Ocular Profile and Optical Quality in Anisomyopia

A thesis presented to the graduate faculty of
the New England College of Optometry in partial fulfillment
of the requirements for the degree of Master of Science.

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March 2020

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This manuscript has been read and accepted by the Thesis Examination committee in satisfaction of the thesis requirement for the Degree of Master of Science.

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ABSTRACT

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New England College of Optometry, 2020

Purpose: Understanding anisomyopia, or why one eye elongates faster than the other during childhood, may bring light to important questions on the development of myopia. Studying anisomyopia also has the advantage of eliminating potential inter-individual confounding factors. In this work, various optical, biometric and structural factors in anisomyopia are evaluated.

Methods: A total of 23 subjects (24.4 ± 2.11 years old) with anisomyopia (difference > 0.875D) were recruited. The subjects' more myopic (MM) and less myopic (LM) eyes were compared in a number of studies. On-axis and peripheral measurements were taken for each of the following tests: (1) measures of retinal thickness across the central 56 degrees obtained with a SD-OCT, (2) axial length (AXL) measures obtained across the central 40 degrees with a Lenstar LS900, and retinal shape computed with fitted conic functions, (3) optical quality (optical aberrations computed as VSOTF, visual Strehl of the optical modulation transfer function) were obtained across the central 50 degrees with a scanning Hartmann-Shack wavefront aberrometer; (4) the same device was used to obtain accommodation responses to targets at 4m, 50cm and for dark focus (tonic accommodation, TA). Matlab was used for processing the VSOTF and fitting the AXL data to determine ocular shape. SPSS and R were used for statistical analyses.

Results: As expected, temporal retinae were thinner with increasing on-axis AXL in both the MM ($p<0.05$, $r^2=0.33$) and LM ($p<0.05$, $r^2=0.22$) eyes. Nasal retinae were also thinner with increasing AXL, but only for the LM eyes ($p<0.01$, $r^2=0.54$). T-test comparisons revealed no differences in retinal thickness at any location between the MM and LM fellow eyes (all $p>0.05$). Not surprisingly, AXL was significantly shorter at more peripheral eccentricities ($F=13.312$, $p<0.01$). However, there was no effect of eye and eccentricity on the AXL values, indicating the differences in peripheral AXL depend more on on-axis AXL than differences between MM and LM eyes. Also, within the range of AXL tested, longer eyes did not show differences in posterior retina asphericity (Welch statistic 0.102, $p=0.752$) or curvature (Welch statistic 1.286, $p=0.267$). Likewise, there was no significant change in optical quality (VSOTF) across the central 50 degrees tested, which may be explained by the large interindividual variability observed. However, on-axis AXL did predict optical quality in both the MM ($p<0.05$, $r=-0.509$) and LM ($p<0.05$, $r=-0.498$) eyes, with longer eyes showing poorer optics.

No effect of eccentricity was found on the accommodation responses across the 40 degrees tested. Eccentricity did have a significant effect on dark focus TA responses ($F=6.026$, $p<0.001$), with no differences between the MM and LM eyes. When analyzed separately, only the MM eyes showed a significant effect of eccentricity on TA ($F=4.940$, $p<0.001$) with larger TA responses temporally than nasally. Although there was no effect of eccentricity on the amount of Spherical Aberration (SA) ($F=1.499$, $p=0.185$) during the accommodative response, on-axis SA values were significantly more positive during accommodation in both the MM ($p<0.05$, $r=0.676$) and LM ($p<0.05$, $r=0.578$) eyes. On the other hand, there was a significant positive effect of eccentricity on SA during the TA state for the MM eyes only ($F=3.464$, $p<0.01$). Interestingly, the LM eyes showed a significant correlation of on-axis SA and TA values ($r=0.549$, $p<0.05$) with higher on-axis SA correlated with higher TA values.

Conclusions: Temporal retinae were more thinned in longer eyes than nasal retinae, but no thickness differences were found between the fellow eyes of each subject in this study. This indicates the thinning is associated to on-axis AXL but not the anisomyopia. Both the MM and LM eyes showed shorter AXL with increasing eccentricity, however, differences in peripheral AXL depended more on on-axis AXL than differences between fellow eyes. Also, within the range of AXL tested, longer eyes did not show differences in posterior retina asphericity or curvature. Likewise, optical quality (VSOTF) did not vary with eccentricity across the central 50 degrees tested, but longer eyes showed poorer optics. Overall, these results indicate that none of these three factors (retinal thickness, ocular shape, and optical quality) are likely to be associated with myopia development.

Similarly, there was no effect of eccentricity on the accommodative response in either the MM or LM eyes of anisomyopes. However, there was an effect of eccentricity on the TA responses; in the MM eyes, peripheral eccentricities showed larger TA values, more so temporally. This result could be associated with differences in accommodation effort during near work between the fellow eyes. However, since on-axis AXL showed a negative effect on TA in all eyes, this result is more likely a consequence of the ocular shape. SA did not change differently across the central 50 degrees during accommodation, but on-axis SA values were more positive during accommodation in all eyes. SA did vary across eccentricities during the TA state in the MM eyes, with increasingly more positive SA values temporally. In the LM eyes higher on-axis SA correlated with higher TA values. The potential implications of all these results in myopia development are discussed.

Acknowledgments

I would like to extend a sincere thank you to Dr. Fuensanta Vera-Diaz for her constant support and guidance while I completed my MS. I am very thankful for her mentorship and to have had her as my thesis advisor. I would also like to thank Dr. Nancy Coletta for her invaluable aid while I completed the OCT portion of my thesis. You both have taught me a lot and I will always be grateful for this.

Additionally, I would like to thank Dr. Christopher Taylor and Dr. Anthony Guarino for their help with statistics, as well as Dr. Ji He for his help in computing the VSOTF data. I want to also thank Dr. Jane Gwiazda for being patient with me and always answering any technical questions I had about the MS program, and Dr. Kristen Kerber and Dr. Peter Bex for agreeing to be members of my thesis committee.

I would like to thank the entire Voptica team for their help with aberrometer maintenance, and Dr. Carles Otero for his help with part of the aberrometer data exporting. Finally, I want to thank my classmate and fellow MS student Gabriella Velonias for the moral and spiritual support that she provided during these 3 years.

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1. General Introduction

Myopia, or nearsightedness, is a condition characterized by an eye that has too much power for its length as a consequence of excessive axial elongation. Due to this excessive length, light coming from distant objects focuses in front of the retina, resulting in defocus blur. Importantly, as the eye lengthens, the retina stretches out [1–3], which increases the risk of sight-threatening conditions such as myopic maculopathy, retinal tears and detachments as well as primary open angle glaucoma. Myopia has become in the past decade a global epidemic that causes reduced quality of life, productivity, and increased risk of visual impairment [4–6].

The specific mechanisms whereby a child's eye continues to grow beyond emmetropia and becomes too long are not yet understood. However, it is widely agreed that myopia is the result of a failure to correctly emmetropize during childhood, and that this failure occurs via a visually-guided process [7–11]. During the normal emmetropization process in childhood, certain components of the retinal image quality provide feedback signals to guide eye growth. If these signals are abnormal or not available (e.g. due to poor image quality caused by optical blur), or they cannot correctly be used, the result is that the child's eye continues to grow [7]. Previous studies have indicated that the image quality across the entire retina, not just at the fovea, may be important to provide such emmetropization signals [11–13]. Based on evidence from animal models [7,12], we propose that an integration of signals within the central 20 to 40 degrees diameter is likely used during emmetropization. It is therefore important in studies of myopia to evaluate retinal image quality not only centrally, but across the periphery as well [11,14,15].

Optical blur associated with the eye's decreased optical quality deteriorates the retinal image quality and may therefore impact the normal growth of a child's eye. Higher order aberrations such as coma or spherical aberration (SA) vary across the periphery [16,17]. However, studies comparing peripheral aberrations in emmetropic and myopic eyes have found conflicting results. Mathur et al. [18] showed that coma and SA varied across the periphery, with SA showing a weaker change compared to coma. They found that in myopes, coma increased more rapidly with eccentricity compared to emmetropes, and that myopes showed a slight negative shift in SA with eccentricity. Osuagwu et al. [16] on the other hand found that SA and coma did not change differently across the periphery in myopic and emmetropic eyes, but did indicate that their SA findings trended towards the same direction as those of Mathur et al.

Accommodation also regulates the quality of the retinal image. Accommodation may be elicited not only by foveal blur, but also by blur in the near-peripheral retina [19–21]. Previous studies have shown that when emmetropic eyes accommodate, there is an increase in the normal amount of relative peripheral myopia, however in eyes with myopia, accommodation only elicits a small change in relative peripheral refraction [22]. An integration of central and peripheral blur signals may be more significant during near work, when there is a larger range of dioptric blur across the retina [23]. These data together indicate that eyes with myopia may be exposed to different central and peripheral blur signals than emmetropic eyes [22,24].

While the development and progression of myopia have been major research topics for decades, there are a lack of studies investigating anisomyopia, a condition characterized by a difference in myopic refractive error between the two eyes due to a difference in axial length [1,25]. It has been suggested that the greater the disruption to the emmetropization process, the more likely that myopia may progress at different rates between the two eyes [26]. Interestingly, any kind of refractive error earlier in childhood may increase the chance of anisometropia development later on [27]. Studies have shown that anisomyopia tends to increase with the child's age, as myopia increases. Deng and Gwiazda [27] found that the amount of anisomyopia specifically increases between the ages of 5 and 15 years. Similar results were found by Tong et al. [28] who found that subjects with anisomyopia tended to progress towards more myopic refractive errors, suggesting a connection between anisometropia and myopia progression.

Parsinnen [26] also found that more myopic children tended to show greater chances of progression towards anisometropia. Overall, the increase in anisomyopia eventually stabilizes as myopia progression stabilizes [29].

There is no clear understanding of why myopia progresses faster in one eye than the other. It is possible that near work may have a greater effect on elongation in the more myopic (MM) eye compared to the fellow less myopic (LM) eye [1]. Another explanation may be that abnormal visual input, of yet unknown origin, in one eye may result in more axial elongation in that eye, something that has been demonstrated in animal studies [30,31]. The field of anisomyopia has many unanswered questions. Yet, understanding anisomyopia would bring light to important questions on myopia development. If we can understand why one eye elongates faster than the other, we could answer many important questions on the etiology of childhood myopia. Studies on anisomyopia also have advantages in that they eliminate potential inter-individual confounding factors since the two eyes of the same individual are compared [1]. In this study, optical, biometric, functional and structural parameters in anisomyopia are evaluated.

2. General Methodology

2.1. Subjects

Subjects with anisomyopia (n=26) were recruited from the New England College of Optometry student population (**Table 2.1**). Of the initial 26 candidates, 23 subjects (87% female) met the inclusion criteria and participated in the study. The age range was 22-31 years, with a mean age of 24.40±2.11 years. The spherical equivalent (SE) refraction, based on binocular subjective refraction as described below, ranged from -0.13D to -11.38D (mean -5.07±3.29D) in the right eye, and -0.25D to -9.63D (mean -4.46±2.65D) in the left eye. Anisometropic SE differences between the two eyes ranged from 0.88D to 4.75D (mean 1.75±0.94D) (**Table 2.1**).

The inclusion criteria that subjects adhered to are as follows:

- 18-32 years of age.
- SE within +0.50DS and -12.00DS in each eye.
- No more than 3.00D of astigmatism in either eye.
- At least 0.875D (SE) of anisometropia, as determined by best binocular subjective refraction.
- Best-corrected distance LogMAR visual acuity (VA) = 0.0 (20/20 equivalent) or better in each eye.
- No history of amblyopia, binocular vision abnormalities, ocular surgery or diseases that may have resulted in visual consequences.
- No nystagmus or restricted movement of either eye.
- No current use of drugs that may affect vision.
- No use of RGP lenses at least 30 days prior to the study.
- No long-term previous or recent use of Ortho-K.
- No history of refractive surgery.

The study followed the tenets of the Declaration of Helsinki. Informed consent was obtained from all subjects after they were fully informed about the nature of the measurements and the different devices used.

2.2. Vision Screening

Subjects who responded to the recruitment email and had differences in habitual refraction SE between the two eyes of 0.875D (SE) or greater were scheduled for a vision screening, as described below:

1. Explain study and sign Informed Consent.
2. Ocular and relevant Health History.
3. Distance and near VA with habitual eyeglasses correction:
    a. Distance logMAR acuity was measured with a computerized PVAT chart (Precision Vision, https://www.precision-vision.com/).
    b. Near logMAR acuity was measured with the NECO letters near card.
4. Estimated distance and near cover test with habitual glasses.
5. Motor dominance test (with habitual glasses) using a cardboard with a hole.
6. Autorefraction using a Grand Seiko WAM 5500 open field Autorefractor (Shigiya™, http://grandseiko.com/en/)
7. Subjective refraction through a phoropter followed by a binocular balance.
8. Sensory ocular dominance with a +1.50D loose lens to determine over which eye did the lens make the target letters blurrier.
9. Slit lamp evaluation of the cornea, lens and vitreous to rule out any media opacities.

