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## Does the Best Aberration Correction for the Eye Depend on Neural Factors?

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### Abstract

#### Purpose:

Subjective image quality depends not only on optical blur but also on neural factors (Webster et al. 2002). Artal et al. (2004) showed that the eye is adapted to its particular pattern of higher order aberrations, because the subjective blur produced when viewing a scene through one's own wave aberration was less than that when the wave aberration was rotated. Here, we studied whether this neural adaptation modifies the amount of aberration correction that produces the best subjective image quality. This may have important practical consequences for customized vision correction in eyes with large amounts of higher order aberrations.

#### Methods:

Three subjects performed two tasks, method of adjustment and matching, while viewing a monochromatic stimulus through the Rochester Adaptive Optics System. In both tasks, the subject's wave aberration was multiplied by a scaling factor between 1 and –1, where 1 corresponds to the normal wave aberration, 0 to aberrations minimized with adaptive optics, and –1 to the normal wave aberration but with the sign reversed. The visual stimulus was high contrast, containing many sharp edges at all orientations. In the adjustment task, subjects adjusted the scaling factor to find the best subjective image quality. In the matching task, subjects adjusted the amount of defocus to match the blur corresponding to different

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factors multiplying the aberrations.

### **Results:**

For the method of adjustment task, all observers chose a scaling factor significantly greater than zero, ranging from 0.03 to 0.18. This is consistent with a small amount of neural adaptation since the best image quality occurred when the wave aberration was shifted slightly in the direction of the normal wave aberration. For the matching task, each of the three subject's data revealed a small amount of neural adaptation since the amount of defocus required to match subjective image quality was minimal for aberration factors slightly greater than zero.

### **Conclusions:**

The best subjective image quality occurs when some aberrations are left uncorrected. Neural adaptation slightly modifies the best aberration correction, though this effect averaged only ~12% of complete adaptation and may well disappear following longer visual experience with fully corrected optics. Neural adaptation is neither large enough nor probably permanent enough to warrant partial instead of complete correction of the eye's aberrations with customized contact lenses or refractive surgery.

**Keywords:** adaptation: blur • refractive surgery: optical quality • refraction



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