SPATIO-CHROMATIC CONTRAST SENSITIVITY ACROSS THE LIFE SPAN:

INTERACTIONS BETWEEN AGE AND LIGHT LEVEL IN HIGH DYNAMIC RANGE

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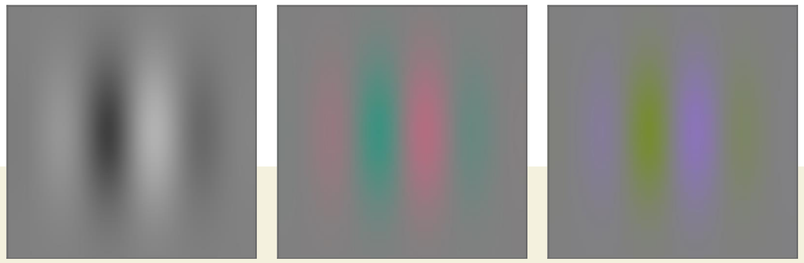

MOTIVATION

- The senescence of spatio-chromatic sensitivity at high light levels for both achromatic and chromatic stimuli has not been thoroughly explored before.
- We are investigating the joint effects of luminance (ranging from 0.02 to 2000 cd/m 2) and age on spatio-chromatic sensitivity.

EXPERIMENT

Psychophysical task

- 4AFCQUEST-based detection task
- Viewing distance: 91 cm
- Display size: 12.5 x 9.4 visual degrees

Observers

- Color normal observers
- 20 young participants; mean age: 33 years
- 20 older participants: mean age: 65 years

Stimuli

- Fixed-cycle Gabor patches, spatial frequencies: 0.5, 1, 2, 4, and 6 cpd
- Color modulations: (1) Black-white; (2) Red-green; (3) Lime-Violet
- Mean background luminances: 0.02, 0.2, 2, 20, 200, 2000, and 7000 cd/m^2

FINDINGS

- Age-dependent decline in achromatic contrast sensitivity (Figure 1, row 1) becomes larger with increasing spatial frequency.
- Chromatic contrast sensitivity declines with age for luminance levels up to 20 cd/m^2 for all spatial frequencies (Figure 1, rows 2, 3).
- Measurement variations (error bars in Figure 1) are higher for older age group as individual variability becomes more pronounced with advancing age.
- Highest differences between achromatic sensitivities of the two age groups is recorded in mesopic range (Figure 2, 1st quadrant).

Contrast sensitivity degradation with age depends on luminance.

- Peak frequency of achromatic contrast sensitivity functions decreases with age (Figure 3, column 1).
- Peak sensitivity for achromatic contrast decreases with age, and the rate of decline is luminance dependent. No age-dependence of chromatic peak sensitivities is found (Figure 3, column 2)
- Cut-off frequency for achromatic and red-green stimuli become more age-dependent with increasing luminance level (Figure 3, column 3). This shows greater impact of age on contrast sensitivity at higher frequencies.
- Contrast thresholds can be applied to image components to simulate visions at different ages (see demo application below).

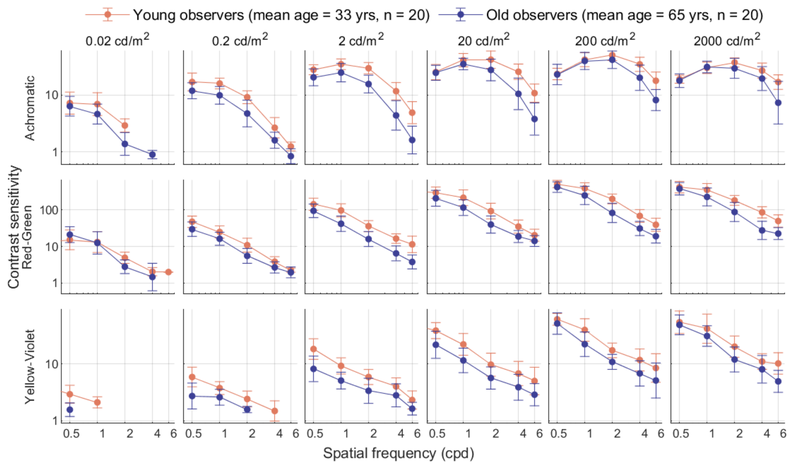

Figure 1. Mean contrast sensitivity (error bars: standard deviation) from younger and older observers' age group. Each subplot contains the contrast sensitivity function for the corresponding color and luminance combination.

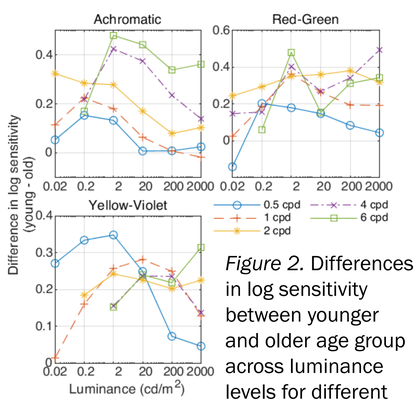

Figure 2. Differences in log sensitivity between younger and older age group across luminance levels for different spatial frequencies

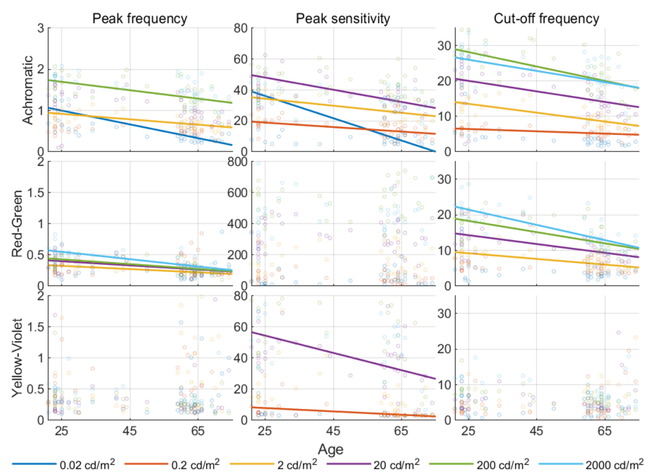

Figure 3. Change in log-parabola CSF[1] parameters with age. Empty circles in the figure are optimized parameters: peak frequency, peak sensitivity, bandwidth, and cut-off frequency for each observer at multiple luminance levels plotted with respect to age. Solid lines are linear regression lines fitted to age vs. the optimized values of the four parameters.

Scan the QR code

For a demo of image appearance simulation for difference ages

References

[1]Wuerger, S., et al. "Spatio-chromatic contrast sensitivity under mesopic and photopic light levels." *Journal of Vision* 20.4 (2020): 23-23.

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