

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

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## Subjective Image Quality Depends on:

- Neural as Well as Optical Blur
- The Patient's Past Experience

test



Webster MA, Georgeson MA, and Webster SM (2002)  
Nature Neuroscience 5, 839-840

adapt



retest



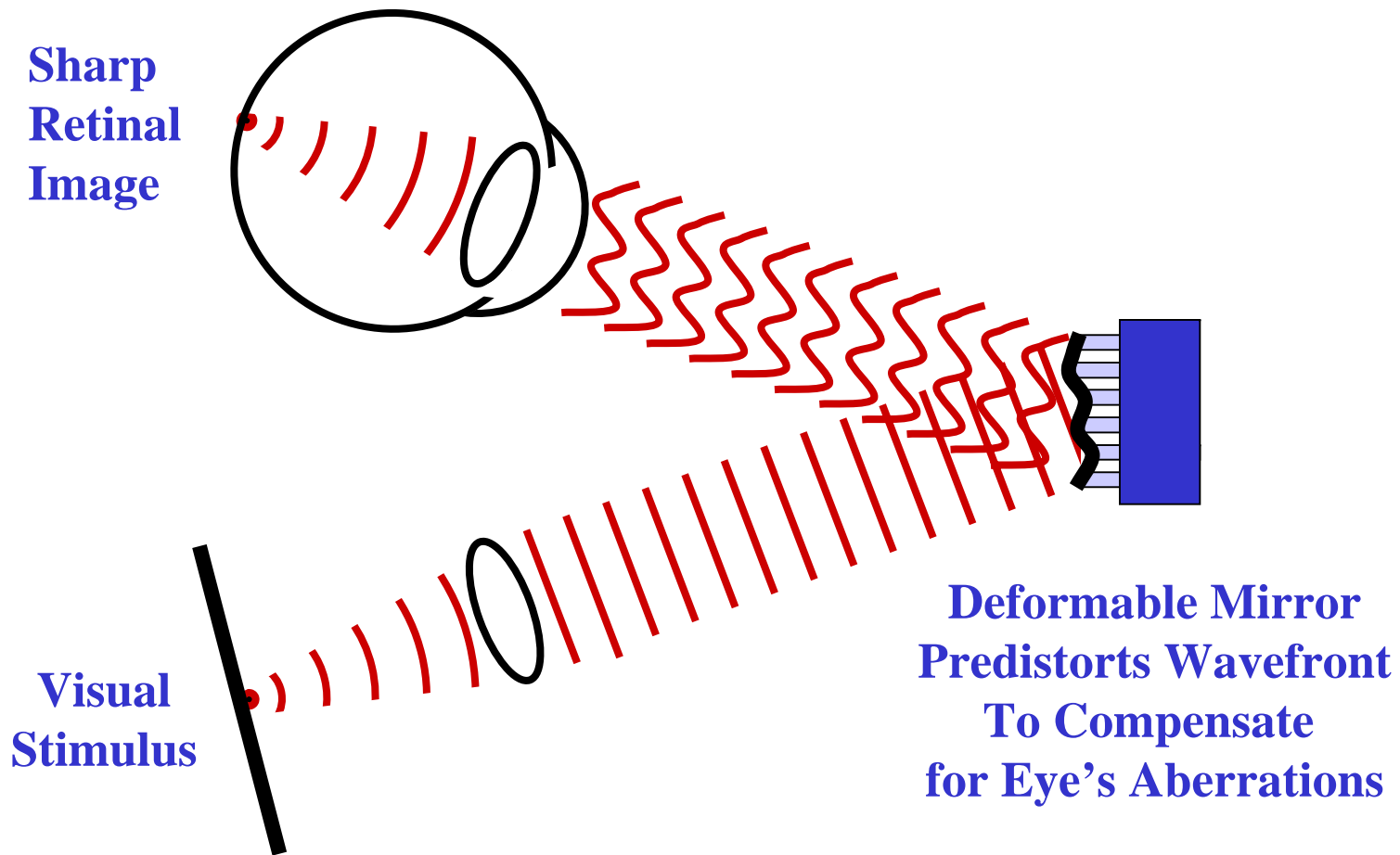
**Subjective image quality does depend on a neural factor**

