Optical and Biometric Bases of Anisomyopia

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Poster #: 3677/B320

INTRODUCTION

It is now generally accepted that both genetic and enviromental factors play important roles in myopigenesis. As these factors are expected to similarly influence the two eyes of an individual, that the two eyes develop quite different refractive errors in some individuals in the absence of ocular pathology seems paradoxical.

The purpose of the current study was to investigatethe the optical and biometric interocular differences in anisomyopes, with the over-riding goal of obtaining new insight into myopigenesis.

METHODS

Subjects were all student volunteers, aged between 20 and 27 years, divided into 2 groups based on interocular differences in their spherical equivalent refractive error (SERE); exclusion criteria included rigid contact lens wear or previous ocular surgery. All subjects were free of ocular pathology.

Table.1 Subject information summary

	Anisometropic myopes (ANISO)	Isometropes (ISO)
Classification	SERE |OD - OS| > 1.00D	SERE |OD - OS|< 0.75D
SERE ranges	-0.25D ~ -5.25D for less myopic eyes -1.75D ~ -7.00D for more myopic eyes	+0.50D ~ -6.00D
Subject number	10	12

Measurement protocols and parameters measured are summarized in Table.2. The research adhered to the tenets of the Declaration of Helsinki and was approved by the Committee for Protection of Human Subjects of UC Berkeley.

Table.2 Measurement instruments and techniques

Measurements	Derived parameters
Objective refraction (Grand Seiko auto-refractor)	Refractive errors (diopter)
Subjective refraction	Refractive errors (diopter)
Visual acuity (Bailey-Lovie chart)	Best corrected visual acuity (BCVA,logMAR)
A-scan ultrasonography (Mentor Ophthalsonic)	Anterior chamber depth (mm) Lens thickness (mm) Vitreous chamber depth (mm) $
Corneal topography (Carl Zeiss Atlas)	Corneal power (diopter) Corneal asphericity (corneal shape factor)
Aberrometry # (Wavefront Sciences COAS)	Refractive errors (diopter) Higher order aberrations (micron)

$ Optical axial length is derived as the sum of all three components
\# Measured under cycloplegia with 1% topicamide

Aberrations were analyzed using OSA standard Zernike polynomials and a 5 mm pupil size; SERE and astigmatism were derived from the 2nd order Zernike coefficients (Thibos et al,2002). Data analyses included comparisons of interocular differences between the 2 groups using unpaired t-test ($p<0.05$), and interocular correlations, with the significance of correlation coeffcients tested using t-tests, where t-statistic is computed as $t = r\sqrt{(n-2)/(1-r^2)}$.

RESULTS

Refrations derived from aberrometry data are highly correlated with those measured by subjective and objective refraction (subjective, r = 0.983; objective, r = 0.975; OD SERE, see Fig.1; OS data are similar). Aberrometry-derived refraction data are used in other analyses. The ANISO and ISO groups differ significantly in terms of mean interocular differences in SERE, which are 1.62D and 0.22D respectively (Fig. 2a).

For the ANISO group but not the ISO group, there are significant interocular differences in BCVA (Fig. 2b), vitreous chamber depth (Fig. 2c), optical axial length and corneal asphericity (Fig. 2d). Both vitreous chamber depth and optical axial length are negatively correlated with SERE (r = 0.917 and 0.920 respectively, p < 0.01; OD only, Fig. 3a) indicating axial origin of these subjects' myopia (Wildsoet, 1997). BCVA shows a similar relationship with SERE, though much weaker (r = 0.40, p = 0.03; OD only, Fig.3 b). OS data are similar in all cases.

