Visual performance of aged subjects with tinted lenses

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ABSTRACT

We have analized the chromatic vision and the contrast vision of subjects older than 50 years wearing coloured lenses, in order to compare the performance of these kind of filters when used by this particular population. "PsychoWin 2.25" and "Cambridge Colour Test" (CCT) from Cambridge Research Systems were used to determine the contrast sensitivity function of these subjects and their chromatic discrimination thresholds around three stimuli. The results show that none of the filters studied performs optimally in both tests simultaneously, although the grey filter is the one which impairs performance in a lesser degree.

1. INTRODUCTION

The Colour and Vision Group of the University of Alicante, (GVC), in collaboration with the Optics Department of the University of Valencia, is studying different aspects of human vision, particularly in the field of colour and contrast perception. We are currently collaborating with Essilor España S.A. in the study of specific tinted lenses leading to better visual comfort for subjects of specific population groups: subjects that have undergone refractive surgery, chromatic anomalous, aged subjects, etc. Our aim is to test the utility of tinted filters by means of a clinical study of the vision quality of these subjects.

Tinted lenses for everyday use should not impair contrast sensitivity or spatial acuity, nor should introduce radical changes in colour perception. However, the luminance loss associated to any tinted lens may cause a decrease in contrast sensitivity and its selective transmittance alters colour vision in a greater or lesser degree. However, the visual system possesses adaptation mechanisms that minimise these effects, although their efficiency depends on the spectral profile of the lens[1-5]. Taking this into account, it would be desirable that tinted lenses would protect from UV radiation without undesirably altering visual performance. The Physiotint solar filters, recently made available in the market, are lenses in conventional colours, but that theoretically induced minimal chromatic variation, because the transmittances used are those that would produce minimal colour displacements according to certain colour vision model.

Our study aims to determining a procedure to select those lens chromaticities that alter to a lesser degree the visual performance of aged subjects in contrast perception and colour discrimination.

2. METHOD

We have studied the contrast sensitivity curve (CSF) and the colour discrimination ellipses of observers in the 50-70 age range. We used four "Physiotint" filters, manufactured by Essilor, whose transmittances are chosen to minimize chromatic changes. Grey, green, greyish-green and brown filters were tested in the experiments. The stimuli used in the experiment were generated in a Mitsubishi HL-7955 SKTKL CRT monitor, controlled by a Cambridge Research Systems (CRS) graphic card and software specifically designed for vision experiments.

The CSF has been measured using "PsychoWin 2.25", software developed by CRS. The software allows CSF measurements for chromatic and achromatic gratings of different frequencies and spatial profiles. In this experiment, CSFs to achromatic sinusoidal gratings of 13 cd/m^2 mean luminance were determined by the adjustment method for spatial frequencies 1, 2, 3, 4.6, 6, 8.8, 12.6 and 19 cpd. In each measurement session spatial frequencies were presented at random order. For any given frequency, the final result is the mean of four measurements. Observation distance was 3 meters.

Colour discrimination was assessed by means of the "Cambridge Colour Test" (CCT) from Cambridge Research Systems. The observer must signal the position of the opening in a Landolt C, which changes randomly form up, down, left and right, and appears against a background of fixed chromaticity. Both test and background are formed by circular spots whose luminance changes randomly within a pre-defined interval, in our case from 8 to 17 cd/m^2. In this way, test and background differ only in chromaticity, the task can be successfully performed only when the observer can chromatically discriminate between both stimuli. Three different background chromaticities were tested: white (x=0.313, y=0.330), green (x=0.346, y=0.407) and blue (x=0.280, y=0.253). For each of these backgrounds, discrimination thresholds were determined along eight different directions of colour space, using the staircase method. Mean stimulus luminance and observation distance were those used in the CSF measurements.

Both colour discrimination and CSF measurements were carried out in the dark, with the observer previously adapted for three minutes to a 13 cd/m^2 white stimulus seen in the same conditions as would be used during the rest of the session (that is, with the same filter). Measurement sessions never took above one hour, including pauses for resting, to avoid observer's fatigue. For each filter and test, we show the mean of the results obtained with six observers.

