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Research Article

Influence of various densities of Yellow and Pink Tinted spectacles on Contrast Sensitivity

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Abstract

Purpose: As the cosmetic need for tinted spectacles increases, it is very important to know the influence of tinted spectacles over contrast sensitivity in both daylight and night conditions. This study was conducted to find the influence of various densities of yellow and pink tints on contrast sensitivity with positive and negative contrast backgrounds.

Methods: The study included 25 subjects with 10 Emmetropes, 10 myopes, and 5 hyperopes. Yellow and pink-tinted spectacles were made with various densities of 20%, 40%, 60%, and 80%. Contrast sensitivity (CS), corrected, and uncorrected visual acuity were measured for all subjects.

Results: On comparing the means of both positive and negative contrast sensitivity between each refractive error group for varied tint percentages, no statistically significant difference was found. In emmetropes, 20% yellow and pink tints did not reveal statistical significance with $p < 0.05$ for both positive and negative contrasts. In myopes, 20% pink tint did not reveal statistical significance for both positive and negative contrasts. In hyperopes, 20% yellow tint showed significance with positive contrast only. As there was no significant difference between the groups, all the refractive error groups were combined and ANOVA after applying post hoc analyses between all the percentages of yellow and pink tints for both positive and negative contrasts was performed which revealed a statistical significance with $p = 0.00$. Regression analyses revealed there was a significant influence of yellow and pink tints on positive and negative contrasts with $p = 0.04$, 0.03 and < 0.05 respectively.

Conclusion: Both yellow and pink tints have better positive and negative contrast sensitivity up to 80% tint indicating their usefulness during night driving. In myopes even 20% tint will be effective for various backgrounds indicating its importance to prescribe in spectacle prescriptions, particularly in ocular conditions where contrast sensitivity is affected.

Keywords: pink tint; yellow tint; contrast sensitivity; FrACT: myopes; logMAR; emmetropes.

Introduction

In our habitual life, people view a large number of objects with various backgrounds, whereas visual acuity measurement of a person in a clinical setting predominantly uses black letters on white background. If the person can resolve a 6/6 target, it indicates the subject has normal visual acuity. There are certain conditions where a person has 6/6 visual acuity but has difficulty in distinguishing an object from its background, which is termed as Contrast sensitivity (CS). Contrast sensitivity is the visual ability to distinguish an object from its background and is not the same as visual acuity (VA). A black letter on a white background and a white letter on a black background give positive and negative contrast sensitivity respectively.

In another way, contrast sensitivity can be defined as the ability to perceive slight changes in luminance between regions that are not separated by definite borders and are just as important as the ability to perceive sharp outlines of relatively small objects. It is the reciprocal of the contrast at the threshold, i.e., one divided by the lowest contrast at which forms or lines can be recognized. If a person can see details at very low contrast, his or her contrast sensitivity level is high and vice versa. This indicates that Contrast sensitivity measures the ability to see details at low contrast levels. Contrast is created by the difference in luminance and reflected light, i.e., reflected from two adjacent surfaces. It provides critical information about the edges, borders, and variation in the brightness of two objects.

Numerous studies have shown that contrast sensitivity provides useful information about the functional or real-world vision which is not provided by Visual acuity [1-3]. Contrast sensitivity should be included with VA and visual function (VF) in definitions of visual impairment and visual disability and for legal definitions of blindness [4]. Contrast Sensitivity in combination with VA gives the clinician a better idea of how well a person function visually in actuality.

Measuring contrast sensitivity is a relatively quick and simple procedure, and can provide more sensitive measurements of subtle vision loss than VA. There are many clinical situations in which contrast sensitivity is reduced while VA remains normal, as in post-refractive surgery,[5] minimal capsular opacification,[6]oxidative damage due to heavy smoking,[7]in patients with multiple sclerosis,[8]and diabetics with little or no background retinopathy,[9,10] in cases of glaucoma, etc. For these reasons, CS measurements have become standard for most clinical trials of ophthalmic interventions, and have been widely used in the assessment of refractive surgery,[11,12] new intraocular implants,[6] anti-cataract drug trials,[13] potential treatments for age-related macular degeneration,[14] and optic neuritis [15,16].

