 3, 6 and 18 cpd (Frennesson & Nilsson, 1993). This could be because electronic and computerized equipment were used with spatial frequency of 0.5, 1.0 and 2.0 cpd only as compared to FACT with 1.5, 3, 6, 12 and 18 cpd. Their study also uses different screen luminance of 110cd/m2 which is known to affect the contrast of yellow filter lenses and the present study uses room illumination of 150cd/m2. The subjects in the previous study were ARMD as compared to the current study where all the subjects were healthy without any ocular pathology. According to a study did by Rosenblum *et al.* (2000) using four types of yellow lenses showed a significant improvement of monocular contrast sensitivity in different groups of subjects that is cataract, albinism, aphakic and congenital macular dystrophy. The researcher mentioned that the contrast sensitivity improved by reducing the chromatic aberration, photophobia and intra ocular light scatter. In the present study also, it was found that even for normal subjects with no ocular health problem the contrast sensitivity improved.

Light scattering increases with age which causes a reduction of contrast sensitivity, which leads to a significant improvement with yellow filter which agrees with the present study. Even though they use Pelli Robson and present study uses FACT chart both show improvement upon using yellow filter regardless of the age (Mahjoob *et al.*, 2016). The age groups for their study were five to sixty years old verses seventeen to twenty-five years old. Previous research mentioned that retinal contrast and veiling luminous are reduced due to light scatter leading to degradation of images in normal and in cataract patients (Wolffsohn *et al.*, 2000). It was also reported that there is no significant effect of using yellow filter on contrast sensitivity which is not in agreement with the present study (Kelly *et al.*, 1984). The differences in the results could be because the instrument used Nicolet optronic cs 2000 measures 0.5 to 22.8 cpd verses FACT which measures 1.5 to 18 cpd and percentage of yellow tinting 89% versus 50% in the present. This is also the case for Lacherez *et al.* (2013) study, whereby in his case another difference could be due to yellow filter used Kodak Wratten with 25% transmittance and instrument used was Pelli Robson. Their study consists of young subjects with mean and standard deviation of 31.4 ± 6.7 years and old subjects 74.6 ± 4.8 years compared to the current study where the age group was between 17 to 25.

A study found that tinted lenses have the ability to decrease glare from reflective surface thus improving contrast spatial frequency of 1.5, 3 and 6 cpd. However, for high spatial frequencies the contrast sensitivity function decreases due to size of individual foveal cones (Shaik *et al.*, 2013). This explains the minimal improvement on average spatial frequencies of 12 and 18 cpd. In contrast, the present study showed that there was an improvement seen at 18 cpd. This possibly could be due to the colour of the filter used was blue, brown, and grey which has different spectral transmission compared to the yellow filter due to difference in the wavelength. Moreover, they mentioned that white that is clear lenses and blur lenses with 85% transmission were preferred for all spatial frequencies. A study done by Koh *et al.* (2017), reported that the subjects with dry eye sometimes have associated symptoms of superficial punctate keratitis (SPK) in the center. Even though the subjects do not have SPK, but dry eye also proves to decrease contrast sensitivity. Ridder *et al.* (2013) found no differences in the visual acuity as well as the contrast sensitivity but rather reading speed was slow for both visual acuity and sensitivity.

5. Conclusion

Contrast sensitivity improved with yellow filter for moderate and high special frequencies after adaptation. The improvement shows that yellow filter can improve the work that needs a better contrast sensitivity function.

6. Competing Interests

The author declares that there is no conflict of interest.

7. Ethics declaration

The research complied with the tenants of the Declaration of Helsinki. Ethical clearance was taken from the institute and written consent was obtained from all the subjects of the study.

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Chitkara University, Saraswati Kendra, SCO 160-161, Sector 9-C, Chandigarh, 160009, India

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