DOES THE PREFERENTIAL WAVELENGTH SELECTION OF COMMERCIALLY AVAILABLE BLUE-BLOCKING LENSES AFFECT COLOUR CONTRAST SENSITIVITY?

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MOTIVATION AND AIM

- The selective reduction in visible wavelengths transmitted through commercially available blue-blocking lenses (BBLs) is known to influence the appearance and contrast detection of objects, particularly at low light levels [1-3]. Recent studies reported that while those BBLs have been designed to beneficially reduce exposure to blue hazard light, their secondary and unintended effect on vision has not been fully characterized [4,5].
- This study aimed to accurately quantify the effect of BBLs on the contrast perception of targets defined by color (chromatic) using a visual search design detection task under low and high contrast stimulus conditions.

MATERIALS & METHODS

- Three types of plano BBLs (Crizal Prevencia, Blue Guardian, and Blu-OLP) and untinted lens (control) were used (Fig. 1).
- Five healthy participants aged between 23 and 39 years participated in the study.
- A staircase procedure was used to measure contrast detection thresholds, in which the colour/luminance of the target was modulated using fine contrast steps by a computer-based system. These procedures were repeated for both high and low contrast targets and of different colours.

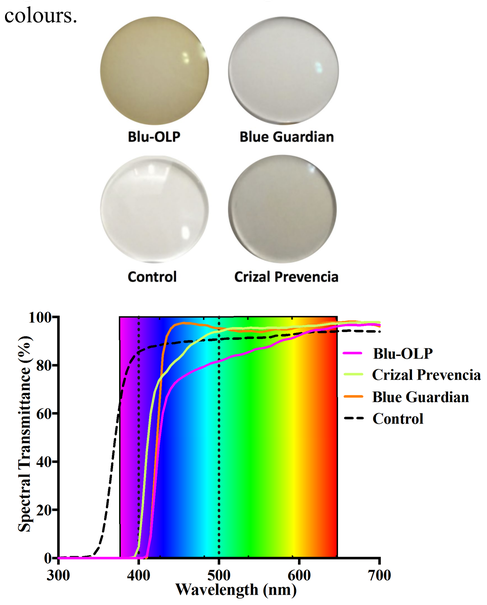

Fig 1. Spectral transmittance of three BBLs from three brands and one clear untinted lens were measured from 280 to 780 nm with 5 nm interval using a Cary 5000 UV-Vis-NIR spectrophotometer.

RESULTS

Experiment 1: Effect of blue-blocking lenses (BBLs) on colour contrast sensitivity

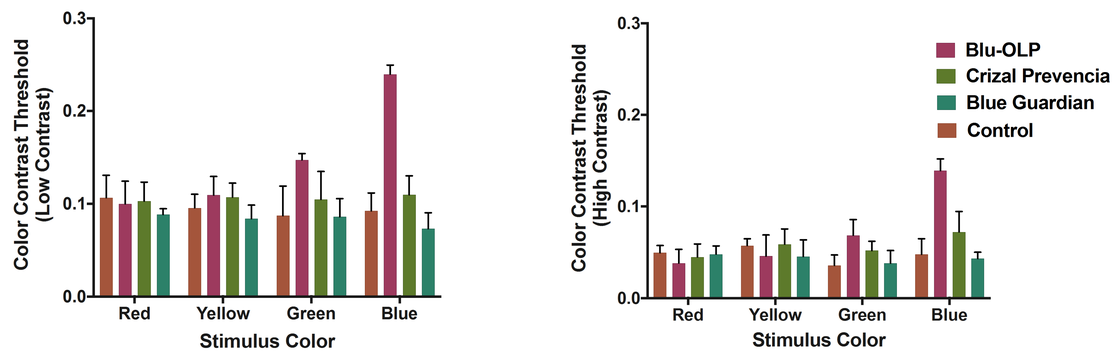

Fig 2.Colour contrast threshold and the standard error of the means SEMs for different lens types. All lenses were tested to each chromatic stimulus displayed with low and high contrast conditions.