3. RESULTS AND CONCLUSIONS

Mean contrast sensitivity functions for each filter (grey, green, greyish-green and brown) are shown in Figure 1:

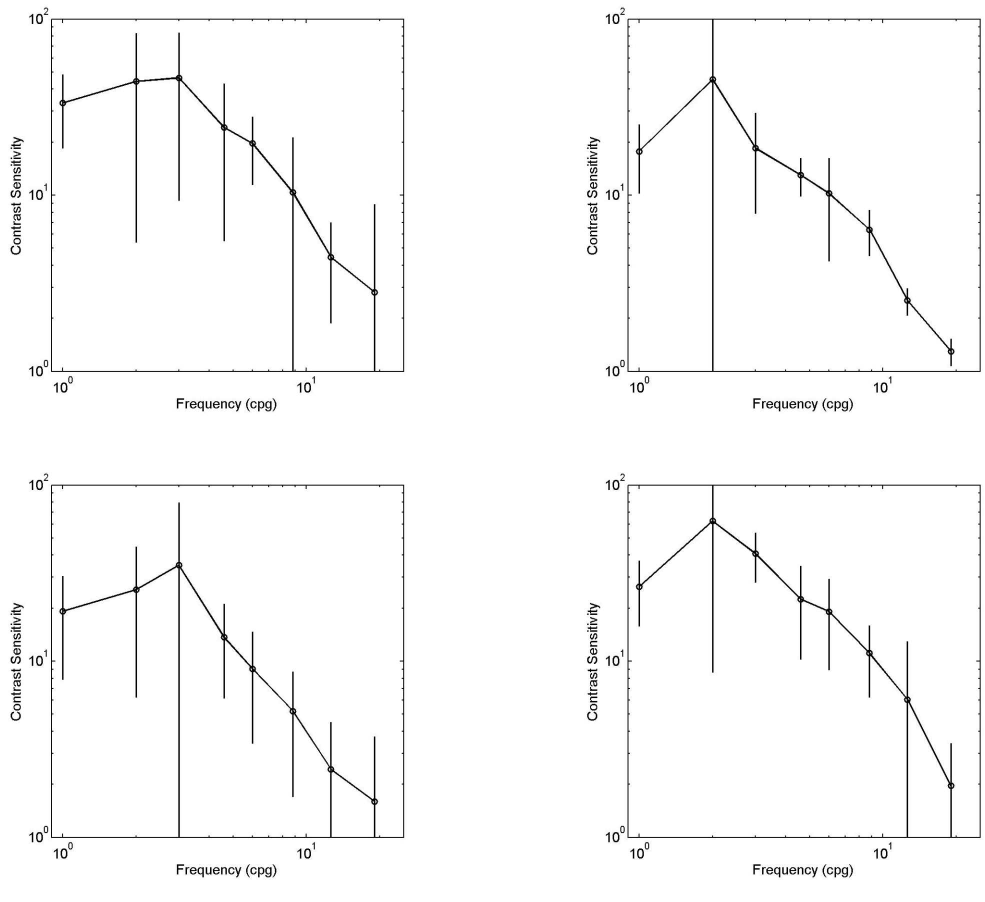

Figure 1 CSF for the grey (up, left), green (up, right), greyish-green (down, left) and brown (down, right) filters.

From Figure 1, the brown and the grey filters yield the best performances and the greyish-green filter yield the worst results. Overall and peak sensitivity are best with the brown filter, whereas with the greyish-green filter sensitivity is not only worse, but also the CSF presents the greatest slope in the high-frequency range. Green filter yield intermediate results between these two extremes. The peak sensitivities obtained with this filter and the grey one are similar, but with the green filter the fall-off at the low and high frequency range is steeper. If peak sensitivity and the slope of the high-frequency fall-off are taken as measurements of performance, the green filter performs better than the greyish-green one.

Chromatic discrimination data corresponding to each of the four filters are represented in the CIEXYZ chromaticity diagram in Figure 2:

