Short-term Visual Benefit Of Correcting Higher Order Aberrations In Keratoconic Eyes

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Higher order aberration correction and visual performance

Conventional correction

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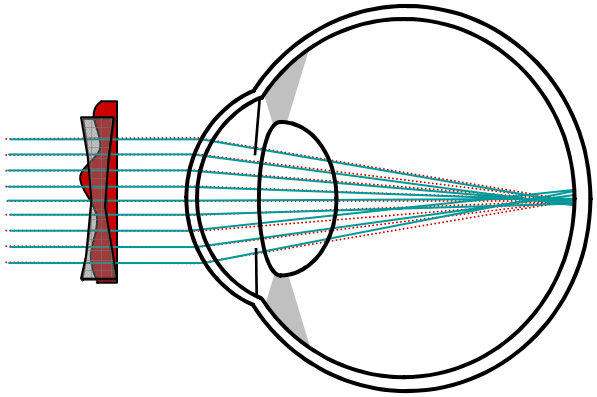
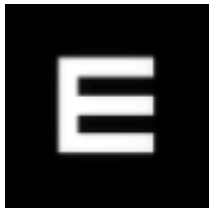
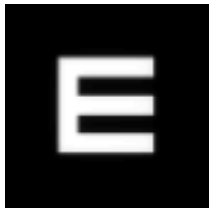
Higher order aberration correction



Retinal image quality





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Visual performance

Previous studies

- **Neural adaptation to lower order aberrations**
  - 'Decreased Uncorrected Vision After a Period of Distance fixation with spectacle wear' Pesudovs et al, Opt.Vis.Sci (1993)
  - *'Improving vision: neural compensation for optical defocus'* Mon-Williams et al, *Proc.R.Soc.Lond. B(1998)*
  - '*Neural adjustments to image blur'*. Webster et al, *Nat. Neuroscience* (2002)
  - '*Blur adaptation and Myopia'*. George et al, *Opt.Vis.Sci* (2004)
- **Neural adaptation to higher order aberrations : normal eyes**
  - '*Neural compensation for the eye's optical aberrations'* Artal et al *J. of Vis* (2004)
  - '*Neural compensation for the best aberration correction'* Chen et al, *J. of Vis.* (2007)

What is the effect of adaptation in keratoconic eyes to the blur due to higher order aberrations?

