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Research Article

The Effect of Blue Blocker Lenses on Contrast Sensitivity and Reading Speed: a Comparison Between Different Wavelengths

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Abstract:

Although blue blocker lenses (BBLs) are specifically designed to reduce the harmful effects of blue light emitted by electronic devices, their effects on visual behavior and color perception have not been fully investigated. Commercially available BBLs selectively attenuate specific visible light wavelengths on electromagnetic spectrum, thereby influencing the contrast sensitivity of individuals. Blue light is defined as the wavelength range in the electromagnetic spectrum (380-495 nm) and can be classified into two subgroups, blue-violet (380-450 nm) and blue turquoise (450-495 nm), and has different effects on human physiology. The aim of our study was to investigate the effects of two different BBLs (460 nm and 500 nm) on contrast sensitivity and reading speed, as well as to assess their impact on visual acuity. The results showed that the use of BBLs increased the number of words read per minute, but the reading speed slowed down with increasing age. This may be attributed to the decline in visual acuity with age. Additionally, the use of BBLs was found to increase contrast sensitivity; however, contrast sensitivity decreased in people aged 41 years and older despite the use of BBLs. The results demonstrate that the use of BBLs affects reading speed and contrast sensitivity, and they may be useful information for ophthalmologists and a criteria for prescribing.

1. Introduction

In 1822, Fourier discovered that an image is the sum of baselines characterized by different spatial frequencies, phases, contrasts, and directions. The power of the human visual system, or the concept of visual acuity, is defined as the degree of ability to recognize and analyse luminance stimuli of various sizes and contrasts because daily activities require the visual system to operate at various levels of light and contrast. Contrast sensitivity is the ability of the visual system to recognize details, edges, and the boundaries of objects in a scene and determines the performance of the visual system in our natural surroundings[1], [2], [3]. When visual acuity examinations are conducted at very high contrast (in order to achieve visibility at the minimum size threshold) and limited to high visual acuity only, this means that 90% of the visible periphery is not evaluated. Contrast sensitivity testing plays a crucial role in determining the true performance of the visual system by forcing the visual system to produce absolute contrast thresholds for targets of varying sizes [4].

The shortest wavelength in the visible light spectrum (380-700 nm), blue light (380-495 nm), has a direct effect on many body functions such as sleep cycle, memory, psychological state, hormonal balance, as well as visual function[5], [6], [7]. However, excessive exposure to blue light causes serious side effects such as phototoxicity in ocular tissue, disruption of circadian rhythms, and psychological disorders [7], [8], [9]. Blue light consists of two components: blue-violet (380-450 nm) and blue turquoise (450-495 nm) wavelengths, and these two different wavelengths have different effects on human physiology. Oxidative processes associated with blue-violet light (380-450 nm) can lead to yellowing of the crystalline lens and cataract formation while altering the function and appearance of retinal structures, triggering photoreceptor cell death and age-related macular degeneration (AMD)[10].

Blue-turquoise light, on the other hand, is essential for human health. It serves as a marker of the circadian cycle, with its peak occurring around 460 nm. Exposure to blue light for 2 hours in the evening suppresses melatonin, but melatonin concentrations recover rapidly within 15 minutes after exposure ends. This phenomenon may be attributed to the short-term effect of light exposure [11], [12]. Even though the sun is the main source of blue light, the intensive use of LED backlighting devices such as mobile phones, computer screens, and televisions in modern life has significantly increased exposure to blue light and has led to increased incidence of conditions such as Computer Vision Syndrome, particularly during the pandemic period [13], [14].

This situation leads to the need to eliminate the negative effects of blue light, including phototoxicity, hormonal imbalances, and disruption of the sleep rhythm, especially phototoxicity, both in the young generation and in the older generation, which is open to degenerative changes [8], [15], [16], [17]. The use of blue filters in spectacle lenses has been increasingly recommended in recent years. Filtered lenses absorb both invisible light and part of the visible light. These lenses usually enhance contrast and help the patient to adapt more quickly to different lighting conditions and can increase the reading speed by two to three times, especially for individuals with visual impairments [14], [16], [18]. However, these lenses have no objective prescribing criteria [19]. Although blue blocker lenses are designed to reduce exposure to the harmful effects of blue light, it is still unclear how they will affect contrast sensitivity and visual performance[20].