If subjects met all inclusion criteria following the vision screening, they were deemed eligible and performed the experimental testing described in Chapters 3, 4 and 5 below. Subjects' eyes were divided into the more myopic (MM) and less myopic (LM) eyes for data analyses. Experimental testing was performed in a single visit that lasted up to 3 hours. Occasionally subjects were asked to return for a second visit. Subjects that needed distance vision correction and didn't wear accurate contact lens correction were provided with soft contact lenses for those experimental tests that required contact lens correction.

2.3. Data Collection and Preliminary Analyses

Data were obtained with three devices that measure various ocular parameters. A Lenstar LS900 (Haag Streit, https://www.haag-streit.com/haag-streit-usa/) was used to take central and peripheral (±20 degrees) biometric measures, including axial length (AXL). Retinal thickness across the central 56 degrees were evaluated with a spectral domain optical coherence tomographer (SD-OCT) (OptoVue, https://www.optovue.com/oct). Optical quality was assessed with a scanning Hartmann-Shack wavefront aberrometer (voptica.com). Data from each instrument were processed using excel and MatLab (MathWorks®). Statistical analyses were performed with R (https://www.r-project.org/) and SPSS (www.ibm.com/analytics/spss-statistics-software). The specific statistical tests used are described in each chapter. Subjects were corrected with soft contact lenses for their distance subjective refraction, within ±0.25D, for all aberrometer measurements.

Ocular dominance (both sensory and motor) matched the LM eye in 16 of the 23 subjects. The amount of anisomyopia (SE) in Diopters and the difference in AXL in mm for each subject revealed a significant and high positive correlation ($r=0.934$, $p<0.001$), showing that as the difference in AXL between the two eyes increases, so does the amount of anisomyopia (**Figure 2.1)**. Furthermore, t-tests comparing the amount of anisomyopia in diopters and the differences in AXL in mm within each subject revealed no differences between these two parameters (t=4.95, p<0.001). The correlation was also found when subjects were separated into those of Asian (r=0.970, p<0.005) and Caucasian (r=0.977, p<0.05) origin. The amount of anisomyopia present was higher in the Caucasian group (1.76D) than in the Asian group (1.54D). Further analyses were not done by ethnic sub-groups as there would be insufficient power.

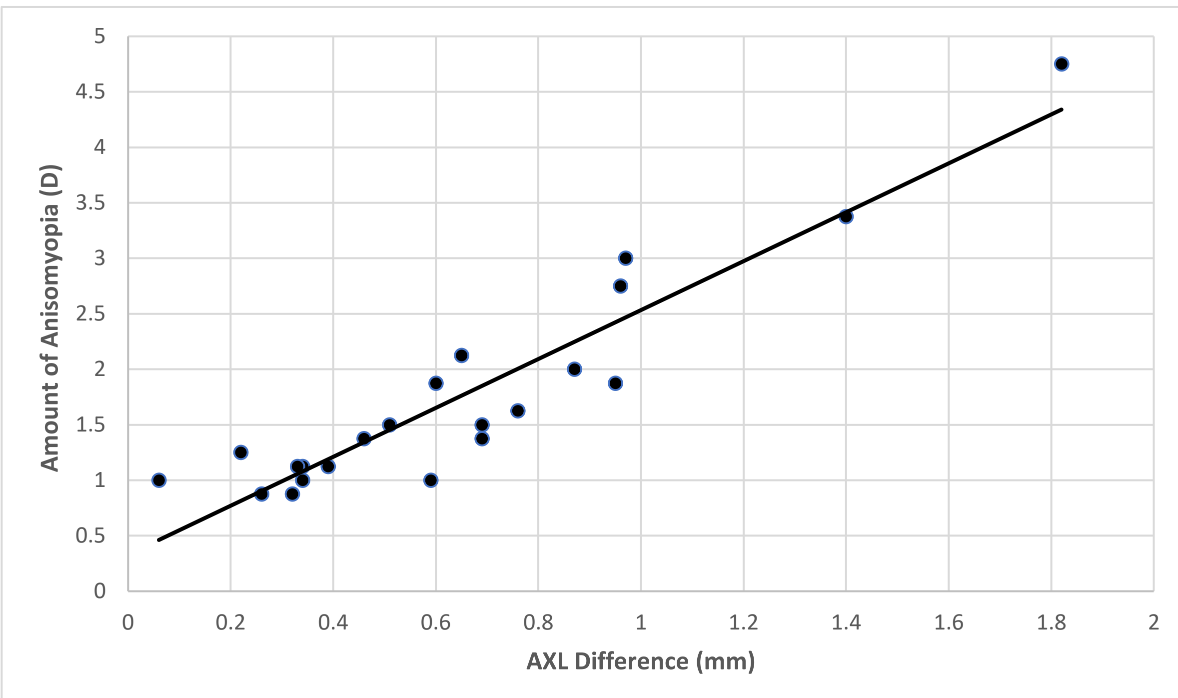


Figure 2.1. Change in AXL vs amount of anisomyopia. Removing the 2 outliers to the right maintains the same relationship between these two factors (r=0.826, p<0.001).

ID	Age	Ethnicity	Sex	Subjective Refraction with Binocular Balance								SE Diff	Sens Dom	Motor Dom
				OD				OS						
				SPH	CYL	AXIS	SE	SPH	CYL	AXIS	SE			
ANI001	24	Caucasian	M	-10.25	2.25	180	-11.38	-6.25	0.75	175	-6.63	4.75	OS	OS
ANI002	24	Caucasian	F	-4.75			-4.75	-2.75			-2.75	2.00	OD	OD
ANI003	26	Caucasian	F	-8.75	0.50	010	-9.00	-7.25	0.50	155	-7.50	1.50	OD	OS
ANI004	23	Indian	M	-10.25	2.25	013	-11.38	-8.50	2.25	172	-9.63	1.75	OS	OS
ANI005	22	Asian	F	-3.00	2.50	177	-4.25	-2.25	1.75	005	-3.13	1.13	OS	OS
ANI006	25	Asian	F	-7.75			-7.75	-6.75	0.25	070	-6.88	0.88	OD	OD
ANI007	23	Indian	F	0.25	0.75	120	-0.13	-1.50	0.50	048	-1.75	1.63	OD	OD
ANI008	23	Asian	F	-2.25	0.50	175	-2.50	-3.00	1.50	180	-3.75	1.25	OD	OD
ANI009	25	Caucasian	F	-2.25	2.25	015	-3.38	-4.25	1.00	140	-4.75	1.38	OS	OS
ANI010	26	Caucasian	F	-7.25			-7.25	-8.75			-8.75	1.50	OS	OD
ANI011	24	Asian	F	-3.00	0.25	070	-3.13	-2.00	0.25	070	-2.13	1.00	OS	OD
ANI012	31	Asian	M	-5.75	2.00	010	-6.75	-7.00	1.75	170	-7.88	1.13	OD	OS
ANI013	25	Asian	F	-5.00	2.25	025	-6.13	-2.00	2.75	180	-3.38	2.75	OD	OD
ANI014	28	Indian	F	-3.50	0.50	175	-3.75	-1.50	0.75	180	-1.88	1.88	OS	OD
ANI015	25	Asian	F	-0.75	1.25	015	-1.38	-1.50	1.75	170	-2.38	1.00	OD	OD
ANI016	25	Hispanic	F	-7.50	0.75	018	-7.88	-4.75	2.50	173	-6.00	1.88	OD	OD
ANI017	22	Asian	F	0.25	2.50	180	-1.00	-1.50	1.75	180	-2.38	1.38	OD	OD
ANI018	23	Caucasian	F	-1.25			-1.25	-0.25			-0.25	1.00	OS	OS
ANI019	24	Asian	F	-3.25	0.75	125	-3.63	0.25	1.00	055	-0.25	3.38	OD	OS
ANI020	23	Caucasian	F	-3.25	0.75	150	-3.63	-4.50			-4.50	0.88	OS	OD
ANI021	25	Middle Eastern	F	-0.75	0.50	165	-1.00	-3.75	0.50	015	-4.00	3.00	OD	OD
ANI022	23	Hispanic	F	-8.00	0.25	110	-8.13	-5.75	0.50	015	-6.00	2.13	OS	OS
ANI023	22	Caucasian	F	-7.00	0.25	010	-7.13	-6.00			-6.00	1.13	OD	OD

Table 2.1. Demographic information for all subjects who enrolled in the study. SE = Spherical Equivalent, DOM = Dominance. SE values are in diopters.

3. Retinal Profiles and Thickness in Anisomyopia

3.1. Background

For most eyes with moderate and high myopia the ocular globe expands in a prolate (sausage-like) shape [32,33]. This results in retinas that are peripherally steeper in myopic compared to emmetropic eyes [33]. This trend is noted even between different amounts of myopia, with higher myopia exhibiting steeper and more prolate (less oblate) retinas [33]. As a consequence of this elongation the retina stretches and thins out in these eyes [3,33–35]. The parafovea and near peripheral retina (up to 15 degrees) seem to exhibit more stretching than the foveal area [36,37]. Previous studies have noted asymmetries between the nasal and temporal retina in myopia, with more stretching nasally than temporally [25,32].

Retinal thickness has previously been measured in myopic individuals. Most studies have found that foveal thickness either increases with AXL or doesn't significantly change [38–40]. There is limited research on retinal thickness at other eccentricities. In a study by Teberik and Kaya [38], both the temporal and nasal retina, at 1000 and 1500 microns from the fovea, were found to be thinner in high myopia compared to emmetropia. This finding is further supported by Jonas et al. [41] who found that the equatorial and pre-equatorial regions were thinner, both nasally and temporally, in eyes with longer AXLs. Lam et al. [42] reported that the retina in the macular region becomes thinner with increasing AXL, while the fovea becomes thicker. A possible explanation for the differences in foveal and peripheral retina thickness is that the retinal periphery thins in order to allow the fovea to be unaffected by an increase in AXL [42,43].

There is limited data on retinal thickness changes in anisometropic subjects. A study by Vincent et al. [44] revealed that the MM eyes in Asian anisomyopic subjects had thicker central foveas; this was different for Caucasian anisomyopes, who displayed no differences, as reported in several other studies on central foveal thickness and AXL. Jiang et al. [43] found that the MM eye in anisometropic subjects displayed a thinner parafovea compared to the fellow eye. At the moment, no information is available on the peripheral thickness values of the retina in individuals with anisomyopia. An SD-OCT (**Figure 3.1**) was used for the first time to measure retinal thickness values at various eccentricities across the central 56 degrees of the retina, as well as a Lenstar to obtain AXL values and compare these between the MM and LM eyes of anisomyopes.

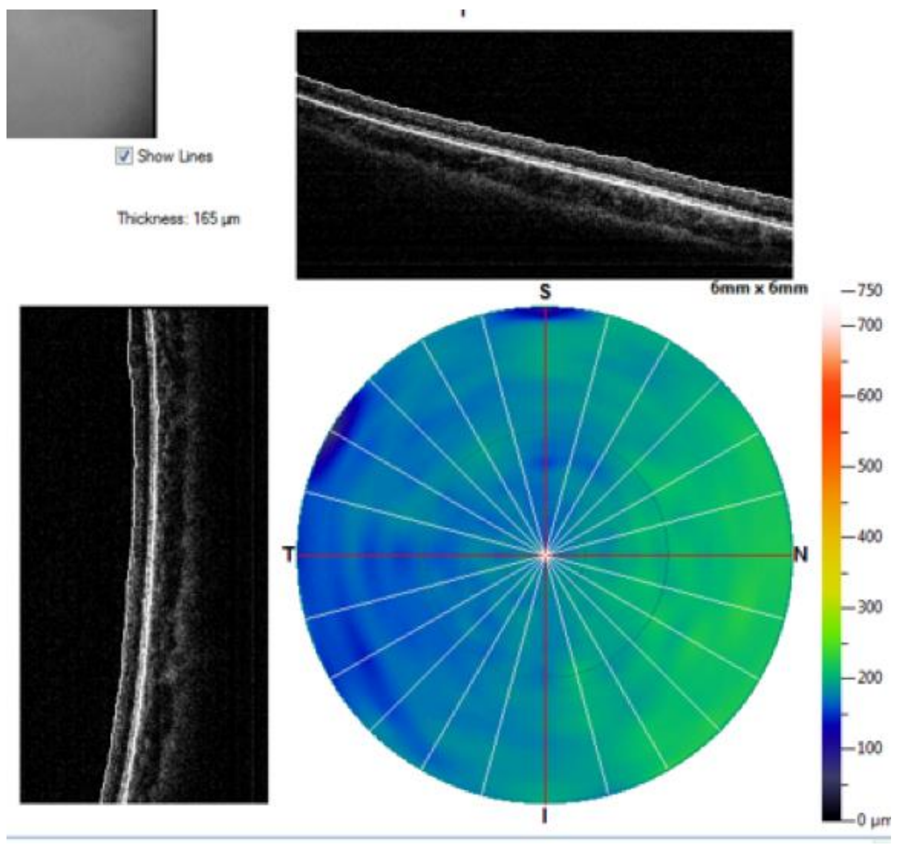


Figure 3.1. The MM6 scan on the OptoVUE OCT. It takes 12 6mm scans in a radial fashion around the specified area. Only the horizontal values were used for analyses. This scan shows the temporal retina as the target looked 18 degrees to one side.