# **Do these neural factors compensate for the eye's particular pattern of aberrations?**

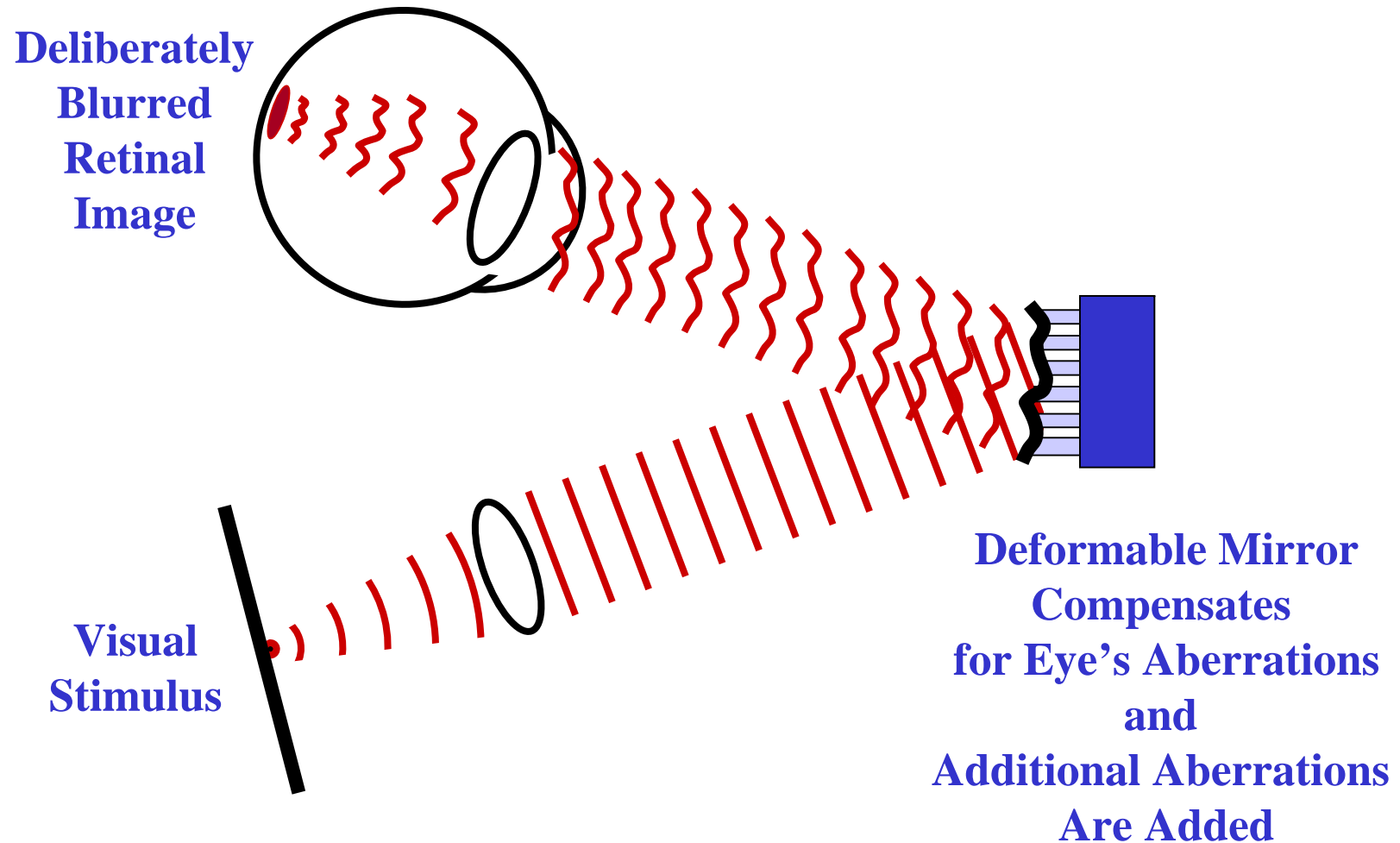
- Higher order aberrations existing in the eye always blur the retinal image.**
- However, our subjective impression is that the visual world is always sharp and clear.**
- This suggests that the brain might partially compensate for their influence.**