Depending on the wavelength of the light, optical filters can transmit, reflect, or absorb it. Reducing the transmission of short-wavelength blue light is the basic idea behind blue light filters. In recent years, there have been numerous studies into the relationship between blue light filters and visual performance and eye health. Blue light filters are known to have the potential to reduce the effects of light scattering and chromatic aberration, improving visual acuity and contrast [21]. Although the use of blue light filters in both healthy eyes and those affected by cataracts, AMD, and/or other retinal diseases is known to improve visual acuity and contrast sensitivity, there is limited evidence to suggest that these filters significantly improve overall visual performance [22]. The most crucial question is whether it is appropriate to filter out all blue light [8], [15], [23], [24]. While it is important to avoid blue light at night to maintain some physiological balances, the human body needs blue light during the day for various essential processes. There are different types of BBLs on the market, depending on the wavelength, but it is not clear which one provides the most benefit with the fewest adverse effects. Furthermore, several studies in the literature have examined how filtering affects intraocular lenses used in cataract surgery.

The aim of our study is to evaluate the beneficial effects (contribution to reading speed and contrast sensitivity) of 500 nm filters, which block all wavelengths of blue light, and 460 nm filters, which specifically block blue-violet part. The goal is to understand whether the beneficial effects of blue light filters can be obtained by protecting against side effects without requiring a high level of filtering.

2. Material and Methods:

2.1 Design and Sampling

Our study was approved by the Ethics Committee of Istanbul Okan University and was conducted according to the principles of the Declaration of Helsinki. Participants were provided with both written and verbal information regarding the study, and written informed consent was obtained. The study included healthy individuals aged 25-60 years, without advanced eye disease and refractive error, systemic diseases such as diabetic retinopathy, neurological diseases or hereditary eye diseases, with full vision with spectacles, who applied to optical stores on the Anatolian side of Istanbul between February and May 2022. The population of the study was 28,800 people expected to apply to optical stores during the research period, and the minimum sample size was calculated to be 380 people with a 95% confidence level and 80% power (8.25 patients/day according to the information from the union of optician chambers). Participants were fully informed about the study, and their consent was obtained prior the application. Data were collected through tests conducted by students enrolled in the opticianry program.

2.1 Data Collection

Tests were conducted with 20 individuals in each optical store. Equal numbers of participants were divided into two groups: the first between the ages of 25 and 40, while those in the second between the ages of 41 and 60. This division was made to assess how different filter lenses affected reading speed and contrast sensitivity in individuals with presbyopia (near vision impairment) after the age of 40. Optician students measured the effects of spectacle filters on reading speed and contrast sensitivity using the Pelli-Robson Contrast Sensitivity Card and MN Read vision thresholds. All measurements were conducted under the supervision of the researchers using the face-to-face interviews with two filtered spectacle lenses that can filter up to 460 nm and 500 nm.

Participants repeated all tests three times. In the first step, they were asked to select and read the line containing the smallest text size they could see without using any filter (naked eye) on MN Read acuity charts held at a distance of 40 cm. Participants who were able to read 20/20 lines without correction were included in the study, and their reading speeds were recorded. Different MN Read cards were used in each step in order to keep the read line in mind and prevent it from affecting the result. The Pelli-Robson contrast sensitivity card was then held at a distance of 1 meter in 480 lux ambient lighting, and the participant was asked to read the letter at the lowest contrast level they could read, and the corresponding scale value was recorded. This measurement was repeated for monocular (right and left eye separately) and binocular vision. In the second and third steps, the same procedures were carried out using BBLs capable of filtering up to 460 nm and 500 nm, respectively.

The validity and reliability of both tests have been approved and are commonly used in eye examinations, and the test material was provided by the researcher. As it was not possible to replicate the original test card, the research was carried out over an extended period of time in the optical stores, under the supervision of the researchers. The Pelli-Robson test consists of letters with different contrasts and does not require knowledge of a specific language or training. The Turkish validation of the MN Read acuity charts was carried out by Prof. Dr. A. İdil [25] . We used these cards to ensure that letter size and difficulty were validated and standardised.