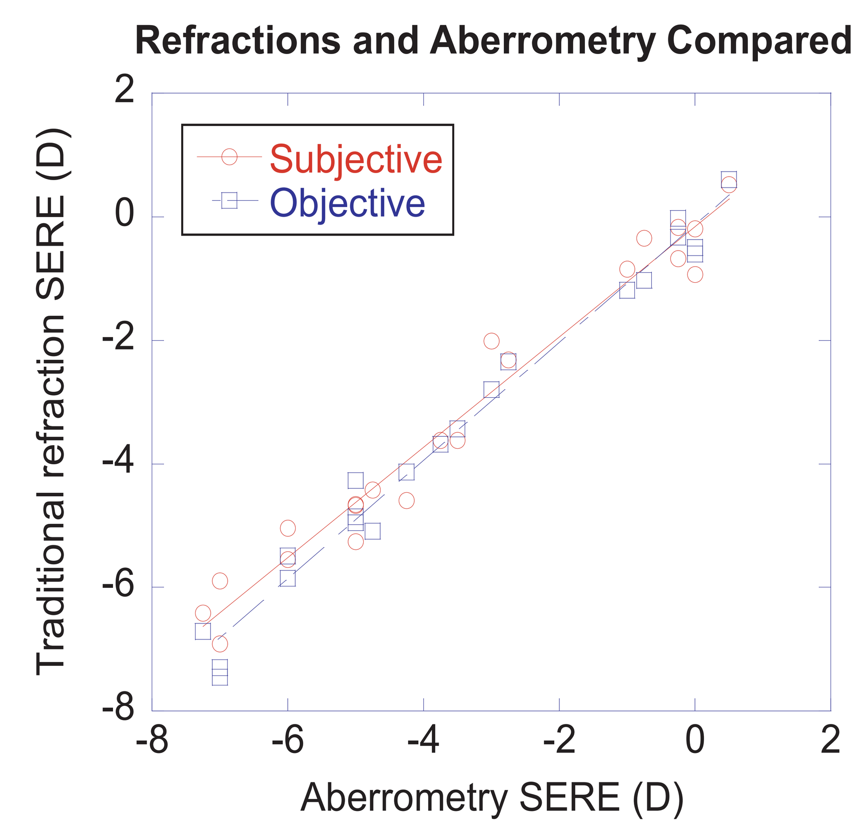

Fig. 1 Subjective and objective refractions plotted against aberrometry-derived refraction (SERE, OD only). Straight lines indicate linear regression results.

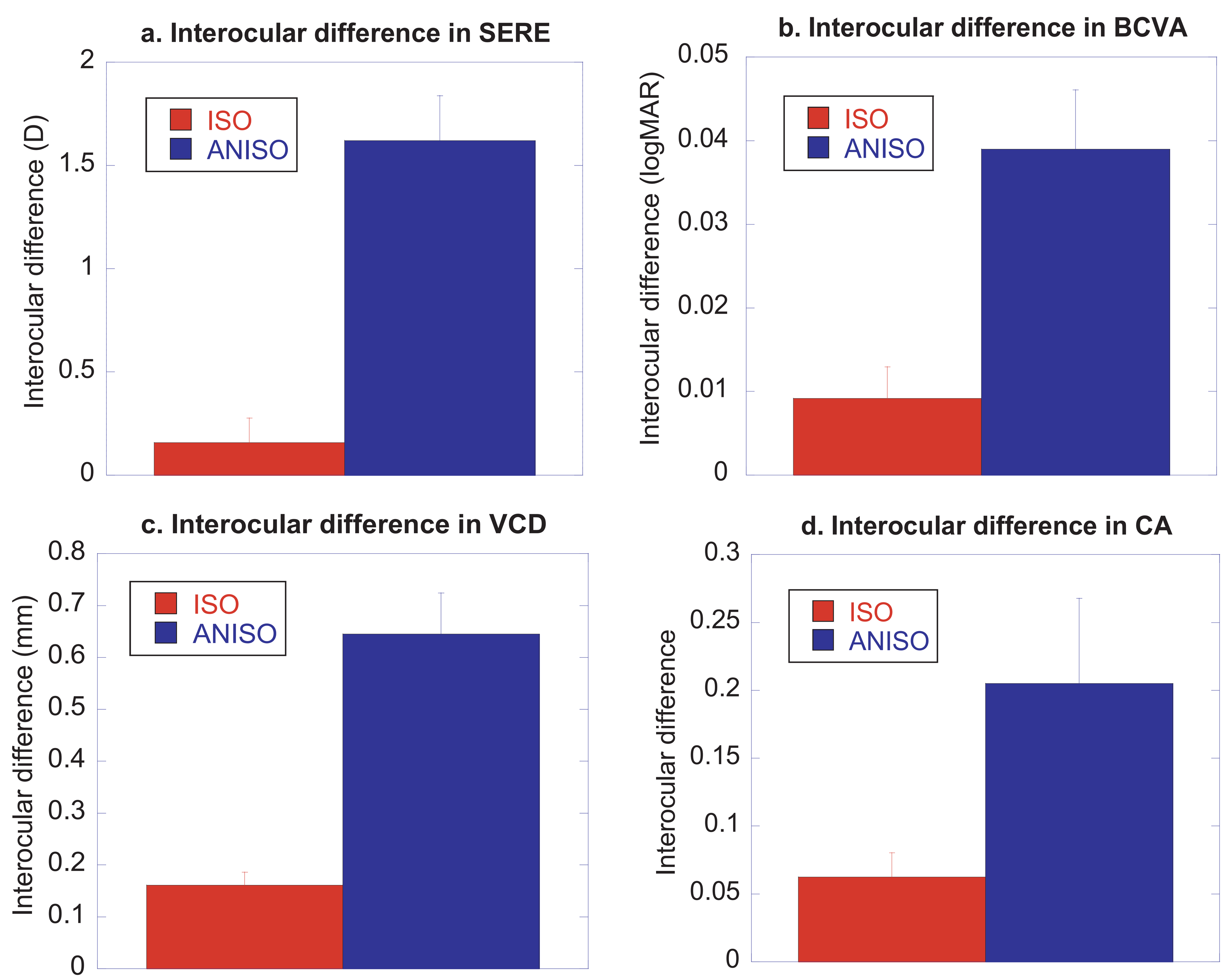

Fig. 2 Interocular differences for anisometropic and isometropic groups: (a) Spherical equivalent refractive errors (SERE). (b) Best-corrected visual acuity (BCVA in logMAR). (c) Vitreous chamber depth (VCD). (d) Corneal asphericity (CA). Error bars are standard errors. Optical axial length (not shown) and vitreous chamber depth data show similar trends.