**Artal P., Chen L., Fernández E., Singer B., Manzanera S., and Williams D., “Neural compensation for the eye's optical aberrations”, *Journal of Vision*(2004) 4, 281-287.**

# Adaptive Optics Can Compensate for Aberrations



# Adaptive Optics Can Generate Aberrations

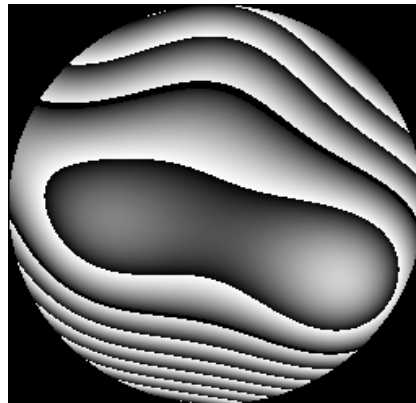


# Wave aberration rotated counterclockwise

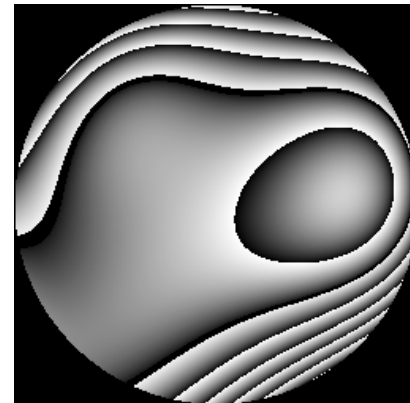
(MC, 6mm pupil)