2.2. Data Analysis

The data were analysed using IBM SPSS (Statistical Package for the Social Sciences) version 21. Descriptive statistics (mean, standard deviation, frequency, percentage, etc.) were calculated based on the collected data. Differences between the two groups in terms of quantitative variables were assessed using an independent samples t-test for variables with a normal distribution and a Mann-Whitney U test for variables without a normal distribution. The difference between the two groups in terms of qualitative variables was analysed by the chi-square test (Pearson chi-square, Fisher's exact test). The significance level was set at $p<0.05$.

3. Result and Discussions

Our study, which investigated the effect of blue light filters on contrast sensitivity and reading speed, was carried out on 427 people on the Anatolian side of Istanbul. 460 and 500 nm filter lenses with two different BBLs and Pelli-Robson contrast sensitivity charts were used with the naked eye to determine the letter with the lowest contrast level that participants could read. Additionally, MN Read acuity charts were employed to read the line with the smallest font size corresponding to 20/20 vision, and reading speeds were recorded. Table 1 shows the distribution of participants according to their demographic characteristics. Among the 427 healthy participants in the study, 46.6% were female and 53.4% were male. The distribution of the participants through their ages was as follows: 13.6% of the were aged 20-25 years, 25.8% were aged 26-30 years, 16.2% were aged 31-35 years, 10.5% were aged 36-40 years, 11.7% were aged 41-45 years, 9.1% were aged 46-50 years, and 13.1% were aged 51 years and older. Table 2 presents the results of one-factor ANOVA and Friedman test for repeated measurements for the comparison of the measurements made with the naked eye, 460nm filter, and 500nm. According to the naked eye measurements, the mean MN Read scale score was 0.49±0.25 s and the mean MN Read duration was 4.96±1.31 s. The mean Pelli-Robson right eye scale was 1.72±0.21 s, the mean Pelli-Robson binocular scale was 1.81±0.23 s, and the mean Pelli-Robson left eye scale was 1.71±0.20 s. For 460 nm filters, the mean MN Read scale score was 0,47±0,25 s and the mean MN Read duration was 4,84±1,31 s. The mean Pelli-Robson right eye scale was 1,77±0,20 s; the mean Pelli-Robson binocular scale was 1,84±0,22 s, and the mean Pelli-Robson left eye scale was 1,76±0,19 s. Lastly, for 500 nm filters the mean MN Read scale score was 0,46±0,23 s and the mean MN Read duration was 4,93±1,39 s. The mean Pelli-Robson right eye scale was 1,76±0,20 s; the mean Pelli-Robson binocular scale was 1,83±0,21 s, and the mean Pelli-Robson left eye scale was 1,76±0,20 s.

Significant differences were found between the measurement scores obtained with the naked eye, 460 nm filter, and 500 nm filter in the MN Read acuity scale ($F = 24.88$; $p < 0.05$), MN Read duration

($X^2 = 8.47$; $p < 0.05$), Pelli-Robson right eye scale ($X^2 = 45.96$; $p < 0.05$), Pelli-Robson binocular scale ($X^2 = 19.79$; $p < 0.05$), and Pelli-Robson left eye scale ($X^2 = 45.25$; $p < 0.05$).

MN Read Scale and MN Read Duration scores in naked eye measurement significantly higher than scores in 460nm filter measurement. The Pelli Robson right eye scale, binocular scale, and left eye scale scores with the 460 nm filter were noticeably higher than those with the naked eye. There was no significant difference ($p > 0.05$) between 460 nm filter and 500 nm filter for MN Read time, Pelli Robson right eye scale, Pelli Robson binocular scale, Pelli Robson left eye scale scores. The MN Read scale values for the measurement with the 460 nm filter are apparently higher than the values for the measurement with the 500 nm filter. Reading speed tests using MN Acuity charts indicate that the use of BBLs reduces reading times. An increase in the number of words read per minute was observed with the use of BBLs, although the difference was not relevant. The results of the Pelli-Robson contrast sensitivity chart test showed that the use of BBLs enhanced contrast sensitivity and allowed the observation of letters with lower contrast.