3.2. Methods

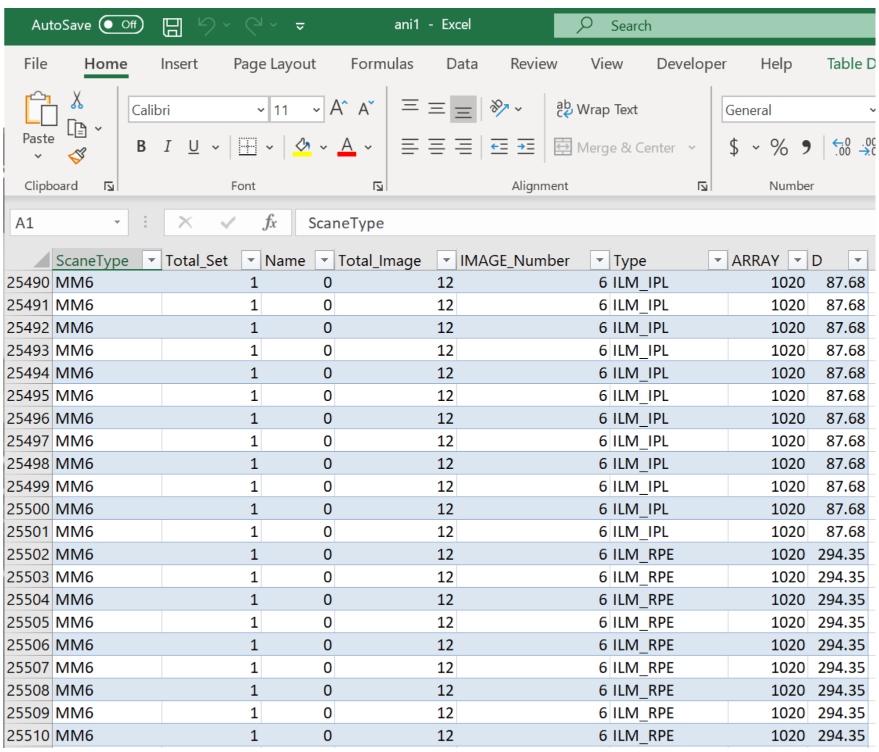
Retinal thickness measurements were taken using an SD-OCT (OptoVUE). We utilized the MM6 scan, which uses twelve 6mm scans that rotate through the fixation mark at 15° intervals **(Figure 3.1).** From these multiple scans obtained, the horizontal scan was used in the analyses reported here. Due to the faulty segmentation present in some of the scans, manual correction as provided in the user manual was used to determine the dividing line for each retinal layer. Images were taken three times: (1) on-axis, while subjects fixated on the OCT target, (2) looking at an internal target located 18 degrees to the right, and (3) an internal target located at 18 degrees to the left. This allowed for retinal thickness values to be obtained across the central horizontal 56 degrees.

The raw data was exported to a .xml file, which gave 1020 total retinal thickness (ILM-RPE), inner retinal thickness (ILM-IPL), ILM-thickness, and RPE-thickness values **(Figure 3.2)**. Only the total retinal thickness is presented here. The 6th set of data in the file corresponded to the horizontal scan on the MM6. These values were transferred over to separate excel files for each subject, organized in a right to left direction, and then graphed accordingly.

Each region of interest **(Figure 3.3)** on the retina was defined as follows:

- **Foveal Pit Thickness:** Defined as the average thickness of the 20 points around the thinnest point within the foveola.
- **Temporal Retina:** Defined as the Y-intercept average of all points at 10-28 degrees temporal to the fovea. The Y-intercept was used in order to get the thickness for the 28 degree eccentricity as this was the farthest point in our measurements.
    - Temporal retina data were flipped for the left eye using the coding abilities of Excel in order to keep it consistent and comparable to the right eye.

- **Nasal Retina:** Defined as the average thickness of the nasal retinal points starting at 70 data points past the optic nerve head, and up to 28 degrees. We used the average here, and not the Y-intercept because we wanted to get the general thickness of that entire region. The 70 points past the nerve were chosen as the start to minimize the effect of the optic nerve on the thickness values.
- **Nasal Foveal Shoulder Thickness:** Defined as the average of the 20 points around the thickest area located nasal to the fovea. This value was compared to both on-axis AXL, as well as the AXL value that most closely matched that region, referred to as "eccentric AXL".



	ScaneType	Total_Set	Name	Total_Image	IMAGE_Number	Type	ARRAY	D
25490	MM6	1	0	12	6	ILM_IPL	1020	87.68
25491	MM6	1	0	12	6	ILM_IPL	1020	87.68
25492	MM6	1	0	12	6	ILM_IPL	1020	87.68
25493	MM6	1	0	12	6	ILM_IPL	1020	87.68
25494	MM6	1	0	12	6	ILM_IPL	1020	87.68
25495	MM6	1	0	12	6	ILM_IPL	1020	87.68
25496	MM6	1	0	12	6	ILM_IPL	1020	87.68
25497	MM6	1	0	12	6	ILM_IPL	1020	87.68
25498	MM6	1	0	12	6	ILM_IPL	1020	87.68
25499	MM6	1	0	12	6	ILM_IPL	1020	87.68
25500	MM6	1	0	12	6	ILM_IPL	1020	87.68
25501	MM6	1	0	12	6	ILM_IPL	1020	87.68
25502	MM6	1	0	12	6	ILM_RPE	1020	294.35
25503	MM6	1	0	12	6	ILM_RPE	1020	294.35
25504	MM6	1	0	12	6	ILM_RPE	1020	294.35
25505	MM6	1	0	12	6	ILM_RPE	1020	294.35
25506	MM6	1	0	12	6	ILM_RPE	1020	294.35
25507	MM6	1	0	12	6	ILM_RPE	1020	294.35
25508	MM6	1	0	12	6	ILM_RPE	1020	294.35
25509	MM6	1	0	12	6	ILM_RPE	1020	294.35
25510	MM6	1	0	12	6	ILM_RPE	1020	294.35

Figure 3.2. Excerpt from an excel file containing the raw data from the OCT scans of one of the subjects. ILM_IPL represents the inner retinal thickness, and ILM_RPE represents the full retinal thickness. There were 1020 values for each.

AXL length values were measured for each subject while the subject fixated at ± 20, 16, 12, 8, 4, and 0 (on axis) degrees. In order to calculate which AXL eccentricity to use when comparing the nasal foveal shoulder thickness, the micron value for each eccentricity was calculated. The MM6 scan is comprised of 1020 data points, and it takes a 6mm scan across the retina. 6/1020 ≈ 0.0060mm = 6 microns, so each data point is 6 microns. Furthermore, 1 degree of visual angle on the retina is roughly 288 microns [45]. Using these numbers, the appropriate eccentricity from the “eccentric AXL” analyses could be calculated. For example, if the nasal foveal shoulder area fell 180 points away from the fovea, then multiplying it by 6 would give you 1080 microns. Dividing this by 288 would result in 3.75 degrees so the 4 degree eccentricity would be chosen in this case.

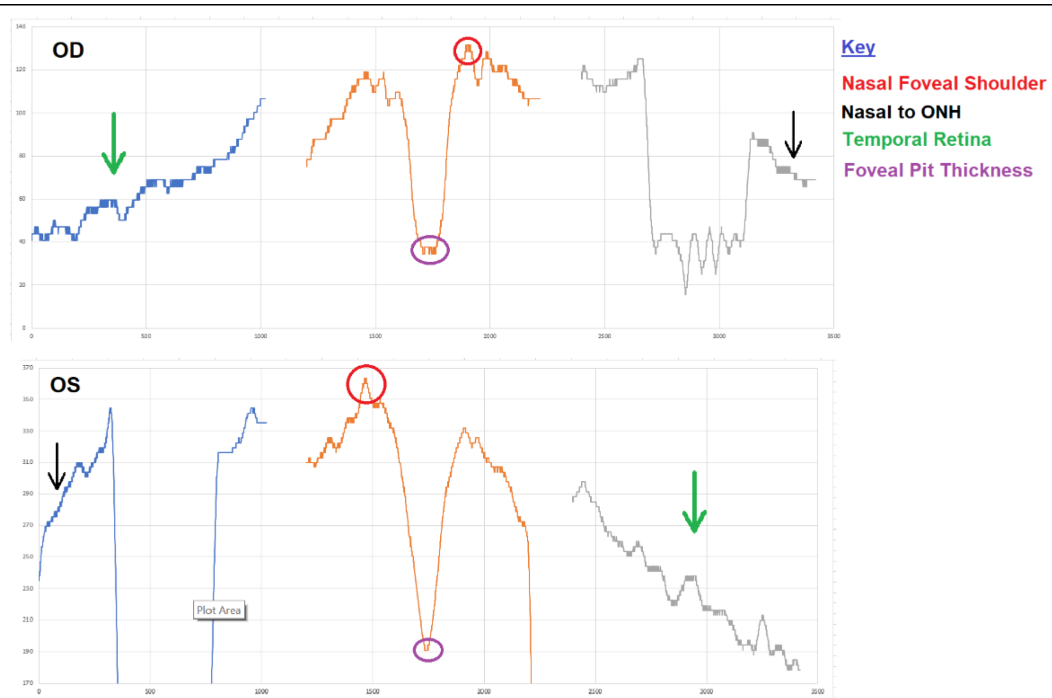


Figure 3.3. Image showing the raw total retinal thickness values. The X-axis represents each individual point (~6µm of retina). The Y-axis is the retinal thickness. The temporal thickness data for the left eye had to be flipped in order to be comparable to the right.

Data for a total of n=19 of the n=23 subjects who participated were used. For one subject the data was not usable even after repeating the scans, for three subjects, they were not able to complete this section of the testing.

Pearson correlations were used to compare AXL to retinal thickness for all four locations, and to compare “eccentric AXL” to the nasal foveal shoulder thickness. Analyses were done twice for two different scenarios: 1. Treating each eye as an individual subject, and 2. Splitting the eyes into LM and MM and comparing each group. Within-subject analyses compared the fellow eyes of each individual subject using t-tests. R was used for all the statistics in this chapter.

3.3. Results

Thickness values were compared among the MM eyes, the LM eyes, and all the eyes together. As expected, on-axis AXL showed no correlation with foveal pit thickness for the MM eyes ($p=0.194$, $r^2=0.097$), the LM eyes ($p=0.276$, $r^2=0.069$), and all eyes together ($p=0.086$, $r^2=0.080$) **(Figure 3.4)**.

On the other hand, central AXL showed a significant negative correlation with temporal retinal thickness for the MM eyes ($p<0.05$, $r^2=0.3286$), the LM eyes ($p<0.05$, $r^2=0.2164$), and all eyes together ($p=0.001$, $r^2=0.259$) **(Figure 3.5)**.

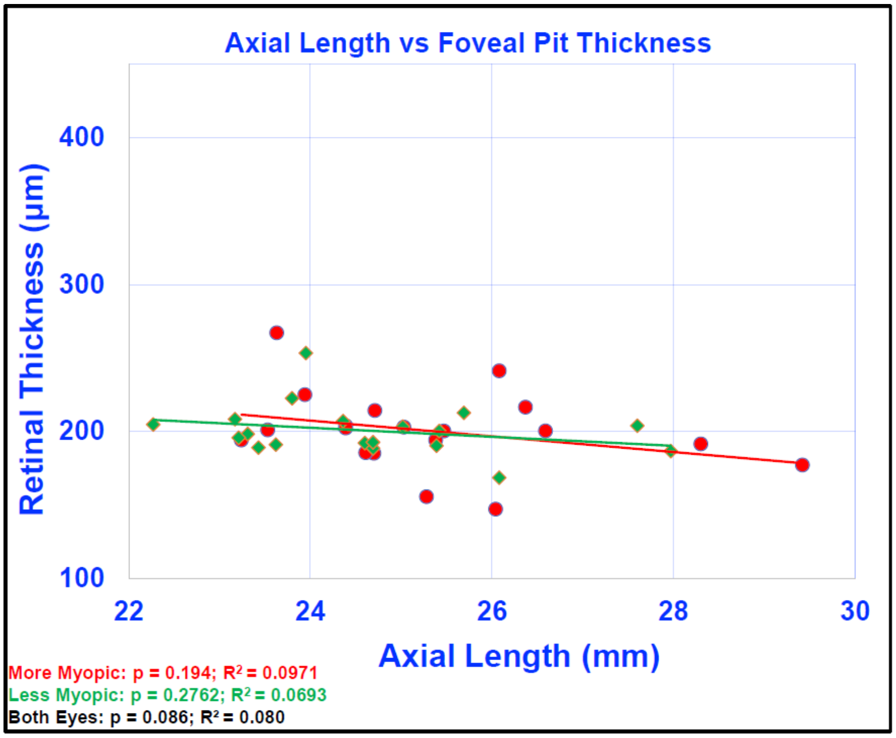


Figure 3.4. Foveal pit thickness values for the MM and LM eyes are shown here. Both eyes together are not shown in the graph.