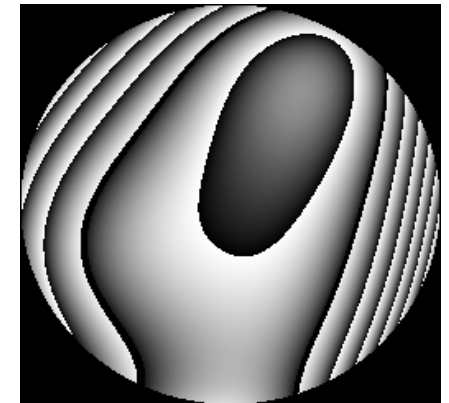
0



45



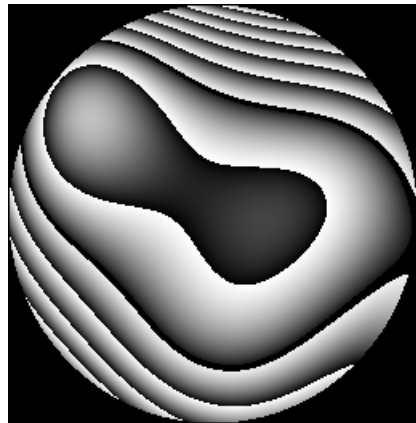
90



135



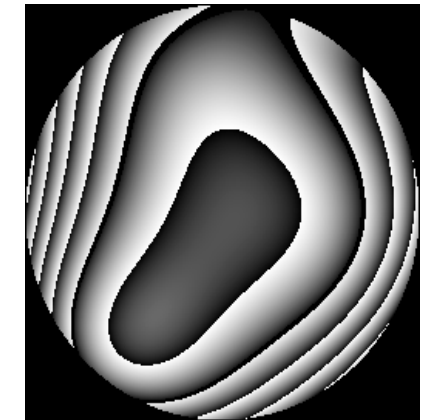
180



225



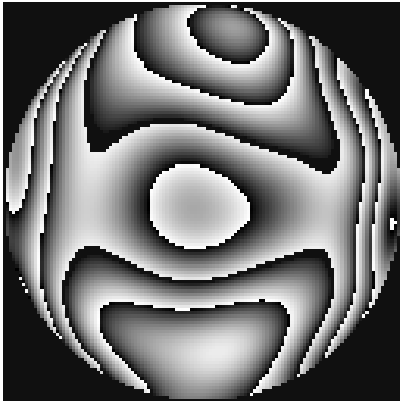
270



315

**This keeps the total amount of aberration constant, but changes the orientation of individual aberrations.**

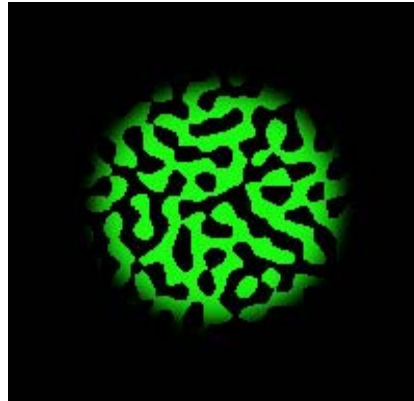
# Method



**Wave Aberration**

**Angle = 0 deg**

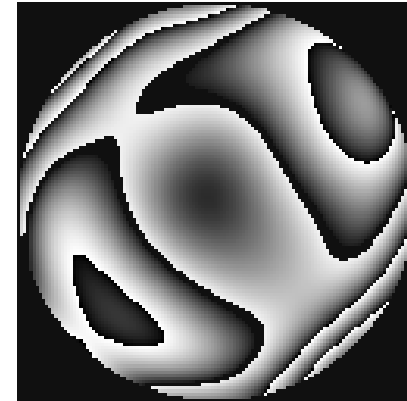