Table 3 presents the results of the independent two-sample t-test used to compare the measurements by gender. It was found that naked eye measurements did not show a significant difference between the genders ($p > 0.05$), and while the use of BBLs reduced reading times, no significant difference was observed between men and women ($p > 0.05$). Similarly, it is observed that the use of BBL does not cause a discernible variation between men and women in terms of contrast sensitivity. Table 4 reflects the results of the ANOVA test for the comparison of the measurements made using the naked eye, 460nm filter, and 500nm filter across various age groups. It was found that MN Read duration ($F=2.85$; $p<0.05$) and Pelli Robson binocular scale ($F=12.69$; $p<0.05$) scores with the naked eye did not differ significantly ($p>0.05$) according to age groups. According to the LSD post-hoc tests performed to determine the differences between the age groups, it was observed that the naked eye MN Read duration score of the participants aged 41 years and over was considerably higher than the score of the participants aged 30 years and under. The Pelli Robson binocular scale scores for participants under 40 years of age were drastically higher than those of persons 41 years of age and older.

MN Read time with 460nm filter ($F=3.04$; $p<0.05$) and Pelli Robson binocular scale ($F=14.94$; $p<0.05$) scores did not substantially affected ($p>0.05$) by age group. The 460nm filtered MN Read duration score of people aged 41 and older was substantially higher than the score of participants aged 30 and under, as indicated by the LSD post hoc tests used to ascertain the age group differences. Participants 35 years of age and younger had a substantially higher 460nm filtered Pelli Robson binocular scale score than those 41 years of age and older.

MN Read time ($F = 4.83$; $p<0.05$) and Pelli Robson binocular scale ($F = 16.56$; $p<0.05$) values with a 500 nm filter did not show a significant difference ($p > 0.05$) according to age groups. According to the LSD post-hoc tests performed to determine the difference between the age groups, the 500nm filtered MN Read duration score of the participants aged 41 years and over is vastly higher than the score of the participants aged 30 years and under. The 500nm filtered Pelli Robson binocular scale score of participants aged 40 years and younger was significantly higher than that of participants aged 41 years and older. In age-related comparisons, the increase in reading times (decrease in reading speed) with advancing age (41 years and over) can be attributed to the decrease in visual acuity associated with aging. With increasing age, the time required to identify letters at readable contrast levels decreases. It is hypothesized that the participants may have reported the first letter they perceived.

In the age-related comparison, the use of BBLs was shown to decrease contrast sensitivity with age and make high-contrast letters easier to read. Contrast sensitivity is known to decrease with age due to a number of physical and biological changes in the eye.

Compared to the naked eye, the use of 460 nm and 500 nm filters shortens the reading times. After comparing the 460 nm and 500 nm filters, it was discovered that the use of the 460 nm filter yielded better results, albeit with a very small difference, and the number of words read per minute being higher than the 500 nm filter. When evaluated according to the age criterion, it can be seen that the reading speed is shorter for individuals aged 20–40, as expected, while this period is longer for individuals aged 41 and over. However, when comparing the 460 nm and 500 nm filters, it reveals a similar trend in the 41 and over age groups as in the 20- 40 age group.

The effect of the two blue light filters on contrast sensitivity was similar. Both filters improved contrast sensitivity, but no significant superiority of either filter was observed.

Table 1 *. Distribution of participants according to demographic characteristics*

Demographic Variables	Groups	n	%
Genders	Female	199	46,6
	Male	228	53,4
Age Groups	20-25 years	58	13,6
	26-30 years	110	25,8
	31-35 years	69	16,2
	36-40 years	45	10,5
	41-45 years	50	11,7
	46-50 years	39	9,1
	51 years and above	56	13,1

Table 2. *Comparison of measurements with naked eye, 460nm filter and 500nm filter*

Variables	Group	n	$\overline{X}$	SD	F	p
MN Read Scale	Naked Eye	427	0,49	0,25	24,88[1]	**0,000**
	460nm filter	427	0,47	0,25		
	500nm filter	427	0,46	0,23		
MN Read Duration	Naked Eye	427	4,96	1,31	8,47[2]	**0,015**
	460nm filter	427	4,84	1,31		
	500nm filter	427	4,93	0,23		
Pelli Robson Right Eye Scale	Naked Eye	427	1,72	0,21	45,96[2]	**0,000**
	460nm filter	427	1,77	0,20		
	500nm filter	427	1,76	0,20		
Pelli Robson Binocular Scale	Naked Eye	427	1,81	0,23	19,79[2]	**0,000**
	460nm filter	427	1,84	0,22		
	500nm filter	427	1,83	0,21		
Pelli Robson Left Eye Scale	Naked Eye	427	1,71	0,20	45,25[2]	**0,000**
	460nm filter	427	1,76	0,19		
	500nm filter	427	1,76	0,20		