Neither group shows significant interocular differences in coma, spherical aberration, 3rd order, 4th order, 5th order and total 3rd to 5th order higher order aberrations. However, spherical aberration and SERE are negatively correlated (r = -0.48, p = 0.016; OD only, Fig. 3c); OS data are similar, i.e. higher myopia is associated with more positive spherical aberration. This result contrasts with the shift towards more negative spherical aberration with increasing accommodation, which renders eyes artificially myopic (Atchison et al, 1995).

In the ISO group, both corneal asphericity and spherical aberration show strong positive interocular correlations (r = 0.81 and 0.67 respectively, p <0.01), and coma (c[3,1]) shows a strong negative interocular correlation (r = -0.63, p = 0.01). In contrast, these correlations were weak and not statistically significant for the ANISO group (r = 0.32, 0.37 and -0.44 respectively, p > 0.1).

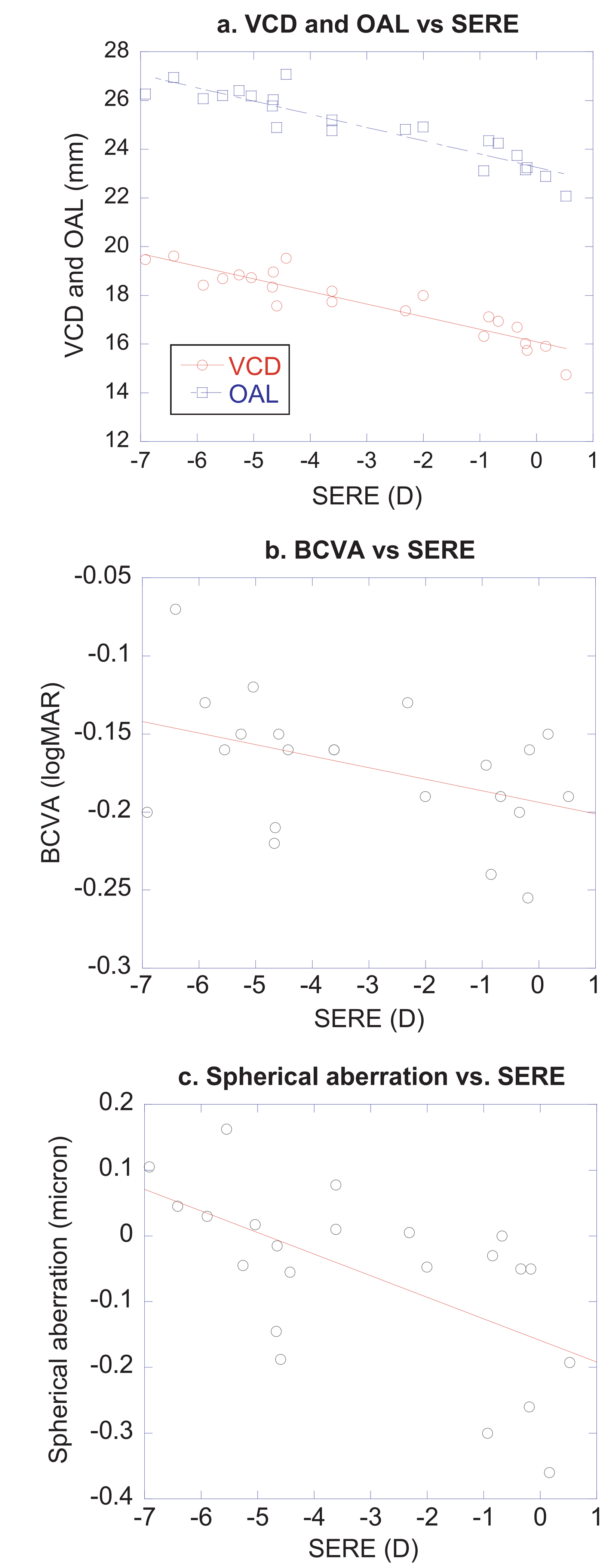

Fig. 3 Parameters correlated with spherical equivalent refractive error (SERE) (OD data only): (a) Vitreous chamber depth (VCD) and optical axial length (OAL). (b) Best-corrected visual acuity (BCVA). (c) Spherical aberration. OS data are similar.

DISCUSSION

The data confirmed the axial nature of both refractives errors and anisomyopia. The reduced BCVA in more myopic eyes is most likely the result, not the cause of myopia, i.e. a complication of increased eye elongation. However, the origins of the larger interocular differences in corneal asphericity in the ANISO group compared to the ISO group, and the weak interocular correlations for spherical aberration and coma in the ANISO group are less clear. The possibility that such differences may have contributed to myopization warrants further investigation.

ACKNOWLEDGEMENTS

We thank Nina Tran for her help in data collection. Supported by NEI grant to CFW (R01 EY12392), University of California Regents Graduate Fellowship to YT and NEI grant to JT (T32 EY070043).

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