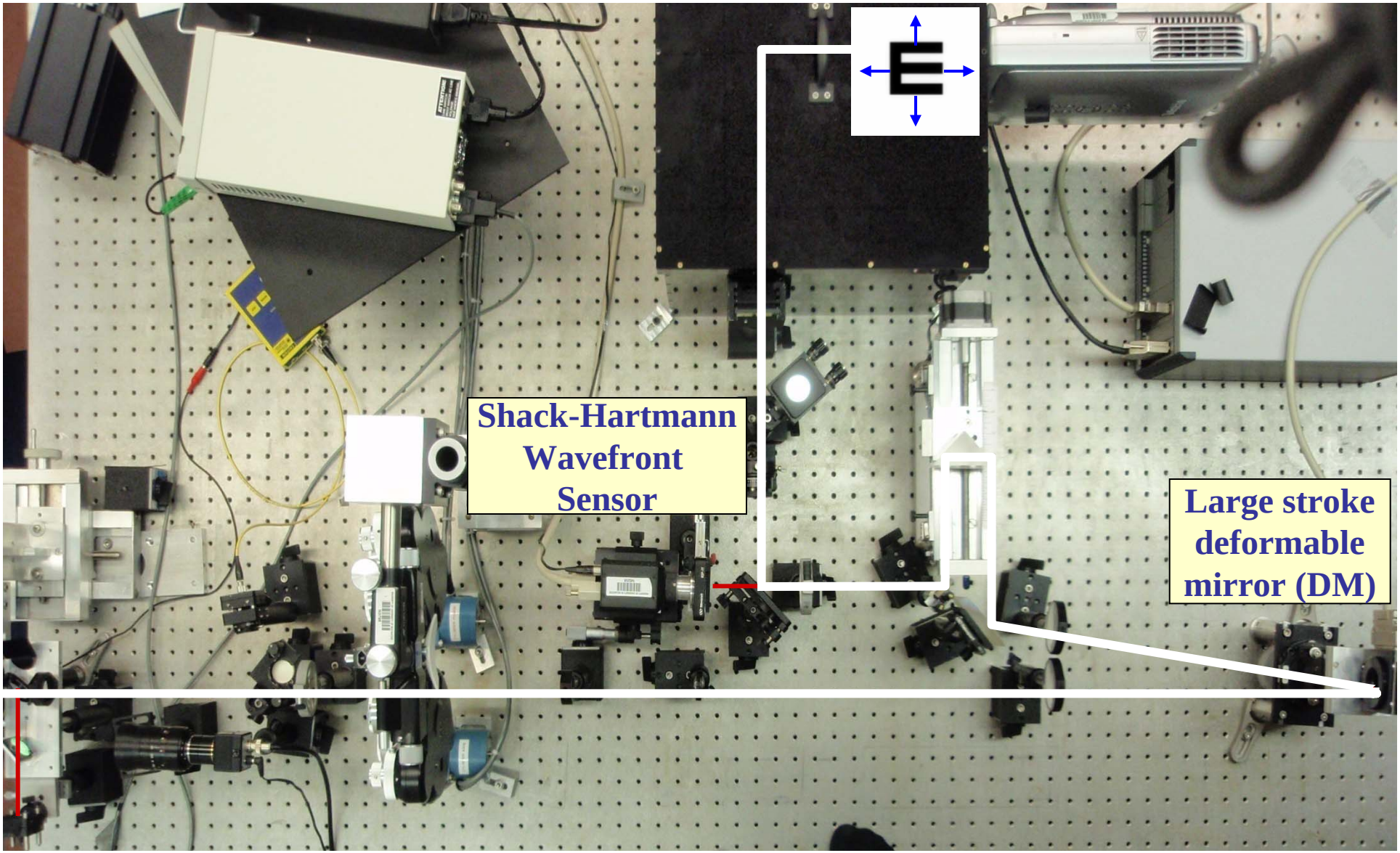
Experiment #1

Goal: To investigate whether keratoconic (KC) eyes can achieve perfect visual performance when their ocular aberrations are corrected nearly to the diffraction-limit

Methods

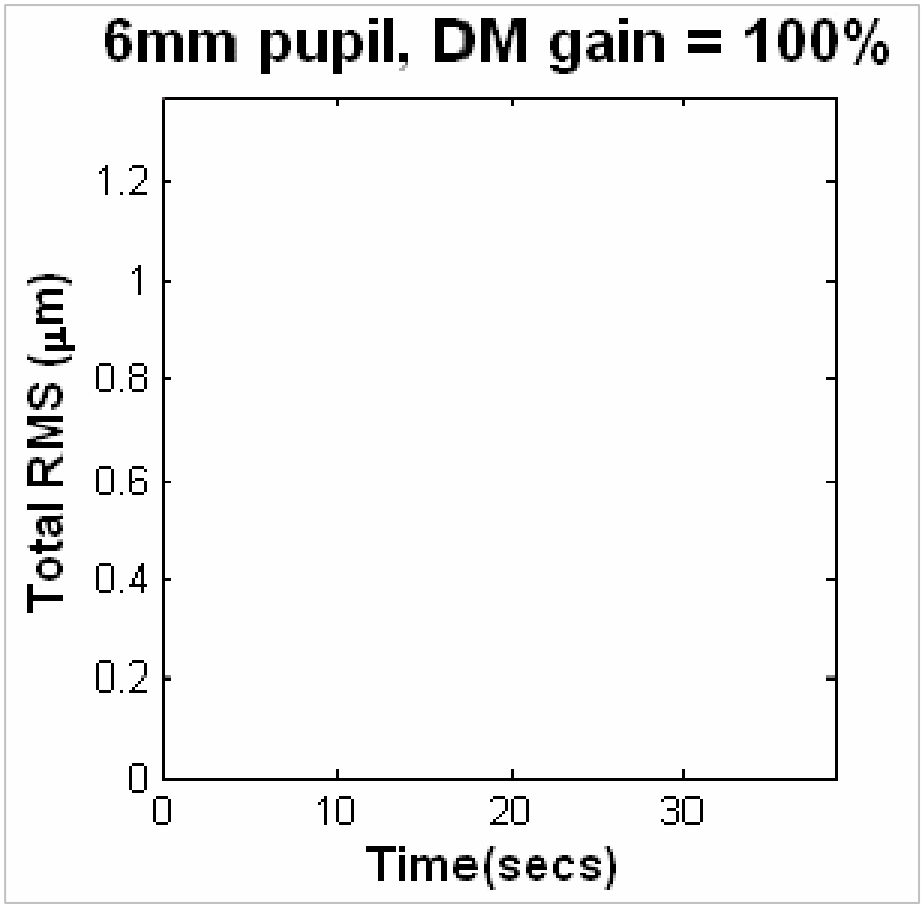
	Normal	KC
# of subjects	**8**	**8** (7 moderate, 1 advanced)
Higher order rms (6mm pupil)	**0.43 ± 0.11 µm**	**2.23 ± 1.07 µm**
Axial length (n=4)	**24.42 ± 0.91 mm**	**23.81 ± 0.55 mm**