[1]: ANOVA statistic for repeated measurements [2]: Friedman test X^2 statistics n: Sample size $\overline{X}$: Mean Arithmetic

SD: Standard Deviation

Table 3*. Comparison of the measurements by gender*

Filter	Variables	Gender	n	$\overline{X}$	SD	t	p
Naked Eye	MN Read Scale	Female	199	0,48	0,25	-0,72[1]	0,382
		Male	228	0,50	0,26		
	MN Read Duration	Female	199	4,89	1,28	-0,97	0,332

		Male	228	5,02	1,33		
	Pelli Robson Right Eye Scale	Female	199	1,74	0,20	1,07	0,287
		Male	228	1,71	0,21		
	Pelli Robson Binocular Scale	Female	199	1,81	0,22	0,15	0,880
		Male	228	1,81	0,24		
	Pelli Robson Left Eye Scale	Female	199	1,70	0,20	-0,76	0,448
		Male	228	1,72	0,21		
460 nm filter	MN Read Scale	Female	199	0,46	0,26	-1,14[1]	0,254
		Male	228	0,49	0,25		
	MN Read Duration	Female	199	4,76	1,29	-1,13	0,257
		Male	228	4,90	1,34		
	Pelli Robson Right Eye Scale	Female	199	1,78	0,20	0,77	0,441
		Male	228	1,76	0,20		
	Pelli Robson Binocular Scale	Female	199	1,85	0,22	0,41	0,678
		Male	228	1,84	0,22		
	Pelli Robson Left Eye Scale	Female	199	1,76	0,19	0,32	0,748
		Male	228	1,76	0,20		
500 nm filter	MN Read Scale	Female	199	0,44	0,23	-1,33	0,184
		Male	228	0,47	0,23		
	MN Read Duration	Female	199	4,88	1,26	-0,67	0,504
		Male	228	4,97	1,49		
	Pelli Robson Right Eye Scale	Female	199	1,76	0,20	0,27	0,787
		Male	228	1,76	0,20		
	Pelli Robson Binocular Scale	Female	199	1,84	0,21	0,32	0,747
		Male	228	1,83	0,21		
	Pelli Robson Left Eye Scale	Female	199	1,76	0,20	0,41	0,685
		Male	228	1,76	0,20		

[1]: Mann Whitney U Test Z statistics n: Sample size $\overline{X}$: Mean Arithmetic SD: Standard deviation t: Independent two-sample t-test statistics

***Table 4**. Comparison of measurements made with naked eye, 460 nm filter and 500 nm filter according to age group*

Filter	Variables	Age	n	$\overline{X}$	SD	F	p
Naked Eye	MN Read Duration	20-25 years	58	4,72	1,32	2,85	**0,000**
		26-30 years	110	4,65	1,09		
		31-35 years	69	4,94	1,33		

		36-40 years	45	5,02	1,23		
		41-45 years	50	5,28	1,34		
		46-50 years	39	5,33	1,24		
		51 years and above	56	5,23	1,57		
	Pelli Robson Binocular Scale	20-25 years	58	1,90	0,19	12,69	**0,000**
		26-30 years	110	1,90	0,22		
		31-35 years	69	1,83	0,19		
		36-40 years	45	1,82	0,23		
		41-45 years	50	1,73	0,20		
		46-50 years	39	1,70	0,24		
		51 years and above	56	1,65	0,23		
460 nm filter	MN Read Duration	20-25 years	58	4,53	1,20	3,04	**0,006**
		26-30 years	110	4,54	1,19		
		31-35 years	69	4,84	1,38		
		36-40 years	45	5,04	1,36		
		41-45 years	50	5,28	1,14		
		46-50 years	39	5,00	1,26		
		51 years and above	56	5,05	1,55		
	Pelli Robson Binocular Scale	20-25 years	58	1,90	0,19	14,94	**0,000**
		26-30 years	110	1,94	0,19		
		31-35 years	69	1,88	0,19		
		36-40 years	45	1,83	0,23		
		41-45 years	50	1,80	0,18		
		46-50 years	39	1,77	0,21		
		51 years and above	56	1,66	0,21		
500 nm filter	MN Read Duration	20-25 years	58	4,62	1,36	4,83	**0,000**
		26-30 years	110	4,59	1,18		
		31-35 years	69	4,68	1,31		
		36-40 years	45	5,16	1,52		
		41-45 years	50	5,38	1,37		
		46-50 years	39	5,15	1,44		
		51 years and above	56	5,46	1,48		
	Pelli Robson Binocular Scale	20-25 years	58	1,90	0,18	1,56	**0,000**
		26-30 years	110	1,92	0,19		
		31-35 years	69	1,88	0,20		
		36-40 years	45	1,85	0,21		
		41-45 years	50	1,75	0,19		
		46-50 years	39	1,74	0,18		
		51 years and above	56	1,66	0,19		