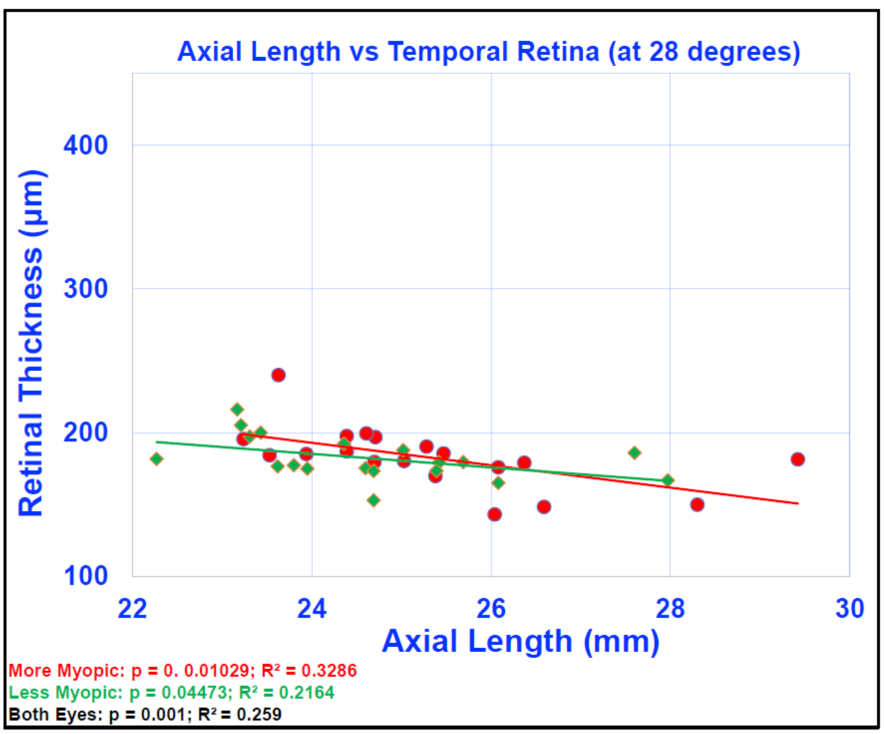


Figure 3.5. Temporal retinal thickness values for the MM and LM eyes are shown here. Both eyes together are not shown in the graph.

Surprisingly, central AXL did not show a correlation with nasal retinal thickness for the MM eyes ($p=0.094$, $r^2=0.156$), but did show a significant correlation for the LM eyes ($p<0.001$, $r^2=0.542$), and when comparing all eyes together ($p<0.001$, $r^2=0.328$) **(Figure 3.6)**. It should be noted that upon removal of the outlier subject on the most right side of Figure 3.6., the nasal retina also became significantly thinner with increasing AXL in the MM eyes ($p<0.01$, $r^2=0.372$). Central AXL did not show any correlation with nasal foveal shoulder thickness for the MM eyes ($p=0.145$, $r^2=0.121$) or the LM eyes ($p=0.155$, $r^2=0.115$), but did show a significant correlation when comparing all eyes together ($p<0.05$, $r^2=0.112$) **(Figure 3.7)**. Eccentric AXL did not show a correlation with nasal foveal shoulder thickness for the more MM ($p=0.146$, $r^2=0.120$), or the LM eyes ($p=0.156$, $r^2=0.114$), but did show a significant correlation when comparing all eyes together ($p<0.05$, $r^2=0.113$) **(Figure 3.8)**.

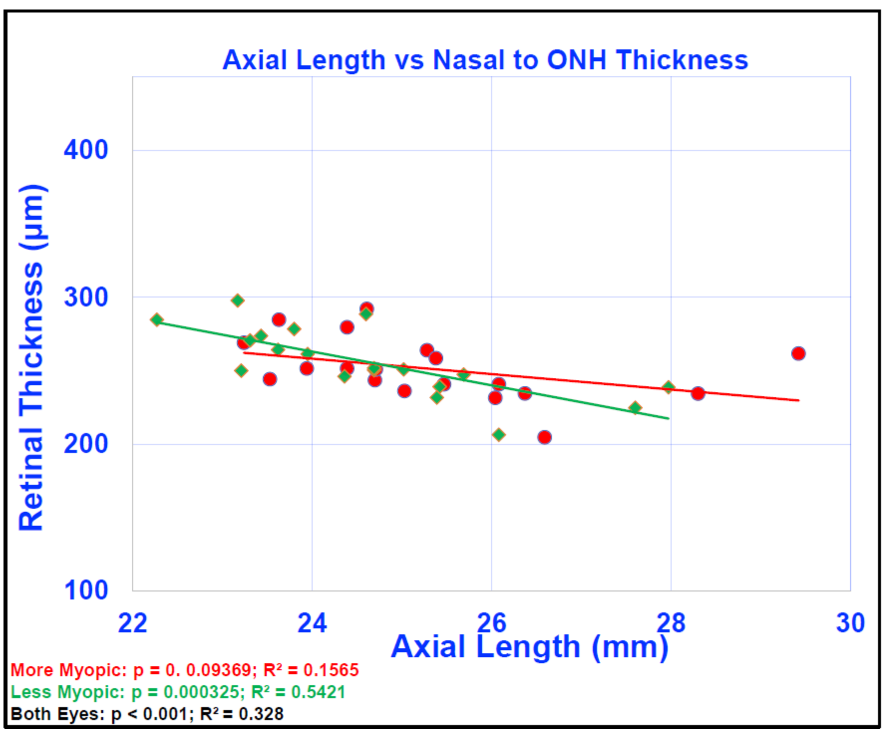


Figure 3.6. Nasal retinal thickness values for the MM and LM eyes are shown here. Both eyes together are not shown in the graph.

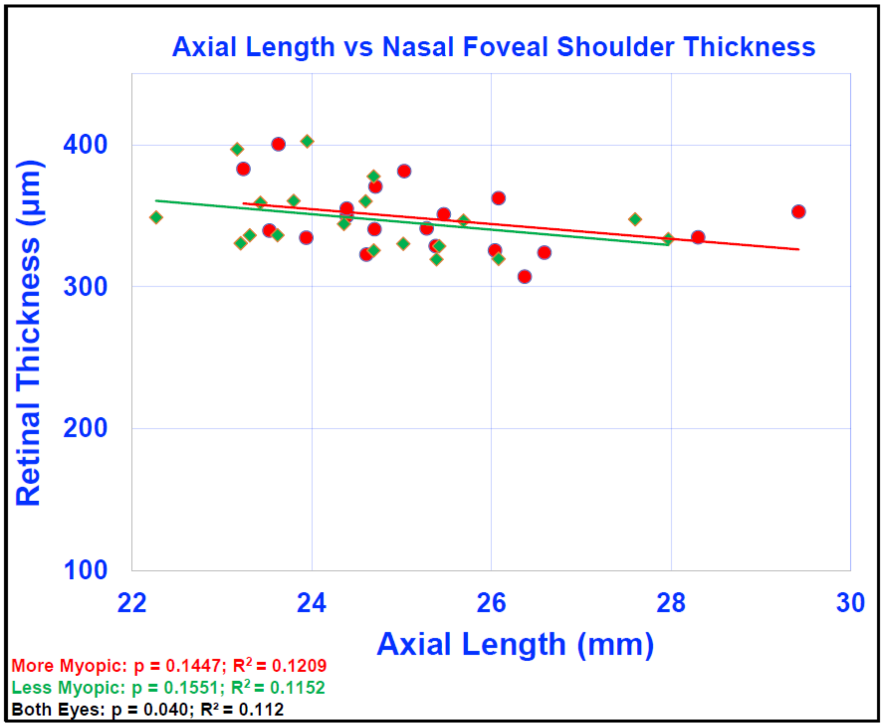


Figure 3.7. Nasal foveal shoulder thickness values for the MM and LM eyes are shown here. Both eyes together are not shown in the graph.

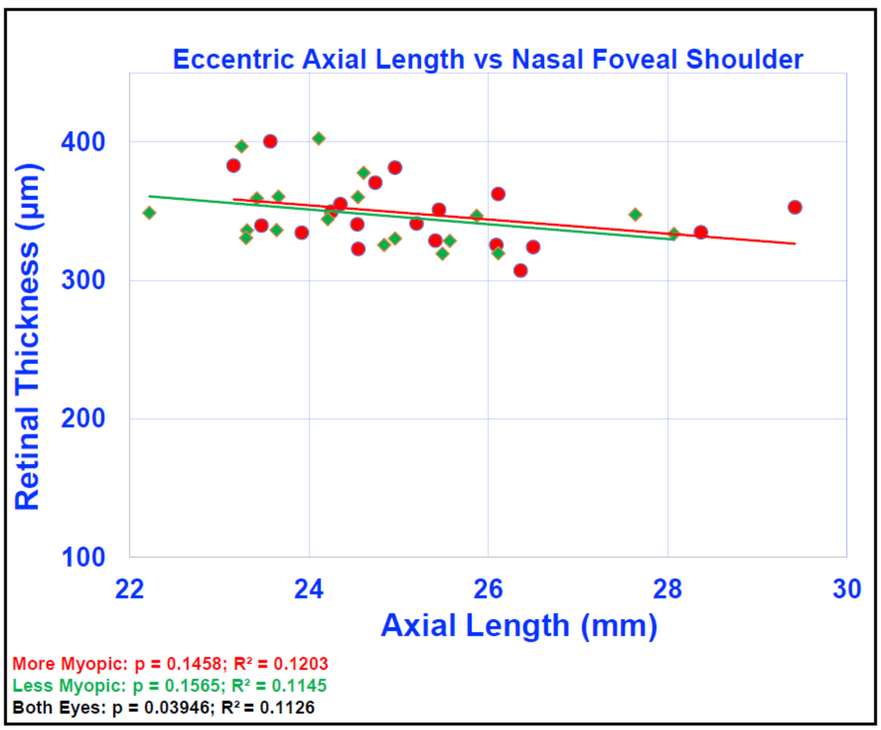


Figure 3.8. Eccentric axial length was compared to the nasal foveal shoulder thickness. Both eyes together are not shown in the graph.

T-tests showed no differences in retinal thickness between the MM and LM eyes of each subject for any of the retinal areas evaluated (Foveal Pit: t=-0.02, p=0.98; Nasal Foveal Shoulder: t=0.06, p=0.95; Temporal Retina Thickness: t=0.08, p=0.94; or Nasal Retina thickness: t=-0.60, p=0.55).

3.4. Discussion

Using an SD-OCT to measure retinal thickness values across the central 56 degrees in subjects with anisomyopia, it was found that foveal retinal thickness did not significantly change with AXL for any of the groups, or all the eyes. This finding agrees with Jonas et al. [41], who found that foveal thickness either increased or was statistically independent of AXL. Other studies have found that foveal thickness increases in high myopia [38–40] while remaining relatively unchanged at lower levels [46,47]. Our findings further support that increasing AXL does not lead to foveal thinning.

Teberik and Kaya [38] and Jonas et al. [41] found that high myopic eyes had thinner nasal and temporal retinae compared to emmetropic eyes. Our data follows the same pattern of decreased thickness of the nasal and temporal retinae with increasing AXL (and thus myopia). The temporal retina showed the largest change in thickness with increasing AXL for all eyes in our study. Both the MM and LM eyes showed a significant negative correlation of temporal retinal thickness with AXL. Nasal retinal thickness measurements were more variable. The area nasal to the optic nerve did not show any difference in thickness with AXL among the MM eyes but was significantly thinner with longer eyes for the LM eyes. However, upon removal of one outlier subject, nasal retinal thickness also became significantly correlated with AXL in the MM eyes. This is the first study evaluating nasal retina thickness beyond the optic nerve.

The nasal foveal shoulder thickness, the thickest area nasal to the fovea and before the optic nerve, was similar between the MM and LM eyes when analyzed in relation to both the central and the eccentric AXL values. However, a comparison of all the eyes revealed that this nasal region does become thinner with increasing AXL. Since this area fell within the 6mm of the central MM6 scan we used, our results are comparable to the findings of Jiang et al.[43], who showed that the inner and outer macular rings (parafovea and perifovea respectively) were thinner in all quadrants in the MM eyes compared to the fellow eyes.

Overall, retinal thickness did not differ between the MM and LM eyes. More important however was that comparisons of retinal thickness within each individual's eyes showed no significant correlation between the MM and LM eyes, indicating a larger between-subjects than within-subjects effect. This large intersubject variability suggests a lack of association of retinal thickness with myopia development. These results are also possibly due to the small size of the sample and the limited amount of anisomyopia in most subjects. It would be interesting to conduct a similar study on a larger scale of subjects with larger amounts of anisomyopia. A larger sample size would also allow sub-group analyses based on ethnicity and other parameters. Recruiting a large enough group of subjects with anisomyopia proved difficult using the pool of graduate students. This study demonstrates the difficulties of studying a very specific group of subjects with anisomyopia, but also illustrates the possibilities of what future, larger scale endeavors may reveal.