Large stroke adaptive optics for vision testing



Dynamic correction of eye's aberration during vision testing

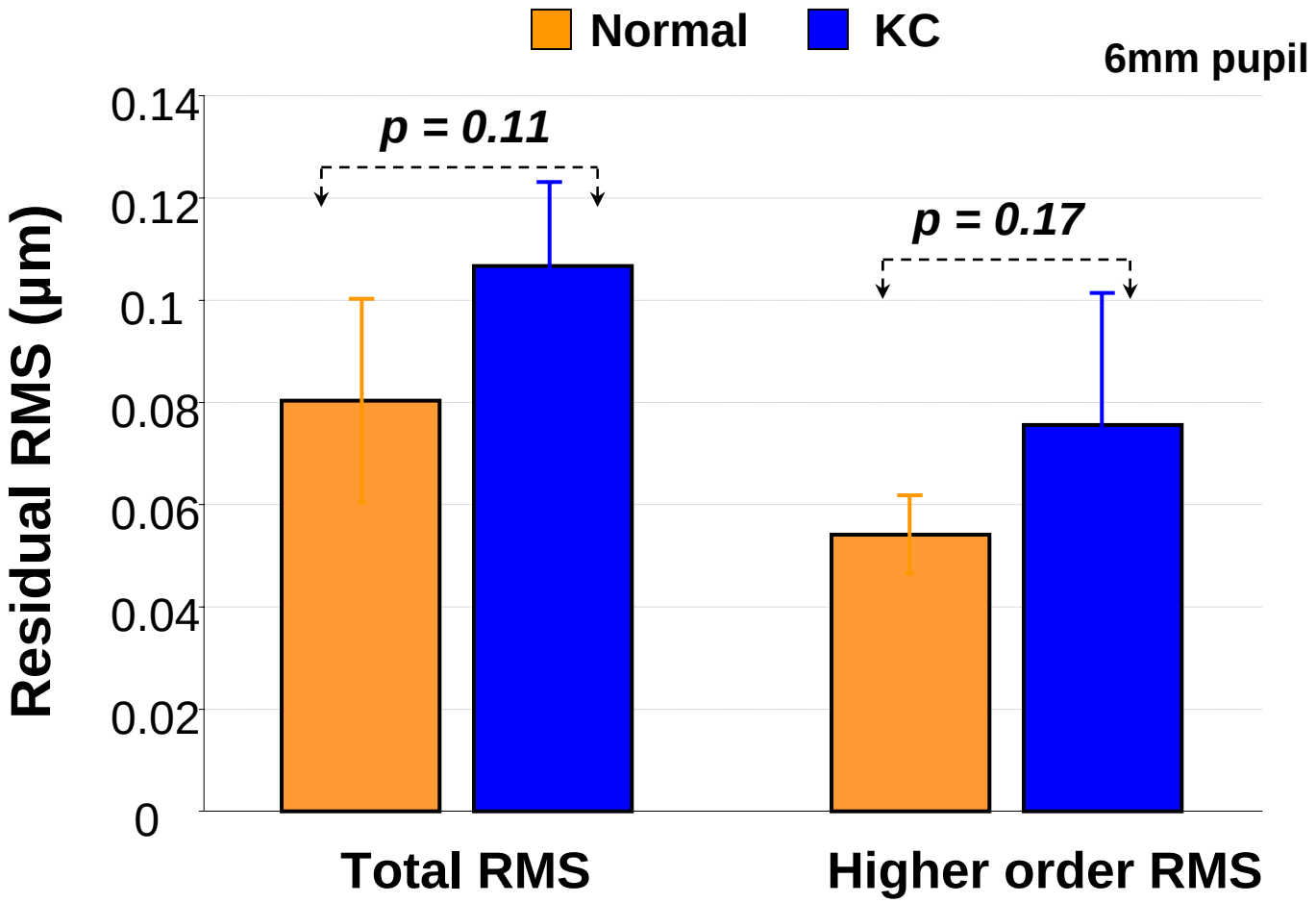
Wavefront RMS



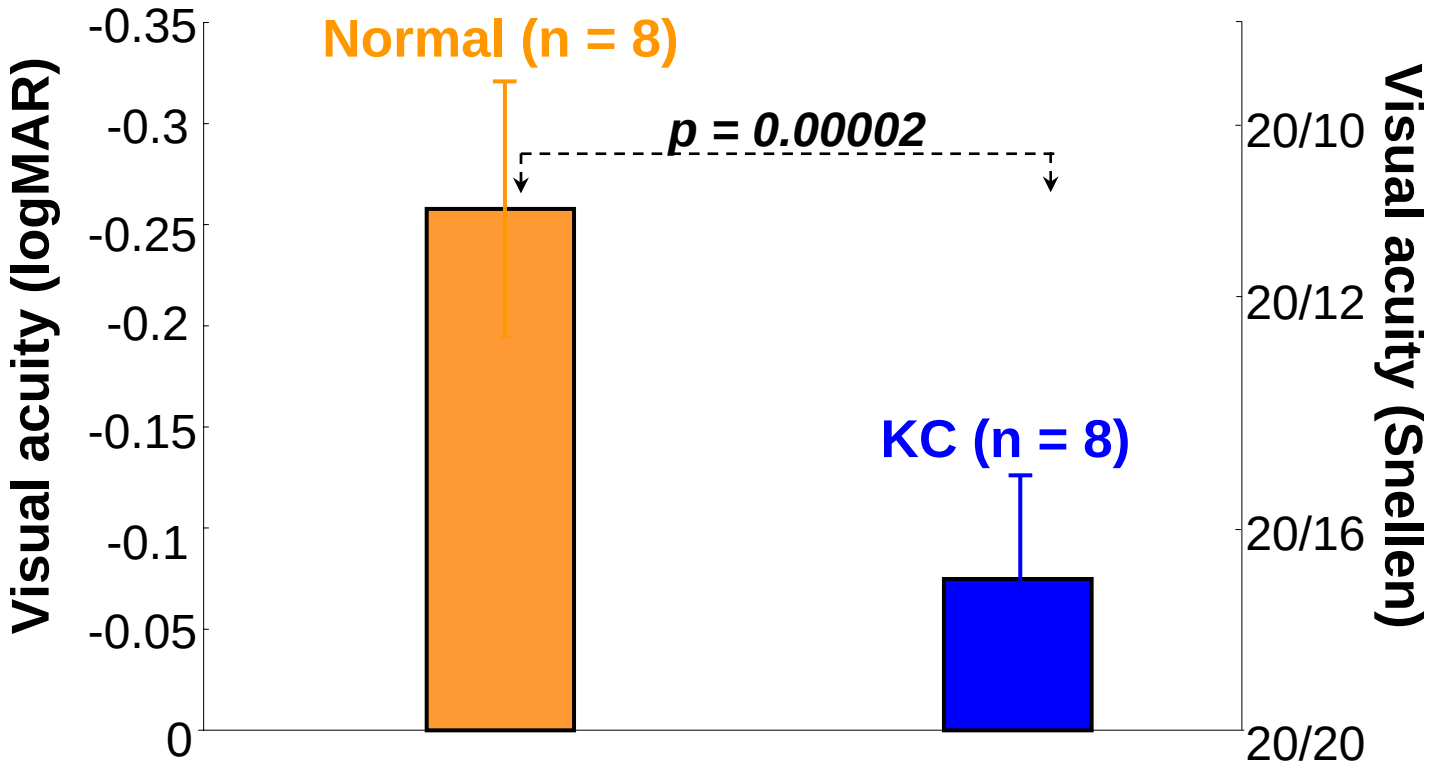
Theoretical PSF

1st Correction : 1.3 µm ⟶ 0.1 µm

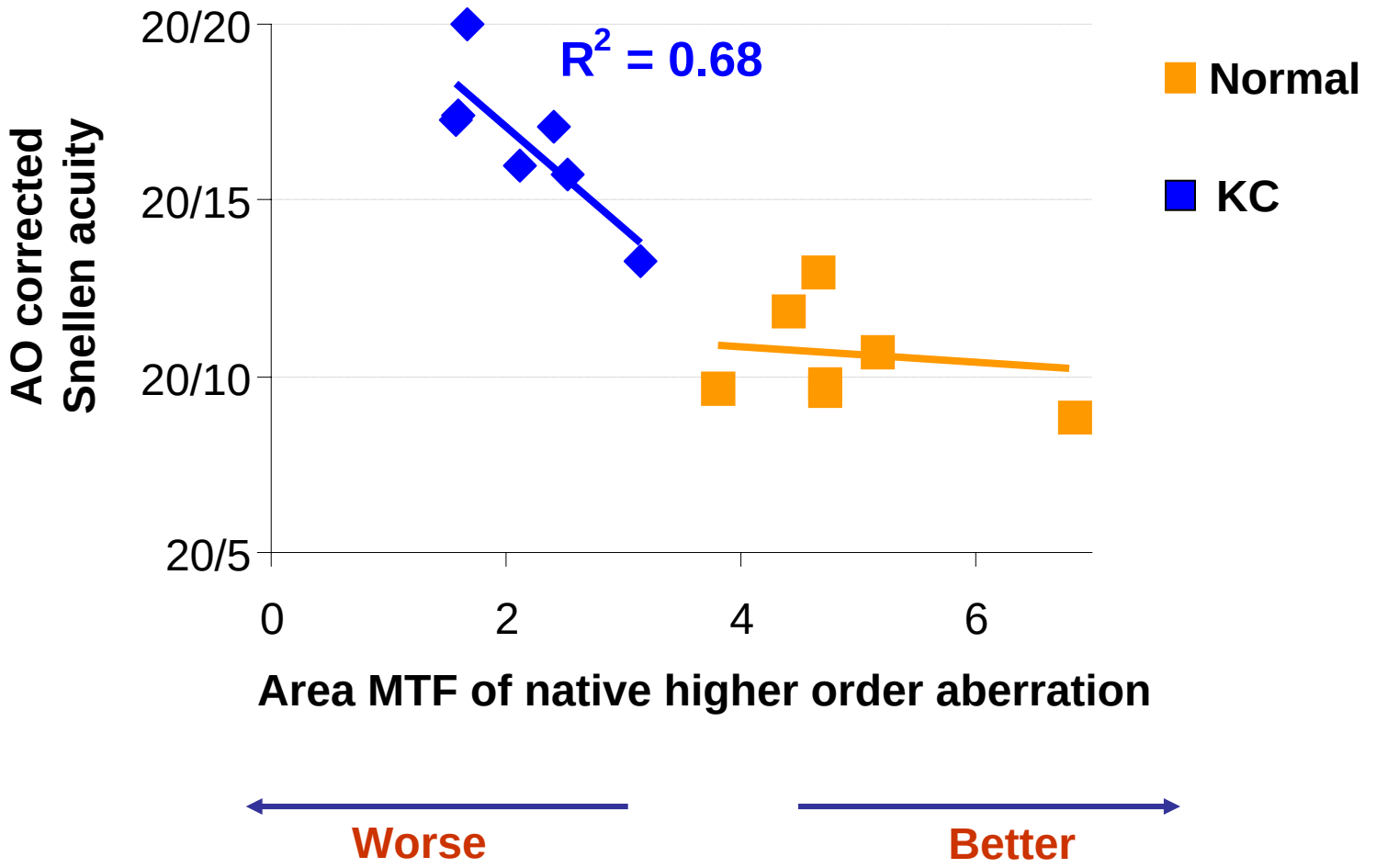
With AO correction, both normal and KC eyes achieved near-diffraction-limited optical quality



Visual performance of keratoconic eyes is significantly worse than normal eyes with same near-diffraction optical quality



In KC eyes, visual performance with AO was correlated to the retinal image quality before higher order aberration correction

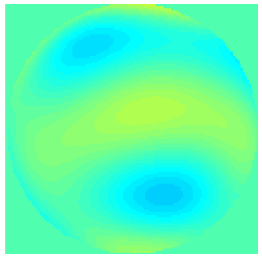


Experiment #2

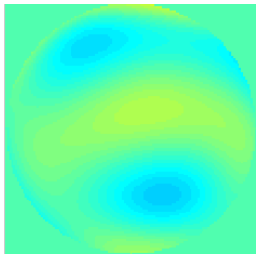
Goal: To investigate, given the same aberrated optical quality in both normal and KC eyes, whether they exhibit similar visual performance improvement with selective correction