[1]: Kruskal Wallis H test X^2 statistics n: Sample size $\overline{X}$: Mean arithmetic SD: Standard deviation F: ANOVA test F test statistics

4. Conclusions

The results may assist eye care professionals in the prescription of BBLs. This study was conducted on healthy individuals aged 25–60 who visited to optical stores in the Anatolian side of Istanbul. However, contrast sensitivity tends to decrease with natural ageing and ocular disorders [20]. It is therefore worth considering additional tests and assessing the overall visual health of the individual before prescribing, particularly for the elderly and those with ocular diseases.

Author Statements:

- **Ethical approval:** The conducted research is not related to either human or animal use.
- **Conflict of interest:** The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper
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References

[1] F. W. Campbell and J. G. Robson, (1968) Application of fourier analysis to the visibility of gratings, *J Physiol*, 197(3);551, doi: 10.1113/JPHYSIOL.1968.SP008574.

[2] C. Owsley and M. E. Sloane, (1987). Contrast sensitivity, acuity, and the perception of 'real-world' targets., *British Journal of Ophthalmology*, 71(10);791–796, doi: 10.1136/BJO.71.10.791.

[3] M. C. Silva-Viguera, M. C. García-Romera, I. López-Izquierdo, C. De-Hita-Cantalejo, M. C. Sánchez-González, and M. J. Bautista-Llamas, (2023). Contrast Sensitivity Assessment in Early Diagnosis of Diabetic Retinopathy: A Systematic Review, *Semin Ophthalmol*, 38(4);319–332, doi: 10.1080/08820538.2022.2116289

[4] M. W. Roark and J. M. Stringham, (2019) Visual Performance in the 'Real World': Contrast Sensitivity, Visual Acuity, and Effects of Macular Carotenoids, *Mol Nutr Food Res*, 63(5);1801053, doi: 10.1002/MNFR.201801053.

[5] P. P. Bither and J. D. Hurt, (1988) CPF-550 vs. C-Lite: a comparison study.," *J Am Optom Assoc*, 59(8);623–628, Accessed: Feb. 09, 2025. [Online]. Available: https://europepmc.org/article/med/3171066

[6] G. Rieger, (2025) Improvement of contrast sensitivity with yellow filter glasses., *Can J Ophthalmol*, 27(3);137–138,

[7] S. Van Der Lely *et al.*, (2015) Blue Blocker Glasses as a Countermeasure for Alerting Effects of Evening Light-Emitting Diode Screen Exposure in Male Teenagers, *Journal of Adolescent Health*, 56(1);113–119,doi: 10.1016/J.JADOHEALTH.2014.08.002.

[8] M. A. Mainster, (2005) Intraocular Lenses Should Block UV Radiation and Violet but Not Blue Light, *Archives of Ophthalmology*, 123(4);550–555, doi: 10.1001/ARCHOPHT.123.4.550.

[9] A. Vagge, L. Ferro Desideri, C. Del Noce, I. Di Mola, D. Sindaco, and C. E. Traverso, (2021) Blue light filtering ophthalmic lenses: A systematic review, *Semin Ophthalmol*, 36(7);541–548, doi: 10.1080/08820538.2021.1900283.

[10] M. C. Sánchez-González *et al.*, (2021) Effect of Blue Light Filters on Tear and Contrast Sensitivity in Individuals Using Electronic Devices, *Eye Contact Lens*, 47(12);642–646, doi: 10.1097/ICL.0000000000000843.