4. Biometry and Optical Quality in Anisomyopia

4.1. Background

Among the different methods available to report the optical quality of the eye, the visual Strehl ratio computed in the frequency domain - based on the optical transfer function (VSOTF) provides the most comprehensive measure [48]. The VSOTF is an objective measure obtained from the optical aberrations of the eye that can predict the subjective best focus independently of the pupil size [49,50]. The VSOTF also has the unique advantage of partly accounting for neural factors such as adaptation that may affect the subjective retinal image quality [49,50].

The optical quality of the retinal image declines with increasing retinal eccentricity [17], with off-axis astigmatism being the primary cause for this degradation [51]. Several studies have evaluated the decline of optical quality of the eye with eccentricity in myopia. Jaeken and Artal [51] found that due to the interaction between defocus and oblique astigmatism, the peripheral image quality was not significantly different between emmetropic and myopic eyes. However, Shen et al. [52], who measured up to ±30 degrees, noted that emmetropic eyes tended to show more peripheral retinal blur as compared to myopic eyes. Ankit et al. [18] found that emmetropic and myopic young adults showed little differences in higher order aberrations across the periphery, with the exception of coma that increased more rapidly in myopic eyes. It is possible to infer from this that if the aberrations are not too dissimilar between emmetropic and myopic eyes, then the peripheral optical quality will not differ much. It should be noted however, that Ankit's group only tested up to 20 degrees. Another interesting study was presented by Mathur et al [53], who showed in a small group of emmetropic individuals that peripheral aberrations did not vary across the central 42 degrees during accommodation, with the only exception being a small, but significant increase in negative SA.

As discussed in Chapter 3, differences in retinal shape have been found between emmetropic and myopic eyes, with a tendency of myopic eyes to be more prolate (less oblate) compared to emmetropic eyes, which in turns results in myopic eyes being steeper overall [32,33,54]. Previous studies have evaluated retinal shape using either biometry data (AXL) [25,55] or optical quality across the periphery, or have evaluated optical quality differences between isomyopes and anisomyopes[56], but no studies have measured both in the same group of anisomyopic subjects.

Studies of on-axis optical quality in anisomyopia have shown conflicting results regarding the differences between fellow eyes. Vincent et al. [57] and Tian et al. [58] did not find differences in higher order aberrations (HOA) between fellow eyes. However, Hartwig and Atchison [59] as well as Hartwig et al. [60] found small yet significant differences in central spherical aberration (SA), vertical coma, tetrafoil, and secondary astigmatism between the MM and LM eyes in anisomyopes. Only one study has measured optical aberrations in the periphery of the MM and LM eyes in anisomyopia [61]: Osuagwu et al. [61] found higher positive SA and secondary astigmatism (i.e., 4th order aberrations) in the LM eyes compared to the MM eyes. All other peripheral optical aberrations were similar between the two eyes when measured across the central 40 degrees.

While a few studies have measured central AXL in anisomyopes, only two have previously measured it across the periphery. Logan et al.[55] found that the MM eye of one subject with anisomyopia had overall longer AXL values across the periphery compared to the LM eye. This study was done on just one subject with the purpose of computing their retinal contour. Some of the same authors [25] found similar findings when comparing the retinal contours out to about 35-40 degrees in each direction of Caucasian and Chinese anisomyopic subjects. Both studies used an IR autorefractor for measuring peripheral refraction, and an ultrasound device (A-scan) to measure AXL. In our study, we measure both optical quality

(VSOTF) and retinal shape (AXL) across the central 40 degrees in the two eyes of anisomyopic individuals to evaluate differences between the MM and LM eyes.

4.2. Methods

4.2.1. Retinal shape

Central and peripheral AXL for each eye was measured using partial coherence tomography (Lenstar LS900). This instrument is commonly used for measurements of AXL and retinal shape [62] and has shown to have good repeatability for peripheral AXL measurements [63]. It has the advantage of giving internal measurements such as anterior chamber depth and lens thickness [64]. The right eye of each subject was tested first, followed by the left eye. The untested eye was patched during the procedure. Biometric measures were taken across the central 40 degrees, at 13 different eccentricities. Peripheral AXL measurements were taken by directing the subject's fixation using a non-accommodative, custom designed target. Subjects were instructed to look at each of the fixation points (stars) on a transparent card (made by fellow MS student Gabriella Velonias) so that AXL measurements were obtained for ±20, ±16, ±12, ±8, ±4 degrees, and on-axis (0 degrees). Three scans were taken at each eccentricity and the results averaged for each location. Raw data were exported to an excel file via the Lenstar's software. Raw AXL data were analyzed using mixed (within/between) model ANOVAs on SPSS.

Raw AXL data were imported into Matlab to fit the standard conic function used to fit retinal contours described by Verkicharla et al [62]. The equation used for biometry fittings was:

$$y = C * \frac{(x)^2}{(1 + \sqrt{1 - (1 + Q) * C^2 * (x)^2})}$$

where y is surface sag coordinate, C is vertex curvature, Q is asphericity, and x is the AXL co-ordinate along the X-axis.

Fitting functions were created in Matlab to determine the goodness of fit for each subject's AXL data as well as the overall asphericity and curvature of the fit for each subject. Accurate biometric fittings were defined as goodness of fit (r^2) values 0.70 or higher. Two main characteristics were described: radius of curvature (C) and asphericity (Q). Positive Q values indicate oblate shapes, whereas negative Q values are prolate to parabolic, and a value of 0 Q is a perfect sphere.

Biometric fittings were analyzed with one-way ANOVAs to evaluate asphericity and curvature for those subjects with good fittings (n=14), defined as goodness of fit >70%. Tests of homogeneity were performed to identify differences in standard deviations within the MM and LM eyes.

4.2.2. Optical quality

A Hartmann-Shack scanning wavefront aberrometer was used to measure ocular aberrations across the central 50 degrees through a natural pupil. This device is designed to minimize acquisition time (7.2 seconds) and can measure ocular aberrations across the horizontal 80 degrees of the retina at an angular resolution of 1 measurement per degree [65,66]. LabVIEW (National Instruments™) was used to create the user interface for the program. The acquisition time for one frame is 9 ms, and 4 consecutive scans were taken for each condition, resulting in 324 images acquired in 7.2 seconds [65]. All data were evaluated for quality within the instrument's software at the time of testing. If there were any anomalies the measurement was repeated. The program allowed for the unwrapping of the Hartmann-Shack image to account for the elliptical shape of the pupil in the periphery [65]. More information on the instrument and how it functions is provided by Jaeken et al [65]. Data processing was done with Matlab.

Once the subject was placed in the chinrest, they were asked to blink normally while fixating 4 meters away at a red dot created by a laser pointer. The aberrometer was then centered within the subject's visual axis and a scan was taken in each eye while subjects fixated on a target with concentric rings placed straight ahead at 4 meters. Subjects wore soft contact lens correction for all aberrometer measurements.

Raw data were collected at each degree along the horizontal meridian and imported into Matlab for analyses. The optical quality metric VSOTF [48] was used to characterize optical quality across the periphery. For statistical analysis purposes, VSOTF data were grouped for each five degrees to constitute one eccentricity group, totaling 11 eccentricity groups (25, 20, 15, 10 and 5 degrees nasal and temporal, and 0 degrees) used in the analyses (**Figure 4.2**).

4.2.3. Subjects

AXL values were available for 22 of the 23 subjects. For the VSOTF measurements, data for 19 subjects were available for both eyes since four subjects did not have enough aberration data to compute the analyses and were thus excluded.

4.2.4. Data Analyses

The subjects' eyes were separated into the two groups: the MM and the LM eyes and compared with a mixed (within/between) model analysis of variance for two eyes (MM, LM) and 11 ocular eccentricities (25, 20, 15, 10 and 5 degrees nasal and temporal, and 0 degrees). Missing data were replaced using the linear interpolation method. Follow up one-way ANOVAs with Bonferroni correction to control for Type I errors were applied. These analyses were conducted for both the raw AXL and the VSOTF data. Statistical analyses were performed using SPSS. For those eyes with good ocular shape fittings, one-way ANOVAs were used to evaluate asphericity and curvature. Tests of homogeneity were performed to identify differences in standard deviations within the MM and LM eyes.

4.3. Results

4.3.1. Retinal Shape

Raw AXL values across the central 40 degrees were obtained for 22 of the 23 subjects. As expected, a significant effect of eccentricity on AXL was found ($F=13.312$, $p<0.01$) (Huynh-Feldt correction was applied for violating the assumption of sphericity, χ^2 (54)=816.703, $p<0.001$) (**Figure 4.1**). There was no main effect of eye (MM / LM) and eccentricity on the AXL values ($F=1.711$, $p=1.47$). AXL functions followed a quadratic fit ($F=41.667$, $p<0.01$).

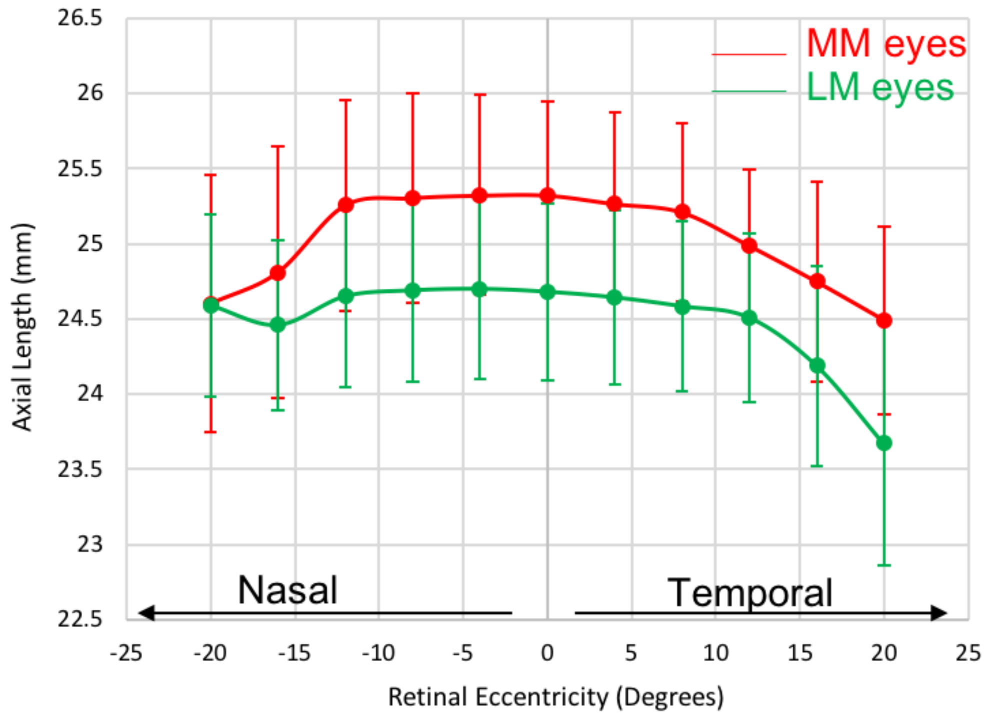


Figure 4.1. Average raw AXL values across the central 40 degrees. The error bars represent 95% confidence intervals.

Similarly, both the MM and the LM eyes showed a significant effect of eccentricity on AXL (MM: F=6.860, p<0.01, LM: F=8.341, p<0.01). When analyzed separately both the MM and LM eyes also followed a quadratic fit (MM: F=23.839, p<0.01, LM: F=17.865, p<0.01).

Subject ID	Eye	AXL	r^2	C	Q
ANI003	MM	26.59	0.941843	-0.1135176	-2.0383281
ANI005	MM	24.7	0.8141658	-0.0972638	-2.3785415
ANI006	MM	25.28	0.9633567	-0.0938265	-1.506474
ANI011	MM	24.9	0.9876944	0.98769436	-4.224E-08
ANI013	MM	24.39	0.9584404	0.95844038	-2.572E-08
ANI014	MM	24.56	0.9217766	0.92177663	-7.035E-08
ANI015	MM	25.03	0.9673992	-0.0723018	-1.809E-10
ANI016	MM	26.37	0.9451148	0.94511476	-3.8747808
ANI017	MM	23.63	0.8756839	-0.0839475	-7.663E-07
ANI018	MM	24.39	0.9657848	0.9657848	-3.6045456
ANI020	MM	23.94	0.9457337	-0.1032371	-2.3180877
ANI021	MM	23.24	0.9748966	-0.1179467	-1.4013611
ANI022	MM	26.04	0.7189753	0.71897529	-5.9405884
ANI023	MM	26.08	0.8813771	0.8813771	-7.658E-09
ANI003	LM	26.08	0.9473208	-0.1038284	-1.6652224
ANI005	LM	24.36	0.7979413	-0.0946775	-4.2744425
ANI006	LM	25.02	0.9852028	-0.0880462	-1.11E-05
ANI011	LM	24.84	0.9633658	-0.1206316	-4.2480354
ANI013	LM	23.43	0.8389178	-0.0733814	-4.378E-09
ANI014	LM	23.96	0.9488588	-0.0636647	-2.116E-08
ANI015	LM	24.69	0.8567192	0.85671919	-2.201E-08
ANI016	LM	25.42	0.7781802	-0.1108382	-4.5864588
ANI017	LM	23.17	0.9842124	0.98421239	-4.081E-07
ANI018	LM	23.8	0.8725809	-0.1258622	-3.751746
ANI020	LM	23.62	0.8643125	0.86431254	-9.94E-11
ANI021	LM	22.27	0.9254919	0.9254919	-4.500718
ANI022	LM	25.39	0.8262207	-0.0786763	-2.7836675
ANI023	LM	25.69	0.8904889	-0.071331	-0.5277892

Table 4.1. Conic fittings for the MM and LM eyes in our 14 subjects. r^2 represents goodness of fit (which we wanted to be >0.70), C is radius of curvature, and Q is asphericity.