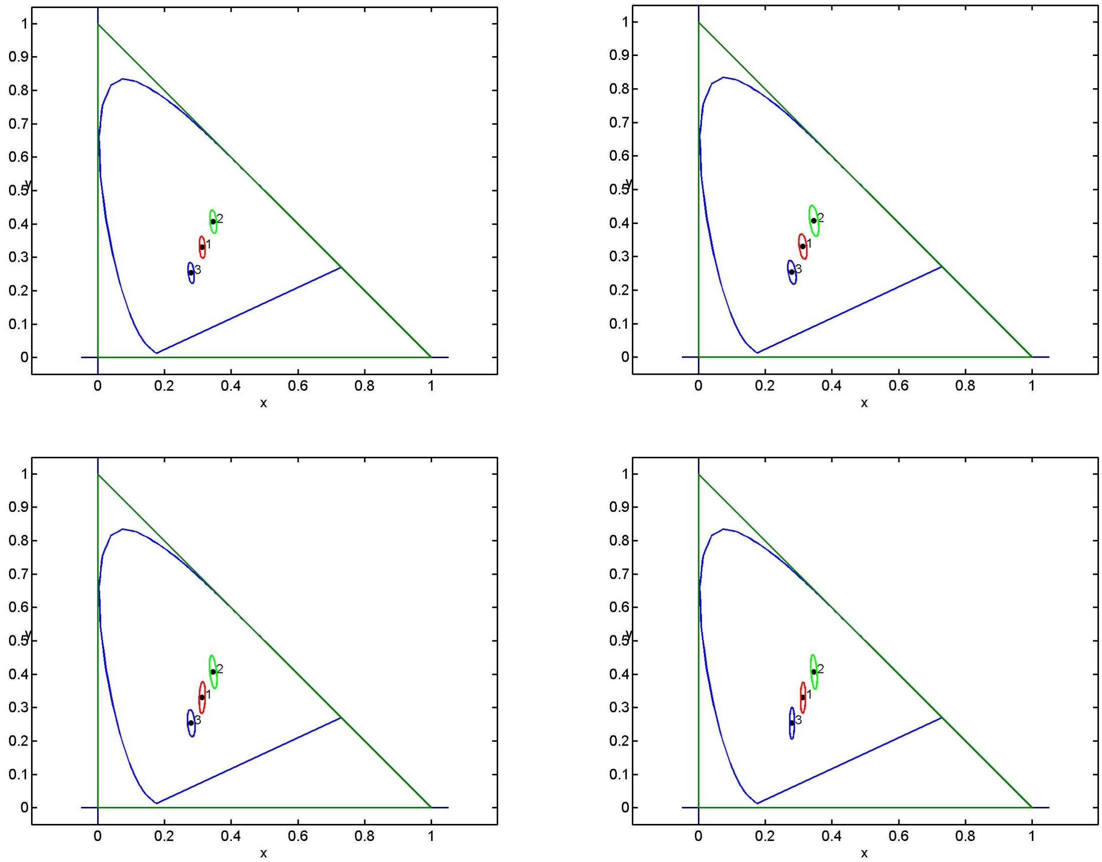

Figure 2: Discrimination ellipses for the grey (up, left), green (up, right), greyish-green (down, left) and brown (down, right) filters.

The grey filter is in this case the one allowing the best performance in this test and the differences among the remaining three are small. To quantify the effect of the filter, we have computed the area of the ellipses corresponding to the mean observer. The results appear in Table I.

Table 1: Major axis, major-minor axis ratio, angle of major axis and area corresponding to each ellipse and filter, as determined for the mean observer. Numbers identifying each ellipse correspond to each of the three background used: 1 white (x=0.313, y=0.330), 2 green (x=0.346, y=0.407) and 3 blue (x=0.280, y=0.253).

FILTER	ELLIPSE	AXIS (10^{-2})	RATIO	ANGLE	AREA (10^{-3})
GREY	1	6.46	3.9051	94.11	0.84
	2	7.02	3.7087	96.18	1.05
	3	6.30	3.6953	96.22	0.84
GREEN	1	7.51	3.4550	98.17	1.28
	2	9.28	3.7982	98.57	1.78
	3	7.14	3.3348	100.02	1.20
GREYISH-GREEN	1	9.44	5.4440	87.89	1.29
	2	9.85	5.1215	96.13	1.49
	3	8.08	3.8129	94.87	1.34
BROWN	1	9.19	6.3070	89.10	1.05
	2	10.29	6.0287	94.17	1.38
	3	9.48	6.6883	89.51	1.06

As expected, the smallest areas correspond to the grey filter, which is the one impairing less chromatic discrimination. Although the performances of the remaining three filters is similar, it appears that the worst overall results are yielded by the greyish-green filter, whereas the brown and green filters yield marginally better results. Note that with all filters discrimination ellipses around green (x=0.346, y=0.407) are always the largest. Normal young observers exhibit the same behaviour with green, brown and blue filters, but this trend is not so clear when cut-off filters are used[1].

In conclusion, the data show that none of the filters studied performs optimally in both the contrast sensitivity and the colour discrimination tests simultaneously, although the grey filter is the one which impairs performance in a lesser degree.

These are preliminary results in a line of work we hope to continue in future by a more exhaustive analysis of the influence of age in the visual performance of wearers of colour filters and by the inclusion of filters belonging to a wider chromaticity range.

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