**Factor = 1**



**Stimulus**

**550nm wavelength**

**1 degree FOV**



**Rotated Aberration**

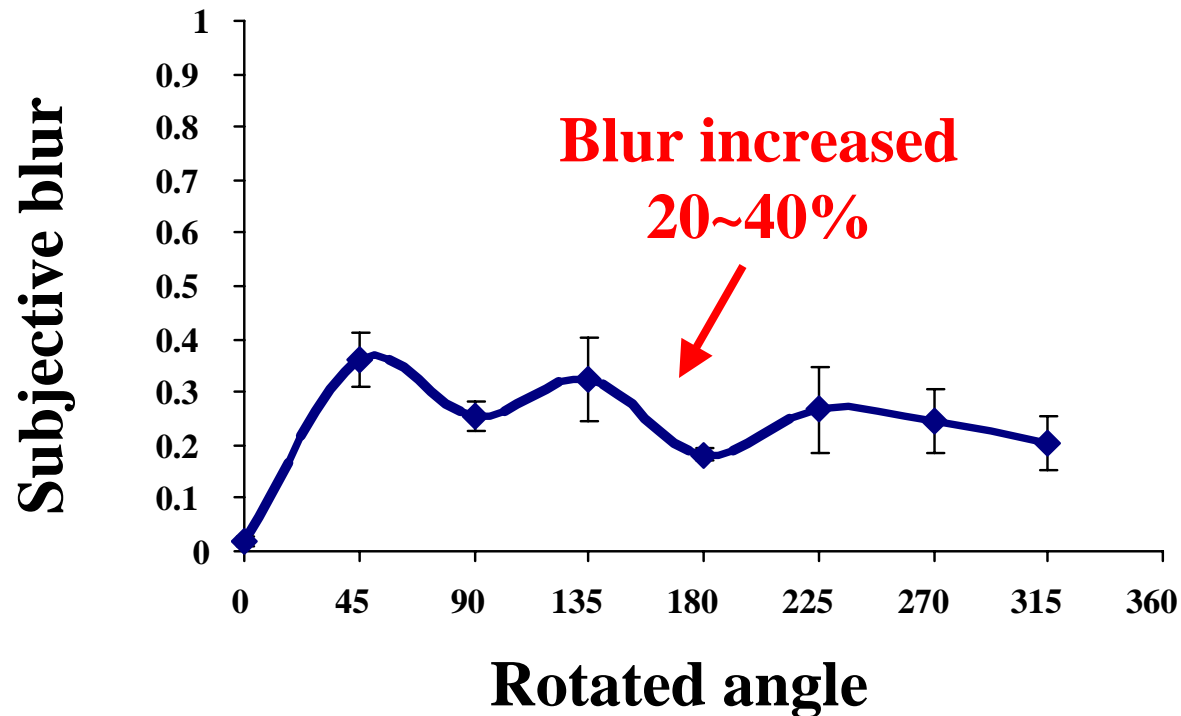
**Angle = 45 deg**

**Factor = 0.6**

scaling factor (F) is proportional to amplitude

Adjust amount of aberration by choosing a factor (F) in the rotated case to match the subjective blur of the stimulus to that seen when the wave aberration is in normal orientation.

# Result

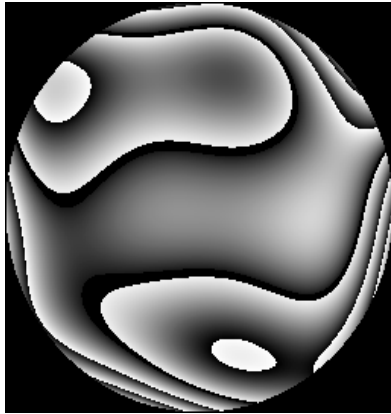


For 4 subjects, when the individual's own aberrations were rotated, the subjective blur of the retinal image increased