Age-related contrast discrimination differences in ON and OFF pathways

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Both optical and neural factors are known to contribute to age-related changes in human spatial vision. With optical factors controlled, Shinomori and Werner have found age-related changes in temporal ON- and OFF-pathways measured with luminance and S-cone modulation. Here we used psychophysical methods developed in the Pokorny-Smith lab to evaluate age-related changes in putative ON and OFF pathways for 10 younger (mean age 22 years) and 10 older (mean age 74 years) observers. Contrast discrimination thresholds were measured using the pedestal-delta-pedestal paradigm, thought to reveal the contrast gain signature of the magnocellular pathway. Observers pre-adapted to a uniform field plus a pedestal four-square array. In the brief trial period (35 ms), the four-square array was incremented or decremented in luminance by a small amount (< 0.1 log units) from the pedestal, with one square presented at a higher or lower retinal illuminance. Trials followed a double-random alternating staircase, with thresholds measured in the 1) increment and 2) decrement directions. Using a four-alternative forced choice procedure, the observer's task was to choose the unique square. Stimuli were presented in Maxwellian view, and heterochromatic flicker photometry was used to equate the illuminance for each observer. Thresholds obtained in the two staircases revealed differential discrimination functions, suggesting discriminations were mediated by the ON and OFF pathways, respectively. The contrast gain slopes obtained with a fitted equation are consistent with previous reports for young observers. Older observers showed a significant change in the contrast gain slope for both increment ($p < 0.001$) and decrement ($p = 0.05$) thresholds, but the change was substantially greater in the putative ON pathway (57% vs. 27% increase in the fitted values). Differences suggest that both ON and OFF pathways undergo age-related sensitivity loss, but the contrast gain signature is altered to a greater degree in the ON pathway.

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