Conic fittings of the raw AXL data to determine ocular shape showed that accurate fittings (defined as goodness of fit, $r^2 > 70\%$) were achieved for most eyes (n=14 of the total n=23 subjects). There was no effect of on-axis AXL in asphericity (Welch statistic 0.102, p=0.752) or curvature (Welch statistic 1.286, p=0.267). Linear regression analyses showed no correlation of AXL with asphericity (Pearson correlation 0.152, p=0.441) or curvature (Pearson correlation -0.090, p=0.649) in the MM or LM eyes **(Table 4.1)**.

4.3.2. Optical Quality

After Huynh-Feldt correction was applied for violating the assumption of sphericity (χ^2 (54)=669.751, p<0.001), no significant effect of eccentricity on the VSOTF values was found (F=0.410, p=0.652) (**Figure 4.2**). There was also no main effect of eye (MM / LM) and eccentricity on the VSTOF values (F=2.154, p=0.127). When divided into the MM and LM eyes, mixed model analysis of variance showed no significant effect of eccentricity on VSOTF in the MM eyes (F=3.000, p=0.092) or the LM eyes (F=0.806, p=0.440). Similarly, the VSOTF for both the MM and LM eyes did not follow a specific fit. Individual ANOVA showed a significant group by interaction effect only for the nasal 4 degree eccentricity (p<0.05, F=4.417), with higher VSOTF values in the LM eyes at this eccentricity.

4.3.3. Correlation of AXL and Optical Quality

On-axis AXL and optical quality (VSOTF) showed a significant negative correlation in both the MM (p<0.05, r=-0.509) and LM (p<0.05, r=-0.498) eyes, indicating poorer optical quality for longer eyes. Of the 19 subjects tested, 6 showed significant negative correlations between VSOTF and AXL across the periphery in the MM eyes (p<0.05 for all), and 4 in the LM eyes

($p<0.05$ for all), not for the same subjects. More complex model analyses may be performed as next steps with these data.

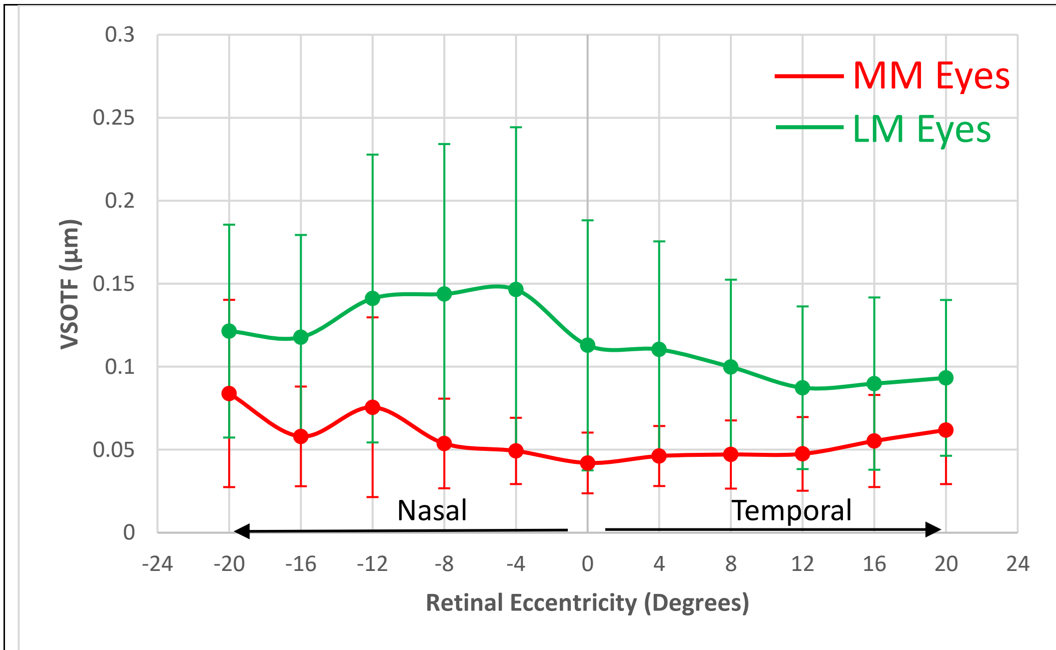


Figure 4.2. VSTOF values across 40 degrees eccentricity. Error bars represent 95% confidence intervals.

4.4. Discussion

As expected, eccentricity had a significant effect on ocular length, with shorter AXL values in more peripheral locations for both the MM and LM eyes. The shapes were also similar, with both eyes following a quadratic fit for AXL.

Interestingly, we found that AXL did not show any relationship with asphericity or curvature in the MM or LM eyes. Most eyes had small negative asphericity values indicating a prolate or close to spherical shape. Previous studies have found that myopic eyes are relatively more prolate (or less oblate) than emmetropic eyes. Atchison et al. [54] found in their population of emmetropic and myopic individuals that both groups had oblate ocular shapes, but the myopic eyes less so (i.e., relatively more prolate). Our finding implies that the overall shape of the fellow eyes in anisomyopes is not very different. It should be noted that for the raw AXL analyses, 22 of the 23 subjects (44 eyes) were used; for the fittings data, only 14 of the 23 subjects (28 eyes) were used due to 9 subjects having inadequate goodness of fit values. It is possible that this may have impacted the results.

On the other hand, there was no significant effect of eccentricity on optical quality as measured with the high order aberration VSOTF. Our data suggests that once we correct for lower order aberrations, optical quality tends to remain stable throughout the periphery. No differences were found between the MM and LM eyes. This finding agrees with Osuagwu et al. [61], who found that most peripheral aberrations were similar in pattern and magnitude between the MM and LM eyes.

Jaeken and Artal [51] found minor differences in peripheral image quality in myopic eyes compared to emmetropic eyes. While we did not include emmetropes in our study, we did not find significant differences between the two eyes in anisomyopia. However, between-subjects analyses show an effect of on-axis AXL on VSOTF, with a negative correlation in both the MM and LM eyes. For different individuals, longer eyes showed lower VSOTF values on-axis, indicating poorer optical quality, but for the same individual, the longer (MM) eye did not show worse optical quality than the LM eye. This is an interesting finding as it shows that individuals with longer eyes have worse optical quality. However, since our findings show no difference in the optical quality between fellow eyes in anisomyopes, this suggests that optical quality may not be a causative factor in the development of myopia since it does not appear to play a role in the development of more myopia in one eye compared to the other. Our findings indicate that the reduction in optical quality is a result of myopia and not a cause, and that other factors may keep the optical quality in fellow eyes of anisomyopes relatively the same.

5. Accommodation and Tonic Accommodation in Anisomyopia

5.1. Background

Accommodation is the process whereby the eye changes power to bring the optical image to the retina when looking at different distances. This process normally requires a stimulus, such as retinal blur or proximity, that elicits the accommodation response. The resting state of accommodation is called open-loop or tonic accommodation (TA), and occurs in the absence of feedback signals [67,68]. Different methods have been used in past studies to create an open-loop accommodation system, including: **(1)** reducing illuminance to dark conditions (dark-focus accommodation) [69,70]; **(2)** viewing through a pinhole; **(3)** a ganzfeld [71]; or **(4)** using images containing only very low spatial frequencies [67]. The dark-focus accommodation method is commonly preferred since it is easier to control [68]. By removing all blur, vergence, and proximal signals to accommodation, this method allows the feedback loop to open [67].

TA has been found to vary greatly among individuals, ranging from -0.5 to 4.5 diopters (D) [68,72,73]. This variability is lessened in studies that use the dark focus method to measure TA, with ranges from 0.74 to 1.15D [68,71].

Previous studies have found differences in various components of the accommodation response between myopic and emmetropic individuals. One of these aspects is the amplitude of accommodation, which has been shown to be lower in myopic subjects compared to emmetropes [74]. Seidel et al. [75] found that progressing, late-onset myopes had more instability in the accommodative response and experienced more microfluctuations. Progressing myopes showed a longer latency in their ability to relax their accommodation after prolonged near work compared to emmetropes and stable myopes [76]. Along this line, Hazel et al. [77] found differences between open- (TA) and closed-loop accommodation conditions and the ability of myopes to relax their accommodation after near work. They showed that under open-loop conditions, myopes took longer to get back to baseline compared to closed-loop conditions. Strang et al. [78] noted that the method of opening the loop results in different TA values, but the TA values did not seem to differ between myopes and emmetropes for any of these methods. Furthermore, multiple studies have found that myopes tend to have a larger lag of accommodation to lens induced blur [79] and near stimuli, and decreased accommodative facility [77,80,81] than emmetropes. These differences have also been found in children [82–84].

Most previous studies have evaluated accommodation responses on the central axis or fovea. But accommodation can also be elicited by near peripheral blur. Gu and Legge [19] showed that stimulation in the parafoveal and perifoveal regions, up to 30° eccentricity, elicits accommodation. More recently, Labhishetty et al. [21] found that defocus presented in the parafoveal and perifoveal regions not only elicits accommodation but influences the accommodative response if foveal stimuli are concurrently present. This is an important concept since the effects of peripheral accommodation and defocus may influence myopia development [21] and myopes may demonstrate slightly less effective peripheral accommodation as they do not respond as well to peripheral defocus [20]. A recent study by Aldossari et al. [85] showed that stimulation of accommodation across the central 60° caused a larger increase in AXL during accommodation in myopes compared to emmetropes. These findings provide some indication that accommodation, both central and peripheral, may influence eye growth.

A few studies have also evaluated the effect of accommodation on the peripheral retinal optical image quality. Lundstrom et al. noted that myopes showed more asymmetric defocus profiles across the central 80 degrees compared to emmetropes, and that these peripheral profiles changed with accommodation in emmetropes, but not in myopes [22]. The accommodation response may also be affected by the sign and amount of SA. Wu and Jiang [86] indirectly measured the effect of SA and found larger accommodative errors in progressing myopes compared to emmetropes and stable myopes. While there is extensive research on different aspects of accommodation both centrally and peripherally, and how it influences various properties of the optical system, to our knowledge, no studies have measured how TA changes across the periphery in emmetropia or myopia.

There is also very limited data on the effect of accommodation in anisomyopia. A potential role of asymmetric viewing during near work in the development of anisomyopia has been suggested [1]. Since there is agreement that human eyes do not have the ability to aniso-accommodate [87,88], and the position of common near work task results in unequal accommodative demands between the eyes, one eye will always be blurred during near tasks. This unequal blur between the eyes may be a possible driver for myopia [88]. Specific studies in anisomyopia showed that the initial amount of near-work induced transient myopia (NITM) as well as its decay is increased in the MM eyes of anisomyopes [89]. However, no differences have been found in the transient changes of AXL during static accommodation responses between the MM and LM eyes in anisomyopia [90]. To our knowledge, no previous studies have measured TA in anisomyopia and no previous studies have measured TA across the periphery in anisomyopia. Having a better understanding of how accommodation varies between the MM and LM eyes in anisomyopic individuals will be key to understanding possible mechanisms of myopia progression and the development of anisomyopia.

In this study, we used a Hartmann-Shack scanning wave-front aberrometer to evaluate accommodation changes from distance to near stimuli, their effect on optical aberrations, and for the first time dark-focus TA across the central 50 degrees in the MM and LM eyes of a group of anisomyopes.

5.2. Methods

The Voptica scanning wavefront aberrometer was used to measure refractive changes across the central 50 degrees as described in Chapter 4. After the aberrometer was centered for the subject's visual axis, a scan was taken in each eye under three different conditions:

(1) subject fixating on a concentric circle target at 4 meters,

(2) subject fixating on a concentric circle target at 50 centimeters, and

(3) subject looking straight ahead in complete darkness to measure dark focus resting accommodation.

The same order was followed for each subject. Subjects wore soft contact lens correction for all aberrations measurements.

To ensure there was maximum darkness during dark focus measurements, all lights in the room were either turned off or covered, except for the red pointer laser of the aberrometer. A black blanket was draped over the subject and the aberrometer to ensure it was completely dark. Subjects were asked to close their eyes for 5 minutes prior to dark focus measurements.

