

Using S-Cone signals to detect the effects of longitudinal chromatic aberration

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Longitudinal chromatic aberration (LCA) introduces blur into the retinal image, especially at short wavelengths. LCA is nearly identical in different individuals (Atchison & Smith, 2000). However, psychophysical sensitivity to the effects of LCA may vary across people, since this sensitivity is likely to depend upon multiple factors (e.g., sampling by the retinal mosaic). This study explores a possible psychophysical method to measure sensitivity to the effects of LCA in different individuals. Contrast sensitivity functions (CSFs) were measured in three conditions: (a) achromatic (luminance) detection, (b) S-cone detection (S-cone mediated contrast sensitivity), and (c) S-cone hue judgment (S-cone mediated color perception). Stimuli were flickering Gabor patches, either white/black in task (a), or S-cone isolating purple/yellow-green, in (b) and (c). CSFs from (b) can be analyzed into two components. At low spatial frequencies (SFs), patches appeared colorful and the CSF shape matched the shape of the hue CSF (task c). At higher SFs, patches no longer appeared colorful and the shape was similar to the achromatic detection CSF (a), likely representing a response to a luminance artifact caused by LCA. Using probability summation to combine the estimated sensitivities of the S-cone hue judgment and achromatic detection produced curves that matched the measured S-cone detection sensitivities. The relationship between S-cone contrast detection, S-cone color perception, and achromatic contrast detection may represent a way to measure and model signatures of the effects of LCA.