Axial length is correlated with the photopic pupil diameter in adults

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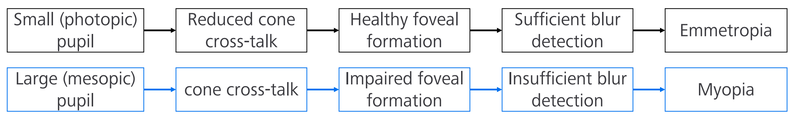
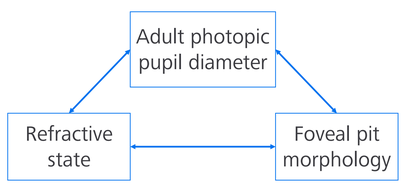
Purpose

It was observed that outdoor activities significantly reduced the onset and progression of myopia.[1,2] A simulation model to explain this observation found that only a photopic pupil sufficiently eliminates any crosstalk between adjacent photoreceptors:[3]



Here, we assess this model by examining a possible relationship between the photopic pupil diameter, the eye's refractive state and foveal parameters in adults with and without myopia:



Methods

Table 1: Study cohort overview. Only dominant eyes (N = 84) were evaluated.

Age	28 ± 8 years
Spherical equivalent (SER)	-1.23 ± 2.31 D [-9.38 to +4.88 D]
Axial length	23.9 ± 1.2 mm [21.0 to 27.0 mm]

Table 2: Used Hardware and measured parameters

TonoRef 3	Non-cycloplegic Obj. Refraction
IOLMaster 700	Axial length
HE High-Res OCT (2 µm/pixel axial)	Foveal pit morphology
DIY Pupil tracker (0.03 mm/pixel)	Photopic pupil diameter at 10,000 lux

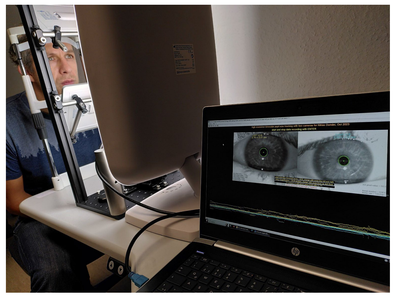


Figure 1: The self-build binocular pupil tracker with day light illumination (TL30 and TL90, Beurer).

Results

Figure 2: The photopic pupil diameter is correlated with axial length, spherical equivalent, and nasal rim height. For an overview of all tested correlations, please scan the QR code for a copy of the correlation matrix. Grey lines in Fig. 2 and 3, or area in Fig. 4 indicate 95% confidence bounds.

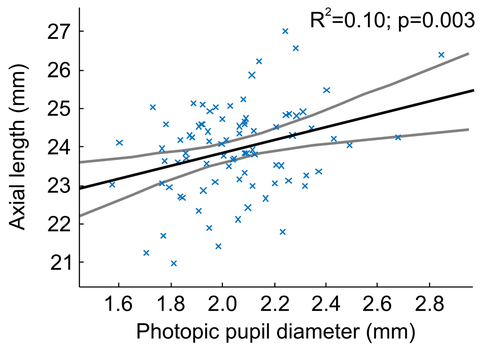


Figure 3: Different correlations between the foveal and optometric measurements evaluated in this study. All plots show raw data. For example, photopic pupil diameter is not corrected for age (see correlation matrix). Even though the p-values show many significant correlations, the low R^2-values demonstrate high residual variability.

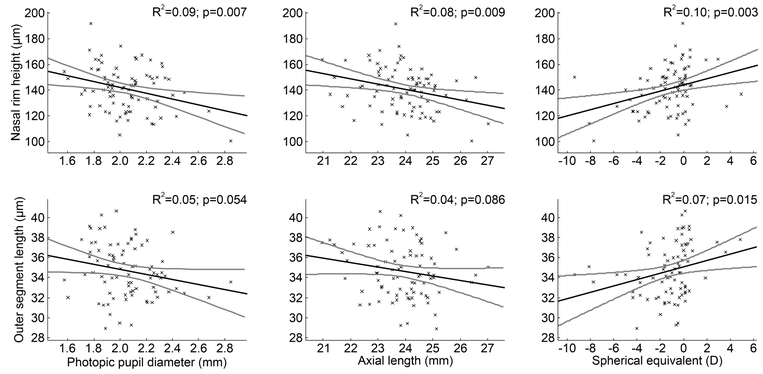
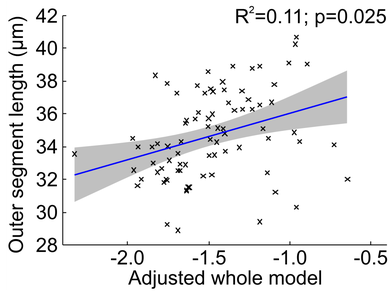
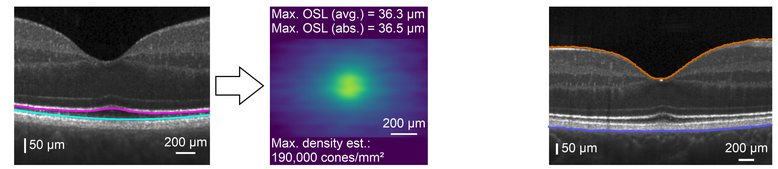


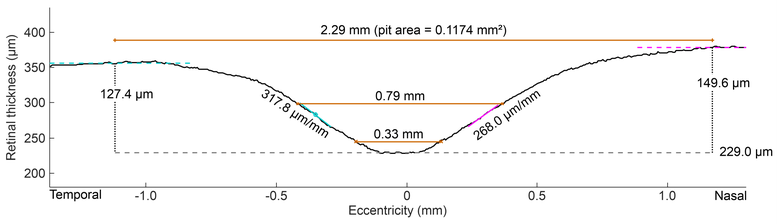
Figure 4: A multi-linear regression model in the form OSL~Pupil*Age+Sex-Age, (including an age dependency for pupil diameter and sex as a variable) slightly reduced the variability observed for the OSL-pupil-relationship. In the next step a more complex model is required to determine any causalities from the observed correlations.

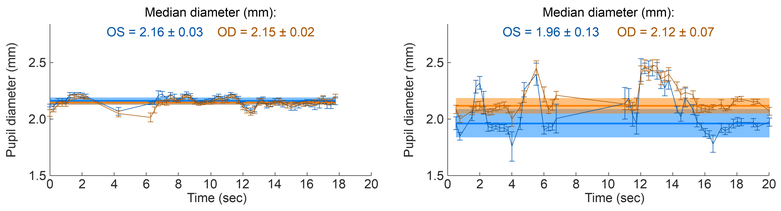


Analysis

Figure 5: OCT B-scans were automatically segmented for the ILM and RPE layers by the instrument algorithm and additionally for the Ellipsoid and Phagosome zone defining the outer segment length by a custom-made algorithm.[4] The photopic pupil diameter was determined as the average out of a 10 to 20 seconds recording (blinks filtered).







Conclusions

The minimal pupil size may play a role for foveal pit formation and emmetropization of the human eye. This supports the model of optimal beam shaping through the photopic pupil.
In a next step, the peripheral retina can be studied to test if the model is equally valid for cones and rods.

References

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