Many non-optical techniques are available to improve contrast sensitivity function. These include painting walls and floors with dark borders, choosing contrast-enhancing kitchen utensils, usage of dark pens, good lighting across the reading materials, bold line papers for writing, etc. Optical techniques include absorptive lenses which can enhance contrast sensitivity to a limit in addition to glare reduction and UV elimination. Yellow or Orange tint is a well-known contrast sensitivity enhancer that can enhance contrast sensitivity function to a significant level. Various contrast-enhancing lenses are available in the market. These lenses generally attenuate most of the visible spectrum below a specific wavelength. These can be fitted-over, or clipped-on, over fashion frames. These are available as readymade goggles too.

Many studies were conducted to find out the effect of tints on contrast sensitivity. It was reported that various tints enhance CS.[17-22] Yellow and Amber tints, apart from blue, grey, purple, and brown are more commonly reported on their relationship with CS, Glare reduction, depth perception, etc.[19-25] Limited studies are available regarding the density of the tint in relationship with improvement in CS.[20-23] Although many studies were mentioning various tints, there were few studied reported on pink tint.[25,26] Most of the studies employed only positive contrast sensitivity (PCS) to evaluate the influence of different tints, and hence can provide results applicable to daylight vision. This study was planned to compare the effect of yellow and pink tints in negative contrast sensitivity (NCS), which also helps assess its influence on night vision. This may help to develop tinted spectacles which can provide maximum functional vision at night time as well.

Hence this study aimed to compare the influence of various densities of Yellow and Pink tints on contrast sensitivity for both positive and negative contrast backgrounds.

Materials and Methods

The study adopted an analytical experimental design. The study included 25 subjects who were selected by simple random technique from the outpatient department of an eye hospital. The right eye of all the subjects was taken for this study. This study followed the tenets of the Declaration of Helsinki and was approved by the Institutional review board and ethics committee. Informed consent was obtained from all participants before data collection. To ensure whether the participants met inclusion and exclusion criteria, a detailed history and preliminary tests including visual acuity, objective refraction, subjective refraction, and contrast sensitivity were measured. The inclusion criteria included emmetropes, myopes, and hyperopes, where myopia was defined as the refractive error ≤ - 0.50 D and hyperopia were defined as ≥ ± 0.50 D. Age range between 18 to 35 years, best-corrected visual acuity (BCVA) of 6/9 or better, and both genders were included in the study. The exclusion criteria included anisometropia, color vision deficiencies, contact lens wearers, and other ocular pathology.

Uncorrected and best-corrected visual acuities were measured using a logMAR chart at a distance of 4 meters. Near visual acuity was measured using a reduced Snellen acuity chart at 40 cm. Objective refraction was done followed by subjective refraction. Spherical equivalent was calculated for both objective and subjective refraction.

Contrast sensitivity was measured over different percentages of yellow and pink tints. Yellow and Pink tinted spectacles were made using the dipping method.[27,28] Both tints had 20%, 40%, 60%, and 80% of tints resulting in 8 pairs of tinted spectacles as shown in figures 1 and 2 respectively. All the lenses used were made of CR39 material. The percentage of tint was measured using a spectrometer. [29] It was used to measure the intensity of light passing through the spectacle lens before and after tinting the lens. The spectrometer had fiber optics sensors to emit the light and sense the light passing through the lens. Initially, direct light was sensed by it (I_1) and later through the various percentages of tints (I_2). The intensity of light got reduced as the percentage of tint increased. The intensity values were recorded for each percentage of tints. With this data, the percentage of tint present in the lens (I_3) was calculated as $I_3 = I_1 – I_2$.

The contrast sensitivity measurements were taken using the software Freiburg Visual Acuity and Contrast Test (FrACT). [30-34] all subjects were tested monocularly under standard room illumination of 500 lux. [35]The contrast testing screen was projected on an institutional laptop screen with maximum brightness and constant resolution. The screen was placed 3M away from the subject without parallax error. The test target was a 'Landolt C' letter with its opening projected in different directions. The subject had to identify the direction of the opening in the 'C'. A total of 8 directions were provided and according to the instruction of subjects, the examiner clicks the appropriate number corresponding to each direction. For each subject, 18 test trials were given with an interval of 30 seconds. Contrast sensitivity for baseline (0%), 20%, 40%, 60%, and 80% was taken for both tints. The test was done for both positive and negative contrast backgrounds i.e. black letters on a white background and white letters on black background respectively. CS was measured in FrACT as Weber's contrast percentage or log CS. In this study, all the values were noted in log CS, where 0.004, 1.61, 2, and 3 denote 99%, 2.4%, 1%, and 0.1% Webber's contrast respectively.

