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Effect of Aberration Correction on Visual Acuity in the Periphery

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Abstract

Purpose:The limit to resolution acuity in the periphery can be either optical or retinal. Although retinal sampling poses an eventual limit, optical aberrations may set a more stringent limit. In this study, we investigate the impact of different optical corrections on acuity in the periphery.

Methods:We used the adaptive optics visual simulator at the University of Murcia to measure and modify the off-axis aberrations of the right eye of six normal subjects at 20° of eccentricity (left horizontal meridian). The system consists of a Hartmann-Shack sensor, a deformable mirror (Xinetics, 97 actuators), and a channel for visual testing. Four different optical corrections were tested: foveal correction; eccentric defocus correction; eccentric sphero-cylindrical correction; and full correction of eccentric low and high order monochromatic aberrations. High-contrast visual acuity was measured in green light using a forced choice procedure with Landolt Cs, viewed via the deformable mirror through a 4.8-mm artificial pupil.

Results:Defocus and horizontal-vertical astigmatism, C(2,2), were the terms mainly affected by eccentricity. At 20° in the periphery, the changes in defocus were subject-dependent, while C(2,2) was consistently modified toward positive values. Each correction condition was successfully implemented on each subject, and the final average RMS values, including defocus, were: $1.01 \pm 0.26 \mu\text{m}$; $0.83 \pm 0.30 \mu\text{m}$; $0.41 \pm 0.06 \mu\text{m}$; and $0.05 \pm 0.02 \mu\text{m}$, respectively. Although there was a general mild tendency of improvement in visual acuity with the successive corrections, the differences were in general small and

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not significant.

Conclusions: Correcting optical aberrations at 20° of eccentricity in the periphery produces only slight improvements in visual acuity. This suggests that for our experimental conditions and subjects, the resolution-limiting factor is retinal sampling instead of optical errors. However, it should be noted that our experiment does not rule out the possibility of improvements in detection tasks or low contrast resolution acuity in the periphery.

Keywords: visual acuity • refraction • optical properties



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