EnChroma: A shift in Chromaticity

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Introduction

- Color vision deficiencies impact approximately 8% of males and 0.5% of females throughout the world[1]. Significant time, research, and marketing has been conducted to develop and sell lenses to aid in color discrimination for individuals afflicted with color vision deficiencies.
- Several studies have been conducted on theses lenses and point to evidence that while these lenses do not "cure" color blindness, they do enhance contrast and luminance differences between commonly confusable hues[3] and enhance the transmission of certain wavelengths within the region of poor wavelength discrimination in color deficient people[2,3].
- This study investigated two types of EnChroma filters: the Ellis Cx3, for mild-to-moderate protans and duetans, and the Northside Cx3 Sun SP, developed for strong protans[4].
- This study reports on the shifts in hue, chroma and lightness induced by each EnChroma filter type.

EnChroma logo[4]

EnChroma Ellis Cx3 Sun[4]

EnChroma Northside Cx3 Sun SP[4]

Methods

- Using a Minolta CS-100A chromometer, chromaticity coordinates were measured for every other cap of the FM-100.
- Lighting was provided directly from the DayLight Illuminator (fitted with a Verilux F15T8VLX bulb, which has a Correlated Color Temperature approximating D65 standard illuminant).
- A +10.00 diopter lens was used over the front lens of the chromometer to enlarge the image size of the caps to ensure accurate measurements in the correct area within each cap.
- Testing was done once without any filters and was then repeated with both the EnChroma Cx3 and Cx3 SP outdoor color blindness lenses placed in front of the objective lens of the chromometer.
- Chromaticity coordinates were converted into L*a*b* indices using a custom written Matlab function to extract hue angles, chroma, lightness and color difference metrics.

Results

- The Cx3 Sun and Cx3 Sun SP filters caused shifts in hue, saturation and lightness.
- A shift in lightness with both lenses is likely attributed to the fact that these lenses were made to be used outdoors. EnChroma also offers lenses for indoors, which were not reported in this study.
- Analysis of the data showed a shift in hue toward the yellow spectrum with the Cx3 Sun and a shift toward the red-yellow axis with the Cx3 Sun SP lenses, with both lenses causing a significant contraction of hue space. This can be observed in Figures 2 and 3.

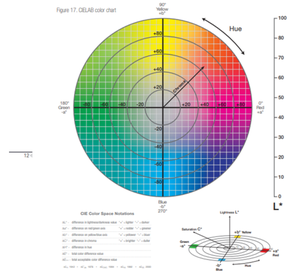


*Figure 1: L*a*b* hue circle[5]*

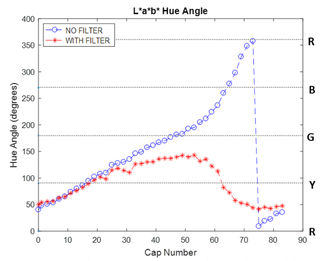


Figure 2: Shift in hue angle induced by the Cx3 Sun filter

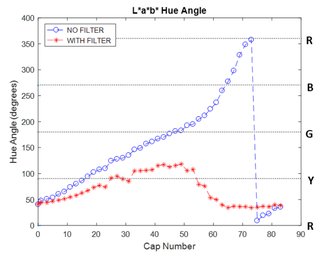
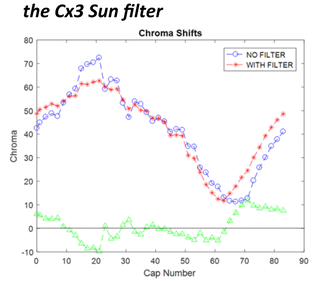
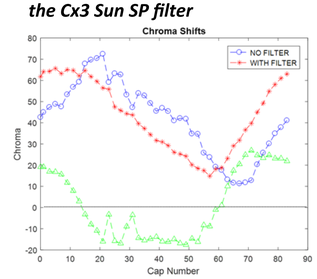


Figure 3: Shift in hue angle induced by the Cx3 Sun SP filter



CX3 Sun



CX3 SP

Figures 4,5: Comparison of saturation

- In general, caps corresponding to hues shifted within the red-yellow regions (caps 0-15, 60-85) were also accompanied by an increase in saturation. The enhancement in saturation of these caps was larger with the CX3 SP filters.

Conclusions

- Both EnChroma filters (Cx3 Sun and Sun SP) appear to shift hues away from the red-green axis in L*a*b* space. The Cx3 Sun lenses induce a vertical shift in hues toward the yellow axis with associated contraction in hue space. In contrast, the Cx3 Sun SP filters shift hues diagonally toward the red-yellow axis with a more significant contraction in hue space
- The increase in saturation within the red-yellow range is much greater for the Cx3 Sun SP filters. The contraction of hue space noted with both filters also predicts a significant contraction in the gamut of hues that can be experienced or perceived with use of these filters.
- The use of these filters induces significant changes to the appearance of colors. While the enhancement of color differences induced by the EnChroma lenses may assist deutanomalous and protanomalous color deficiencies with hue discrimination within the red-yellow and green hue ranges, the profound shifts in hue within the green-blue and blue-red ranges predicts difficulties with hue identification in this range.

References

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