Figure 1: *Yellow tint with various densities.*

Fig 1a Yellow tint with 20% density; Fig 1b Yellow tint with 40% density; Fig 1c Yellow tint with 60% density; Fig 1d Yellow tint with 80% density

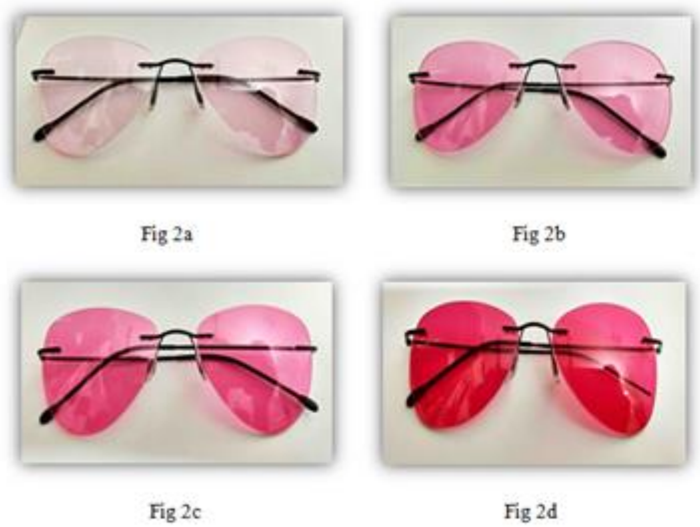

Figure 2: *Pink tint with various densities.*

Fig 2a Pink tint with 20% density; Fig 2b Pink tint with 40% density; Fig 2c Pink tint with 60% density; Fig 2d Pink tint with 80% density

Statistical Analysis

The data were entered into Microsoft Excel 2010 and analysed by using IBM SPSS Software (Version 17.0). Descriptive statistics were done using ANOVA. The normality of the data was tested with the K-S test. The regression analysis of each group was done separately to find out the influence of the variables among the two groups.

Results

A total of 25 eyes from 25 participants were included in this study, of which 2 were males and 23 were females. Among 25, 10 were emmetropes, 10 were myopes and 5 were hyperopes. The mean age of each group was 23.90 ± 1.449, 20.10 ± 1.912, and 23.00 ± 5.656 years for emmetropes, myopes, and hyperopes respectively. The mean best-corrected visual acuity was 6/6 and N6 for both groups of myopia and hyperopia. The mean SE for myopes and hyperopes was found to be -2.75 ± 2.45 D and +0.65 ± 0.22 D respectively. The means and standard deviation of positive and negative contrast sensitivity in all the groups for yellow tints and pink tints are shown in Tables 1 and 2 respectively.

On comparing the means of both positive and negative contrast sensitivity between each refractive error group for varied tint percentages, no statistically significant difference was found.

ANOVA after applying post hoc analysis revealed statistically significant difference within the emmetropic group with $p < 0.05$ for both yellow and pink tints among the varied percentages except 20% tint in both PCS and NCS.

In myopic group, statistically significant difference was found with $p < 0.05$ for both yellow and pink tints among the varied percentages of PCS and NCS except 20% tint in NCS.

Similarly in hyperopes, statistically significant difference was found with $p < 0.05$ for both yellow and pink tints among the varied percentages of PCS and NCS except 20% yellow tint in NCS and 20% pink tint in both PCS and NCS.

As there was no significant difference between the groups, all the refractive error groups were combined and the data was analysed for all 25 participants.

ANOVA with Bonferroni post hoc analysis was performed within the varied percentages of yellow and pink tint for positive contrast, which revealed a statistical significance with $p < 0.05$ except 20% pink tint. Regression analyses revealed a significant influence of both yellow and pink tints on positive contrast sensitivity with $p = 0.04$ and 0.03 respectively and is shown in Figure 3 and 4.