substantially. This supports the hypothesis that the neural visual system has adapted to its own particular pattern of optical defects.

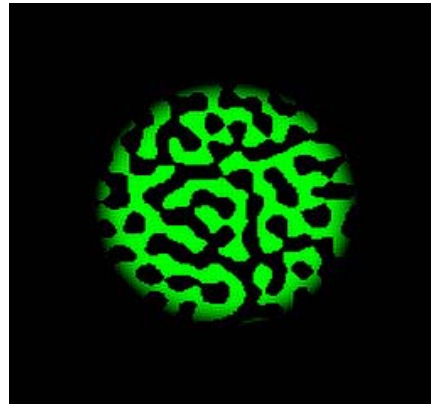
**Does the neural factor modify the best correction?**

**If so, might the best subjective image quality occur when some aberrations are left uncorrected?**

# Subject Adjusts Amount of Defocus to Match the Blur from Scaling Wave Aberration



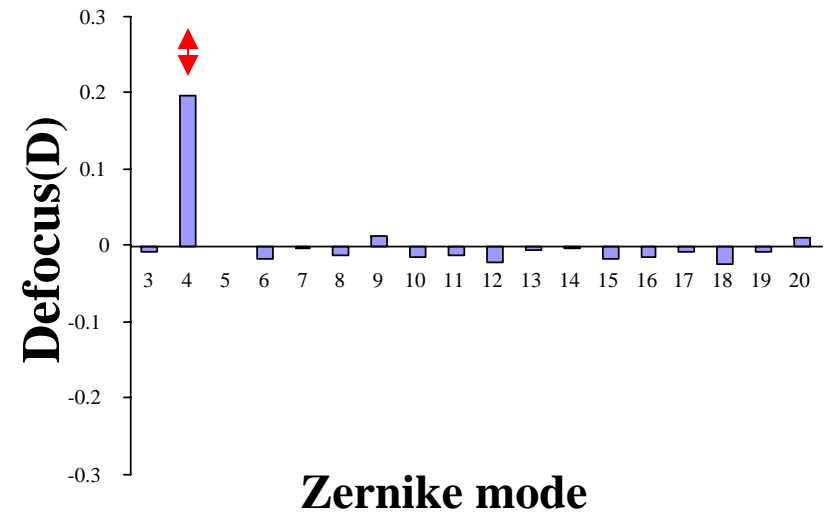
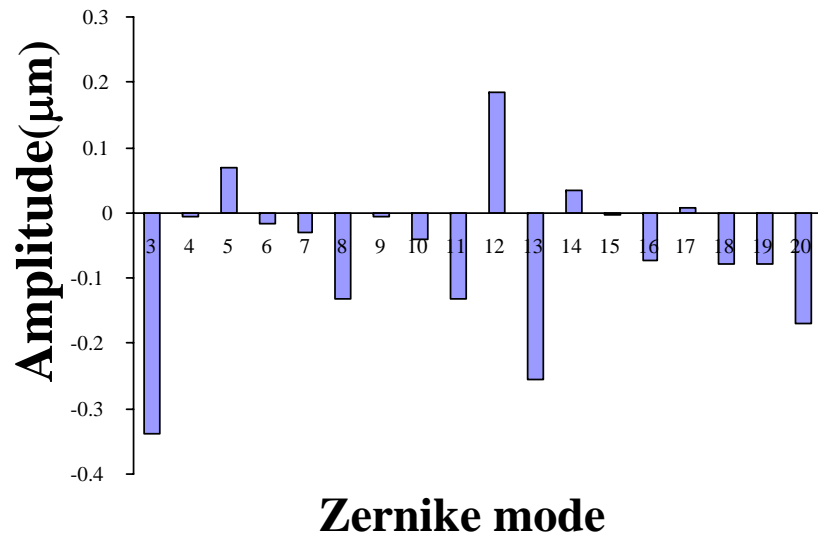
Scaled wave aberration