Experiment 2: Effect of BBLs on the detection of blue coloured stimuli

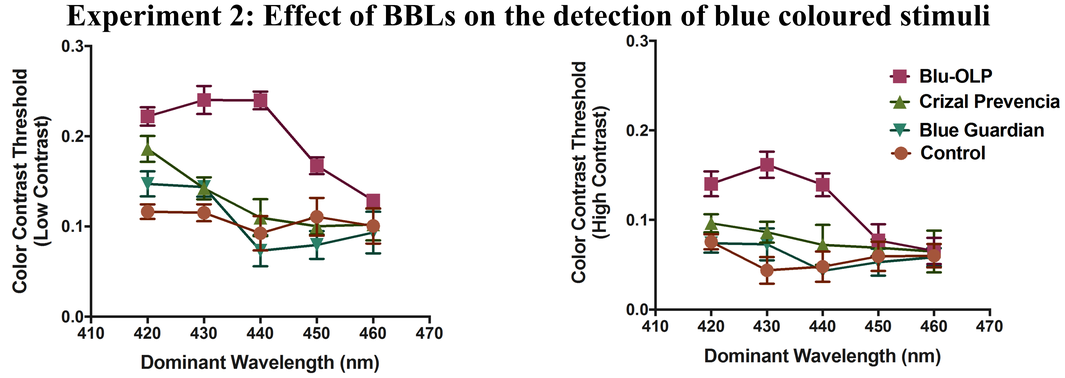

Fig 3. Colour contrast thresholds for three BBLs types and control lens obtained at : (a) Low and (b) High luminance contrast respectively. All lenses were tested at blue stimuli with dominant wavelengths of 420 nm, 430 nm, 440 nm, 450 nm, and 460 nm.

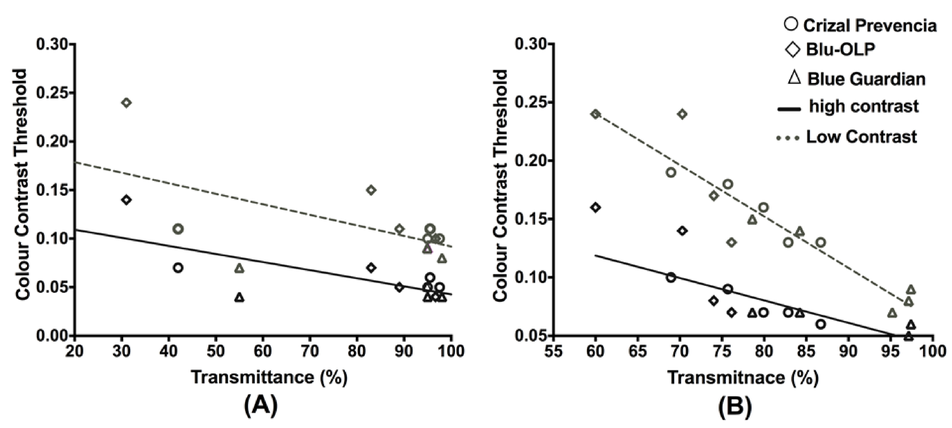

Fig 4. Linear regression analysis between the lens transmittance value and colour contrast.

DISCUSSIONS

- In Experiment 1, under both low- and high-contrast targets, Blu-OLP lens was the most effective in reducing the detection of colour contrast for blue colour in comparison to control lens and other BBLs ($P < 0.05$) (Fig 2).
- In Experiment 2, under both contrast stimuli conditions, the change in contrast sensitivity for shorter wavelengths is heightened, but converges at longer wavelengths, and this change was significant only for the Blu-OLP and Crizal Prevencia lenses ($p < 0.05$) when compared to the control lens at the wavelength of 420 nm, 430 nm, 440 nm, and 450 nm (Fig 3).
- In Experiments 1 and 2, a significant negative linear relationship was observed for both low and high contrast stimuli which indicates that BBLs with transmittance profiles that block the most blue-light resulted in the largest increase in colour contrast thresholds (Fig 4A -Expt. 1 and B – Expt. 2).

CONCLUSIONS

- Reducing transmitted blue light through BBLs whilst potentially minimises the harmful effect of blue hazard light, leads to a reduction in colour contrast sensitivity, that impairs the detection of coloured targets (particularly blue) at low and high light levels. This might reduce the effectiveness and visual sensitivity of BBL wearers particularly under low-lighting conditions in real world conditions.
- This impairment in the detection of a low-contrast blue target might pose a safety risk for nighttime activities, which may limit their benefits which at present have not been definitively proven.

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