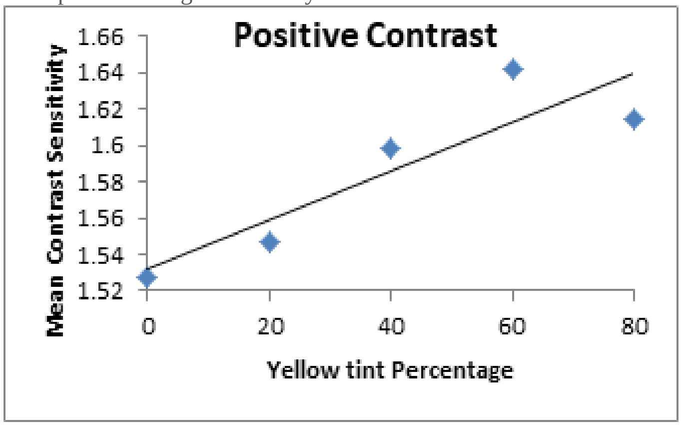

Figure 3: *Influence of yellow tint on positive contrast sensitivity.*

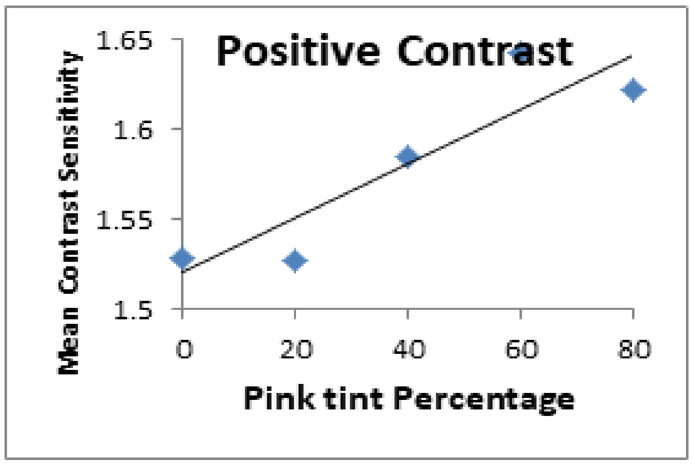

Figure 4: *Influence of pink tint on positive contrast sensitivity.*

Similarly, the analyses within the varied percentages of yellow and pink tint for negative contrast revealed a statistical significance with $p < 0.05$, except 20% pink tint. Regression analyses revealed there was a significant influence of both yellow and pink tints on negative contrast sensitivity with $p < 0.05$ and is shown in Figure 5 and 6.