Stimulus

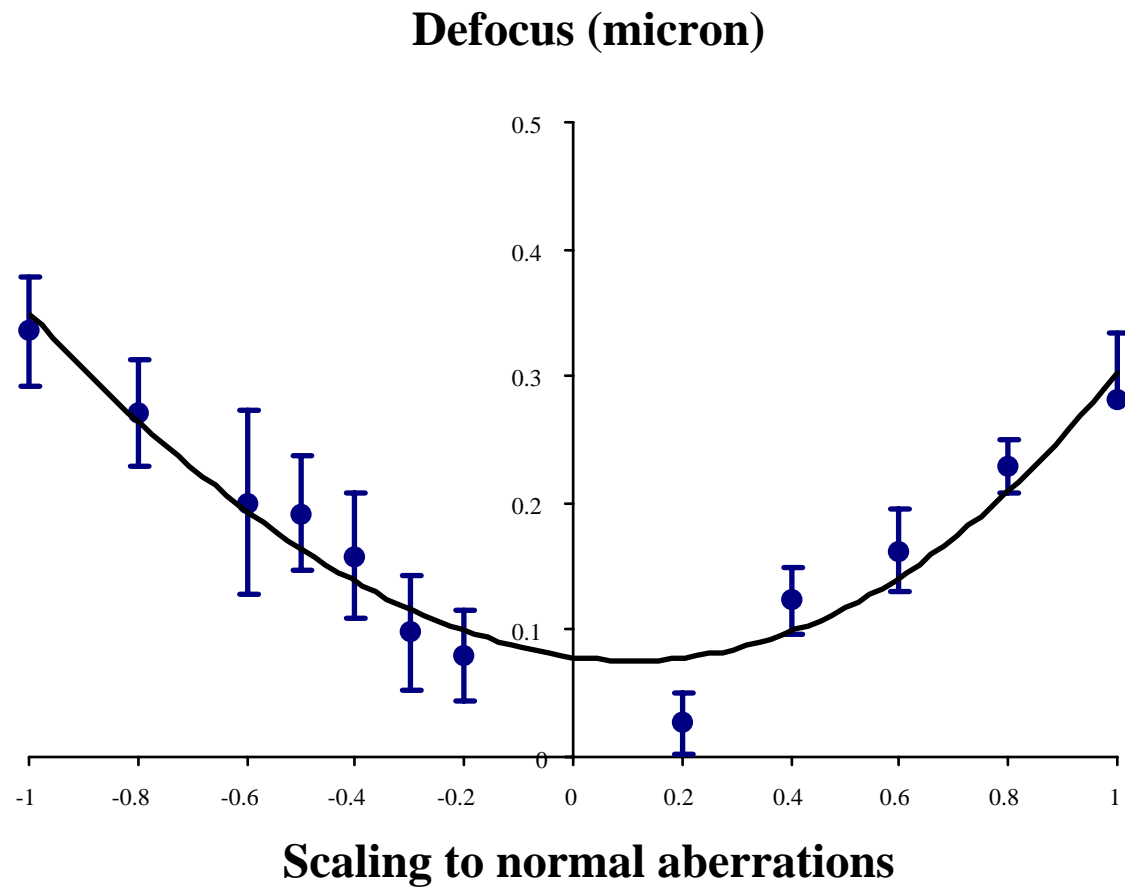


Defocus



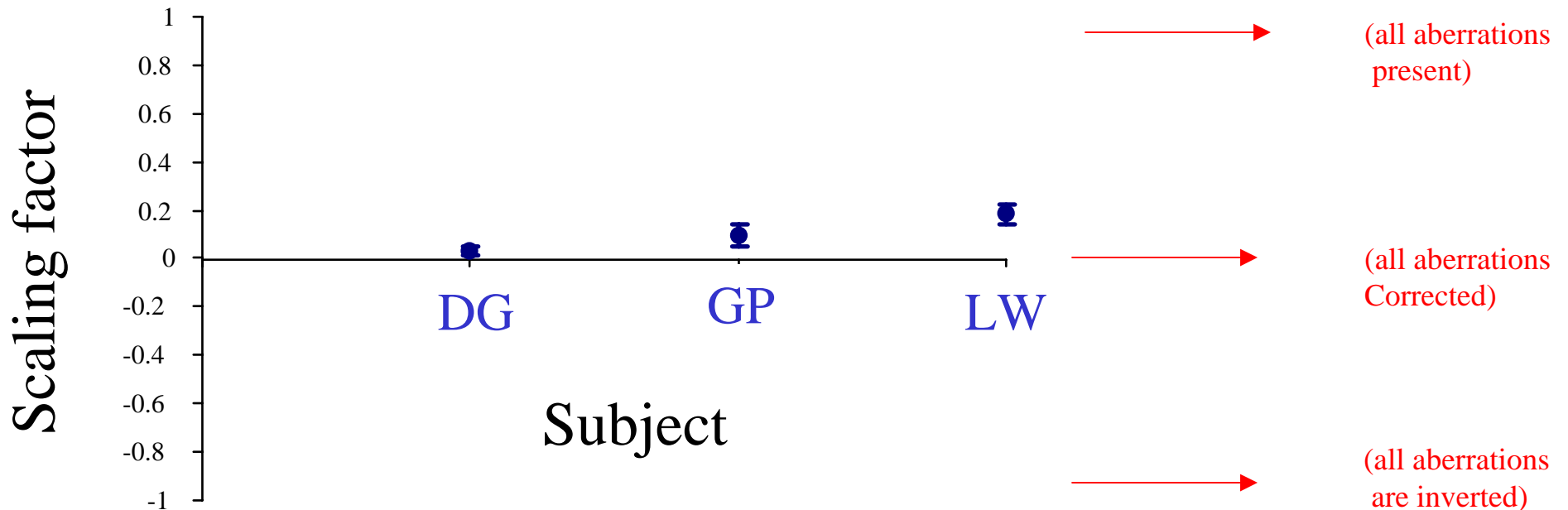
# Blur matching with defocus

(Error bar from 3 subjects' measurements)



# Neural factor does modify the best correction

Subject was asked to adjust scaling factor from -1 to 1, which will change the amplitude of wave aberration, to find where the best image quality is.



# Conclusion

- Adaptive optics can be used not only to correct the eye's wave aberration, but also to generate specific wave aberrations in the eye.
- Psychophysical experiment with AO shows the best subjective image quality occurs when some aberrations are left uncorrected.
- Neural factor does modify the best correction.
- Neural factor may influence the patient's final correction.

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