Methods

KC eye #1 with own aberration



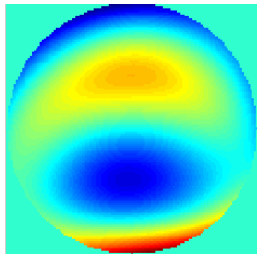
Normals (n=3) with KC eye #1 aberration



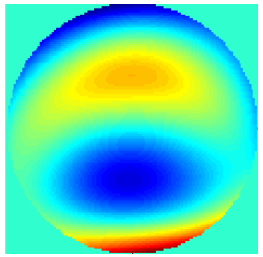
Selectively corrected

Visual Performance

KC eye #2 with own aberration



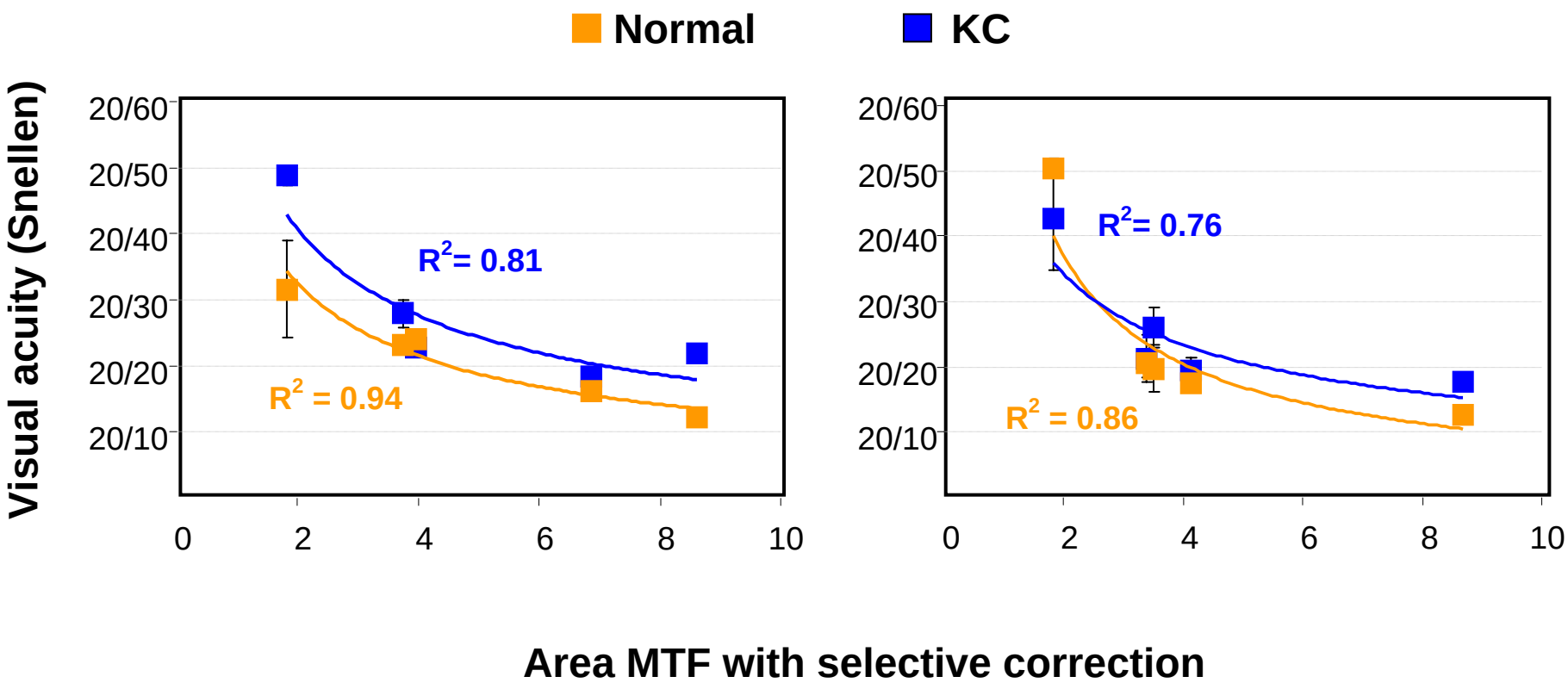
Normals (n=3) with KC eye #2 aberration



Selectively corrected

Visual Performance

With selective correction, visual performance improvement in KC eyes was smaller than that in normal eyes



Conclusion

Keratoconic eyes are adapted to the optical blur induced by higher order aberrations, restricting the visual benefit achievable immediately after their correction