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Better Than Normal Visual Acuity Does Not Require Perfect Ocular Optics

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Abstract

Purpose: Optical aberrations in the eye impose a fundamental physical limit to visual performance. Conventional wisdom assumes that subjects with better than normal spatial vision should have nearly perfect ocular optics. It has been also speculated in the past that some particular aberration patterns would be best suited to produce good vision. In this context, we have performed a study to determine whether subjects with exceptional natural visual acuity also have perfect ocular optics.

Methods: We selected a group of subjects (age range 18–35 years old) having better than normal visual acuity (VA) naturally. We performed a series of different VA tests, including high contrast letter acuity and a forced choice procedure (Freiburg test). For each eye after small possible defocus errors were corrected, an average VA value was assigned. We identified a group of 27 eyes with VA ranging from 20/12 to 20/9. Another group of 33 normal eyes were included as a reference with VA ranging from 20/22 to 20/12. Beyond VA measurements, wave-front aberrations for 4 and 6 mm pupil diameter, using our own research prototype Hartmann–Shack sensor, were collected in each eye.

Results: Eyes with better than normal VA present similar amounts, expressed as the root mean squared (RMS), of higher order aberrations than eyes in the reference group with normal VA values. We did not find any particular Zernike term (up to fifth order) with a significant different value in the better vision group compared to the reference normal group. There was no correlation between high order aberrations and visual acuity, although astigmatism was correlated with acuity when the two groups were combined. The eyes with the best VA (20/9) had around 0.2 microns of RMS for 6 mm pupil, which is higher than in many others eyes (RMS around 0.1 microns) with much lower VA (in the range of 20/14).

Conclusions: Subjects with excellent VA does not necessarily have exceptional ocular optics. The high

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order aberrations in the eyes of the subjects with the best VA were similar or even larger than in eyes of subjects with normal VA. These results could be of importance for aberration–correction refractive surgery. Since excellent VA is occurring naturally in subjects without diffraction–limited ocular optics, a perfect optics target in wavefront guided refractive surgery is not perhaps the best option. The relationship among other factors that affects visual performance, optical, retinal and neural, should be further studied in eyes with excellent vision.

Keywords: visual acuity • optical properties • refractive surgery: optical quality



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