The M, J0, and J45 values provided by the aberrometer for each of the 61 eccentricities were transformed into SE notation [91]. SE values were averaged in steps of 5 degrees between -25 and +25 degrees for a total of 5 nasal values, 5 temporal values and 1 central value. Analyses were conducted for the SE values at these 11 eccentricities for the following conditions: **(1)** 4m, with correction, as the baseline accommodation, **(2)** 50cm, with correction, as the accommodation state at near, **(3)** accommodation response (difference of 4m-50cm SE values), and **(4)** TA, calculated by subtracting the SE values obtained during the dark focus from the 4m measures. The values at 4m were needed even though subjects were optically corrected to consider any differences in baseline accommodation between subjects [92]. These steps were also followed for the organization of the SA data – represented by Z12 on the raw data exports.

The subjects' eyes were separated into two groups, the MM and the LM eyes, and compared with a mixed model analysis of variance for two eyes (MM, LM) and 11 ocular eccentricities (25, 20, 15, 10 and 5 degrees nasal and temporal, and 0 degrees) as described in Chapter 4. Missing data were replaced using the linear interpolation method. Follow up one-way ANOVAs with Bonferroni correction to control for Type I errors were applied. Statistical analyses were performed using SPSS.

5.3. Results

5.3.1. Accommodation Responses:

Data for a total of 16 subjects were available to analyze for the accommodation response changes from 4m to 50cm. Data were unavailable for seven subjects: three of the subjects' data could not be used because it got corrupted during the exporting process, two subjects' data were not collected due to device malfunction, and two subjects had too many data points missing for the analyses.

The SE values obtained while subjects looked at the 4 meter target, with correction, for all eccentricities were first analyzed (**Figure 5.1).** As the sphericity assumption was violated (χ^2 (54)=635.049, $p<0.001$), a Huynh-Feldt correction was applied. No effect of eccentricity was found for the 4m values ($F=2.724$, $p=0.085$) and no main interaction of eccentricity and eye (MM, LM) on the 4m value was noted ($F=1.074$, $p=0.652$). Both the MM ($F=1.416$, $p=0.258$) and LM ($F=1.745$, $p=0.196$) eyes showed no effect of eccentricity on the 4m value after applying the Huynh-Feldt correction. Within-subject contrast testing revealed the effect of eccentricity was best explained with a quadratic fit ($F=9.422$, $p<0.01$) for the MM eyes. The LM eyes did not follow any specific fit.

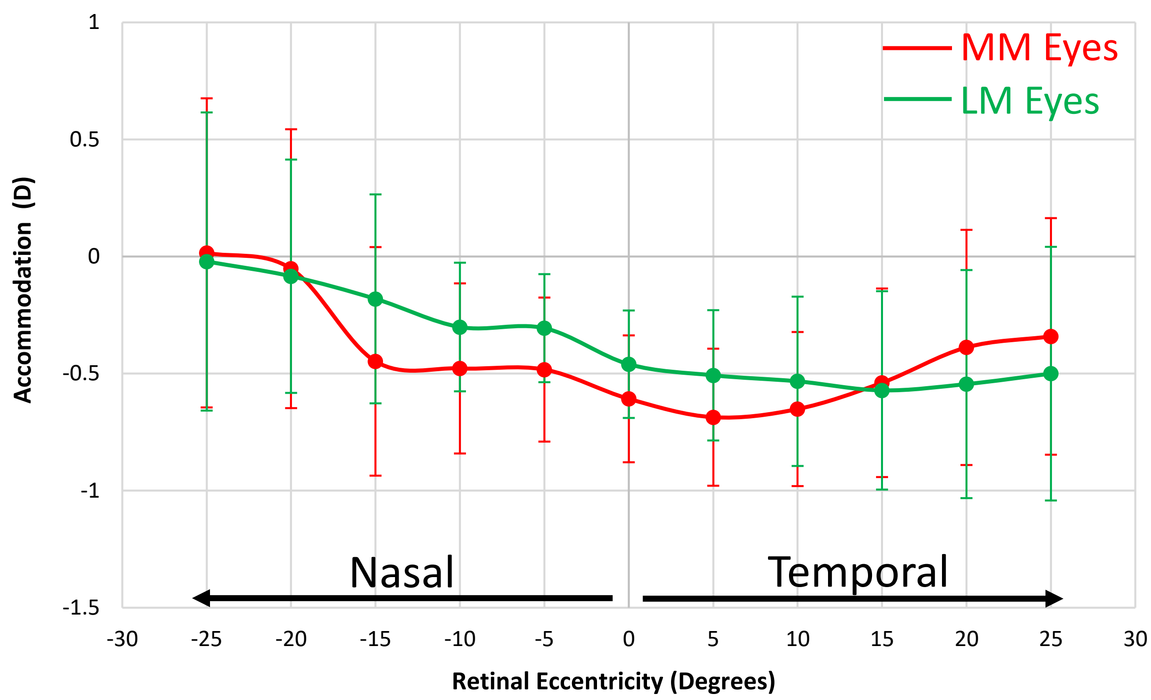


Figure 5.1. Average accommodation values at each eccentricity measured while subjects looked at a 4m target, considered the baseline accommodation for each subject. Error bars represent the 95% confidence intervals.

The SE values obtained while subjects looked at the 50cm target were analyzed next (**Figure 5.2**). A Huynh-Feldt correction was also applied (χ^2 (54)=568.163, $p<0.001$). No effect of eccentricity ($F=2.403$, $p=0.109$) and no main interaction of eccentricity and eye (MM, LM) ($F=0.386$, $p=0.648$) were found for the accommodation values at 50cm. Both the MM ($F=1.169$, $p=0.319$) and LM ($F=1.825$, $p=0.185$) eyes each showed no effect of eccentricity for the 50cm value after applying the Huynh-Feldt correction. Within-subject contrast testing revealed that the effect of eccentricity was best explained with a polynomial fit ($F=6.442$, $p<0.05$) in the MM eyes. The LM eyes did not follow any specific fit.

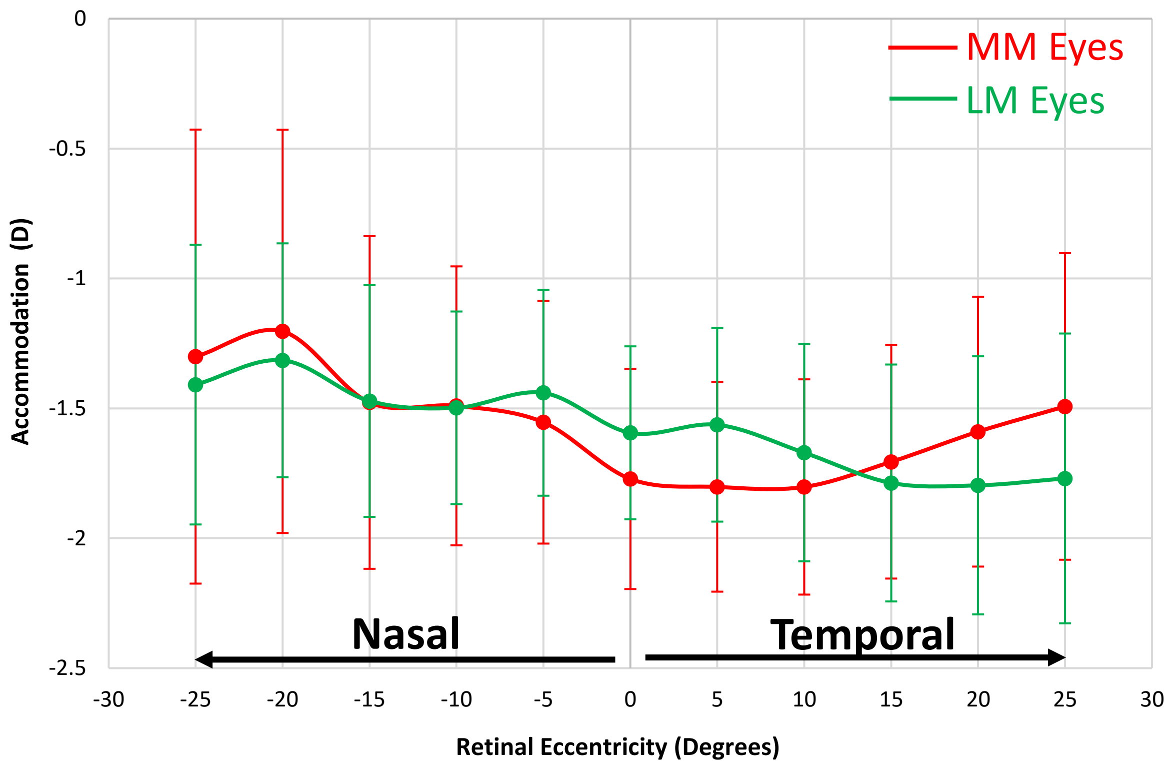


Figure 5.2. Average accommodation values at each eccentricity measured while subjects looked at the 50cm target. Error bars represent the 95% confidence intervals.

Subsequently, the SE values obtained at 50cm were subtracted from the 4m data (**Figure 5.3**). A total of 12 subjects (24 eyes) were compared in this analysis. Since these calculations required complete data from both the 4m and 50cm measurements, subjects missing any of the data had to be excluded. Two subjects were additionally excluded since their data were unable to be interpolated during statistical analysis.

As the sphericity assumption was violated (χ^2 (54)=178.148, $p<0.001$), a Huynh-Feldt correction was applied. There was no significant effect of eccentricity ($F=2.271$, $p=0.068$) and no main interaction of eccentricity and eye (MM, LM) ($F=0.478$, $p=0.750$). Both the MM ($F=0.918$, $p=0.455$) and LM ($F=1.739$, $p=0.159$) eyes each showed no effect of eccentricity.

Within-subject contrast testing revealed eccentricity was best explained with a quadratic fit for the MM ($F=6.140$, $p<0.05$) and LM ($F=6.953$, $p<0.05$) eyes.

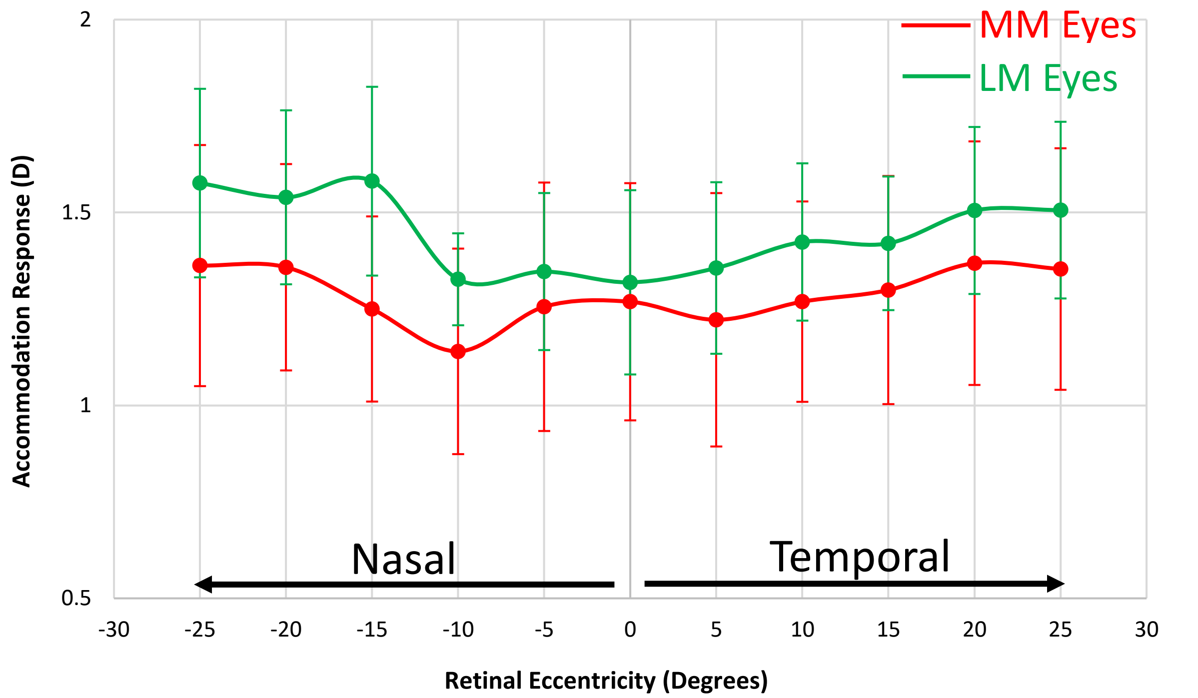


Figure 5.3. Average accommodative responses at each eccentricity (difference in baseline accommodation when viewing the 4m target and the 50cm target). Error bars represent the 95% confidence intervals.

5.3.2. Tonic Accommodation:

We have measured for the first time dark focus values across the central 60 degrees using a scanning peripheral aberrometer. Data for a total of 15 subjects (30 eyes) were used in the analyses. Eight subjects were excluded due to missing data either for the 4m condition or the dark focus condition.