[11] S. A. Giannos, E. R. Kraft, L. J. Lyons, and P. K. Gupta, (2019) Spectral Evaluation of Eyeglass Blocking Efficiency of Ultraviolet/High-energy Visible Blue Light for Ocular Protection, *Optometry and Vision Science*, 96(7);513–522, doi: 10.1097/OPX.0000000000001393.

[12] N. Charoenpipatsin, P. Yothachai, N. Nuntawisuttiwong, O. Wongpraparut, P. Choosri, and N. Silpa-Archa, (2025) Dosimetry Assessment of Potential Hazard from Visible Light, Especially Blue Light, Emitted by Screen of Devices in Daily Use," *Clinical, Cosmetic and Investigational Dermatology* , 18;169–176, doi: 10.2147/CCID.S490977;WGROUP:STRING:PUBLICATION.

[13] A. K. Kiser, E. K. Deschler, and G. Dagnelie, (2008) Visual function and performance with blue-light blocking filters in age-related macular degeneration, *Clin Exp Ophthalmol*, 36(6);514–520, doi: 10.1111/J.1442-9071.2008.01824.X.

[14] W. Seiple, O. Overbury, B. Rosenthal, T. Arango, J. V. Odom, and A. R. Morse, (2018) Effects of Lighting on Reading Speed as a Function of Letter Size, *The American Journal of Occupational Therapy*, 72(2); 7202345020p1-7202345020p7, doi: 10.5014/AJOT.2018.021873.

[15] A. S. Patel and D. M. Dacey, (2009) Relative effectiveness of a blue light–filtering intraocular lens for photoentrainment of the circadian rhythm, *J Cataract Refract Surg*, 35(3);529–539, doi: 10.1016/J.JCRS.2008.11.040.

[16] J. A. Landers, D. Tamblyn, and D. Perriam, (2009) "Effect of a blue-light-blocking intraocular lens on

the quality of sleep, *J Cataract Refract Surg*, 35(1);83–88, doi: 10.1016/J.JCRS.2008.10.015.

[17] T. W. Leung, R. W. H. Li, and C. S. Kee, (2017) "Blue-Light Filtering Spectacle Lenses: Optical and Clinical Performances," *PLoS One*, 12(1);e0169114, doi: 10.1371/JOURNAL.PONE.0169114.

[18] L. E. Leguire and S. Suh, (1993) Effect of light filters on contrast sensitivity function in normal and retinal degeneration subjects, *Ophthalmic and Physiological Optics*, 13(2);124–128, doi: 10.1111/J.1475-1313.1993.TB00440.X.

[19] E. Pateras, "Blue Light Blocking Ophthalmic Lenses and Their Benefits–A Review," Jun. 2020.

[20] H. S. Alzahran, M. Roy, V. Honson, and S. K. Khuu, (2021) Effect of blue-blocking lenses on colour contrast sensitivity, *Clin Exp Optom*, 104(2);207–214, doi: 10.1111/CXO.13135.

[21] S. Tavazzi *et al.*, (2020) Improvement or worsening of human contrast sensitivity due to blue light attenuation at 450 nm, *Clin Optom (Auckl)*, 12,57–66, doi: 10.2147/OPTO.S242818.

[22] F. Cozza *et al.*, (2020) The effects of two longpass filters on visual performance, *J Optom*, 13(2);102–112, doi: 10.1016/J.OPTOM.2019.07.001.

[23] A. J. Augustin, (2008) "The physiology of scotopic vision, contrast vision, color vision, and circadian rhythmicity can these parameters be influenced by blue-light-filter lenses., *Retina*, 28(9);1179–1187, doi: 10.1097/IAE.0B013E3181835885.

[24] D. ALTINBAY and A. M. İDİL, (2019) Az Görme Rehabilitasyonunda Işık ve Filtre Kullanımı, *Turkiye Klinikleri Journal of Ophthalmology*, 28(2);117–122, doi: 10.5336/OPHTHAL.2018-61499.

[25] A. Ş. İdil, D. Çalışkan, and B. N. İdil, (2019) MNREAD okuma kartlarının Türkçe versiyonunun geliştirilmesi ve validasyonu, 39(2);84–90.