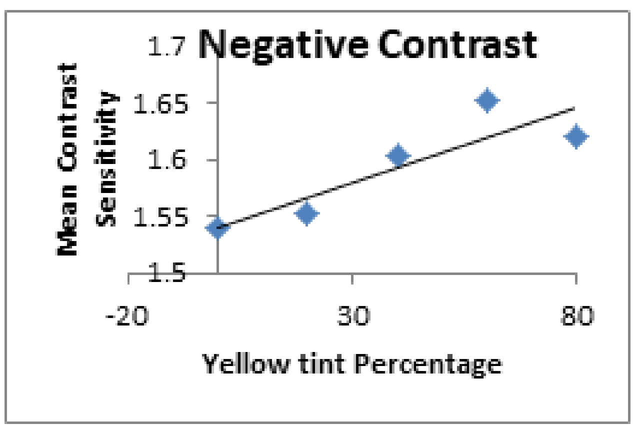

Figure 5: *Influence of yellow tint on negative contrast sensitivity.*

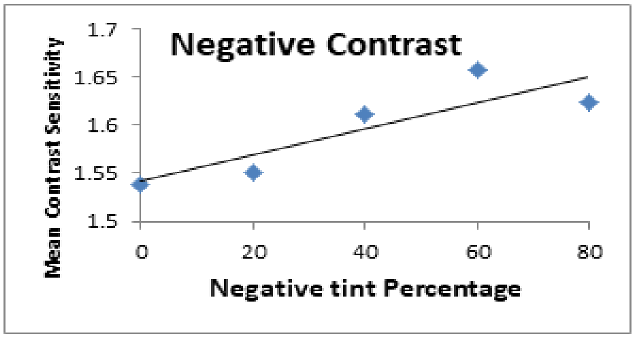

Figure 6: *Influence of pink tint on negative contrast sensitivity.*

Discussion

As the cosmetic need for tinted spectacles increase, it is very important to know the influence of tinted spectacles over other visual components. Many studies have reported the effect of tinted spectacles on contrast sensitivity. In this study pink and yellow tints of 20, 40, 60, and 80 percentage were used.

In an earlier study, [17] 'The effect of blue, grey and brown-tinted spectacle lenses on contrast sensitivity and colour vision" among 90 subjects revealed enhanced contrast sensitivity. That study used 85%, 75%, and 50% tints, whereas in this current study, on comparison of the baseline values with varied tint percentages among all the 3 groups of emmetropic, myopic, and hyperopic subjects, it revealed a significant (P<0.05) increase in 40%, 60% and 80% of positive and negative contrast sensitivity with both yellow and pink tints with a $p < 0.05$.

In other few studies[19,20,36] specifically 'The Effect of Variably tinted Spectacle Lenses on Visual Performance in Cataract Subjects', demonstrated an increase in contrast thresholds under glare conditions regardless of tints in all subjects. Brown and yellow tints resulted in the least and grey lens resulted in the largest amount of increase in contrast threshold. They found that individuals with lenticular changes may benefit from brown or yellow spectacle lenses under glare conditions. The present study is also in concurrence with the previous study stating yellow and pink tints showed improved contrast sensitivity.

A study[21] published on the topic 'Evaluation of the effect of tinted night driving glasses on contrast sensitivity with and without glare' it was found that tinted night driving glasses performed better than normal glasses when tested subjectively. Contrast sensitivity was improved with tints in both presence and absence of glare. Objective measurements did not reveal any significant difference between the tinted and normally prescribed glasses. Similarly, this current work too reports an enhanced performance in negative contrast which simulates the night vision for both yellow and pink tints.

In earlier studies, [37, 38] yellow tints improved CS which is accordance with the present work. Another study, [22] on the topic 'Contrast Is Enhanced by Yellow Lenses Because of Selective Reduction of Short-Wavelength Light' in 20 samples found that brightness improved with yellow tint. They also mentioned that there was an effect on contrast sensitivity with positive and negative contrasts indicating both day and night backgrounds indicating daylight as bright white and night as black backgrounds.

In an earlier study, [26] visual performances did not improve with yellow, pink, grey, blue, and green tints. Likewise, in another work, [25] pink and gold tints were used to assess depth perception and found no significance. Although in this work pink tint enhanced contrast sensitivity, depth perception was not analysed.

In an earlier study, [39] yellow tints enhanced photopic and scotopic vision with a statistical significance only for photopic vision. Whereas in this work, both yellow and pink tints enhanced CS for both positive and negative contrast in photopic vision. Performance of these tints in scotopic vision was not in the scope of the study and hence was not analysed.

Sunglasses of various tints such as grey, green, and brown were studied another work, [40] and revealed good improvement in CS without clinical significance.

An important aspect of this present work was neither the yellow nor the pink tint showed any significant difference in CS with 20% tint. But for other tint percentages of 40, 60, and 80, there was a significant increase or enhancement in CS for both the tints. The CS improved gradually up to 60% and dropped at 80% signifying the drop in visual acuity and visual performance with darker tints.

The subjective preference of tints was not taken in this study which can be of help to prescribe different percentages of tints in clinical practice.

Conclusion

The comparison between positive and negative contrast sensitivity with yellow and pink tint indicates that the effect of tint is pronounced with both the tints. In myopes and hyperopes, even 40% tint will be effective in enhancing the contrast for various backgrounds indicating its importance while prescribing spectacle prescriptions, particularly in ocular conditions where contrast sensitivity is affected. This study reports an enhanced performance in negative contrast for both yellow and pink tints which simulates the night vision. Hence this work is a good reference while prescribing tints for night vision especially driving.

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