As the sphericity assumption was violated, χ^2 (54)=202.853, $p<0.001$, a Huynh-Feldt correction was applied. There was a significant effect of eccentricity on the TA values (F=6.026, $p<0.001$). However, there was no main effect of eccentricity and eye (MM/LM) (F=1.528, p=0.188) (**Figure 5.4**). Pairwise comparisons showed significant differences in TA for the center (zero eccentricity) values compared to the 10, 15, 20 and 25deg temporal eccentricities ($p<0.05$ for all), with temporal TA being larger than on-axis TA. No differences were found for the nasal eccentricities ($p>0.19$ for all). Within-subject contrast testing revealed that eccentricity was best explained with a quadratic fit (F=17.267, $p<0.001$).

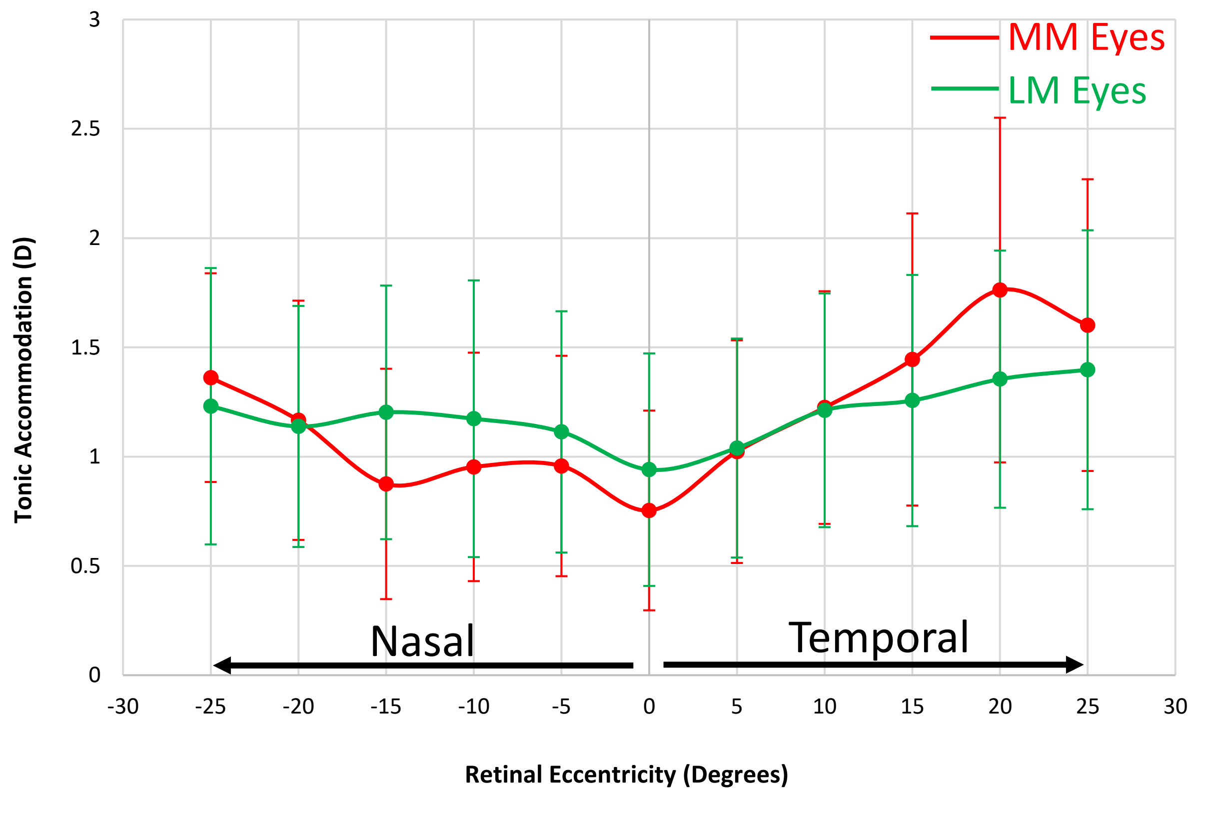


Figure 5.4. Average TA values at each eccentricity. The dark focus values for each subject were subtracted from the 4m viewing values to obtain the TA values. This was done to account for any baseline accommodation. Error bars represent the 95% confidence intervals.

After applying a Huynh-Feldt correction for violating sphericity (MM: χ^2 (54)=120.972, p<0.001; LM: χ^2 (54)=136.414, p<0.001), the MM eyes showed a significant effect of eccentricity (F=4.940, p=0.001) with higher TA values at more eccentric points, while the LM eyes did not (F=1.656, p=0.161). The MM eyes were also best explained with a quadratic fit (F=16.814, p=0.001), but the LM eyes didn't seem to follow any particular fit.

5.3.3. Correlation of On-Axis Accommodation Responses and TA with AXL

One subject was removed for the comparison analyses of accommodation response as their missing data could not be interpolated. On-axis AXL showed a significant negative correlation with on-axis TA in both the MM (p<0.05, r= -0.569) and LM (p<0.05, r= -0.537) eyes. This indicates that longer eyes show less TA on-axis. Comparisons of on-axis AXL to the on-axis accommodation response showed no significant relationship in either the MM (p=0.526, r= 0.203) or LM (p=0.649, r= -0.147) eyes. Overall, there were no distinct relations to set apart the MM or LM eyes of anisomyopes.

5.3.4. Correlation of Peripheral SA and Accommodation Response

SA variations while changing accommodation from 4m to 50cm were evaluated. After Huynh-Feldt correction was applied for violating the assumption of sphericity (χ^2 (54)=163.232, p<0.001), there was no effect of eccentricity on the SA values (F=1.499, p=0.185) (**Figure 5.5**). When divided into the MM and LM eyes, mixed model analysis of variance showed no significant effect of eccentricity on SA in the MM eyes (F=0.536, p=0.794) or the LM eyes (F=1.495, p=0.199). SA showed no specific fit for the MM eyes while a polynomial fit best explained the LM eyes (F=5.056, p<0.05).

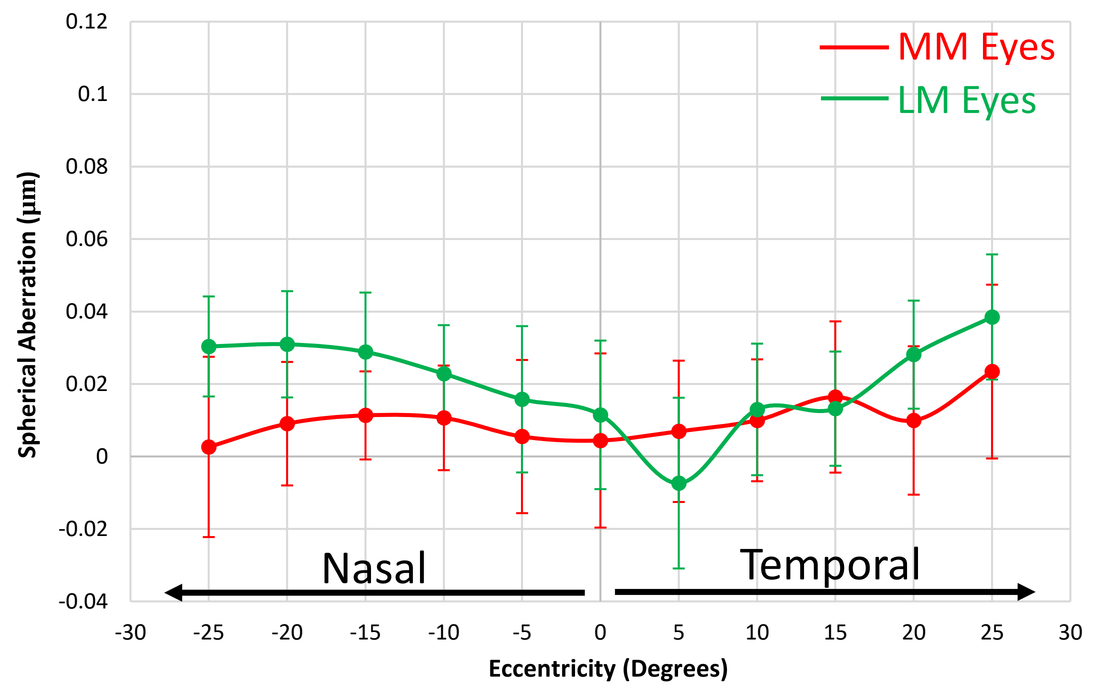


Figure 5.5. Average SA values of the accommodation response at each eccentricity. The 50cm viewing values for each subject were subtracted from the 4m viewing values to obtain the SA values present during the accommodative response state. Error bars represent the 95% confidence intervals.

Correlations between SA and accommodation responses showed a significant positive correlation for only 4 of the 12 MM eyes ($p<0.05$ for all) as well as 4 of the 12 LM eyes ($p<0.05$ for all). On-axis SA was compared to on-axis accommodation response values and this revealed a significant positive correlation in both the MM ($r=0.676$, $p<0.05$) and LM ($r=0.578$, $p<0.05$) eyes, indicating an increase in SA in both eyes during the accommodation response.

5.3.5. Correlation of Peripheral SA and TA

SA values were also evaluated during the TA condition. After Huynh-Feldt correction was applied for violating the assumption of sphericity (χ^2 (54)=220.598, $p<0.001$), we found a significant effect of eccentricity on the SA values ($F=4.162$, $p<0.01$) (**Figure 5.6**). There was no significant main effect of eccentricity and eye on the SA values. When analyzing each group separately, the MM eyes showed a significant effect of eccentricity on the SA values (F=3.464, p<0.01) while the LM did not (F=1.451, p=0.212). For the MM eyes, the SA increased with eccentricity, only temporally, not nasally. SA curves best fitted a polynomial for both the MM (F=14.393, p<0.01) and LM (F=5.116, p<0.01) eyes.

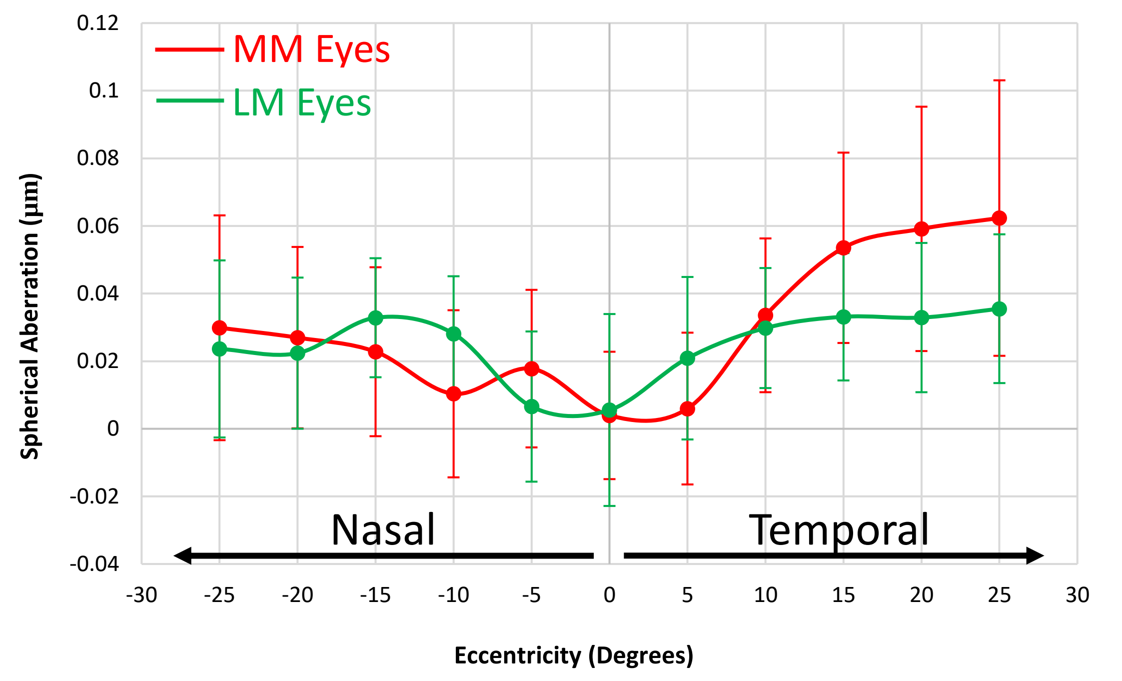


Figure 5.6. Average SA values at each eccentricity during TA. The dark focus values for each subject were subtracted from the 4m viewing values to obtain the SA values present during the TA state. This was done to account for any baseline accommodation. Error bars represent the 95% confidence intervals.

Correlations between peripheral SA and TA showed a significant positive correlation for 11 of the 15 MM eyes (p<0.05 for all), and 7 of the 15 LM eyes (p<0.05 for all). Comparison of on-axis SA to on-axis TA values revealed a significant positive correlation in the LM eyes (r=0.549, p<0.05), but not the MM eyes (r=0.149, p=0.597).

5.4. Discussion

Accommodation responses from far (4m) to near (50cm) do not significantly vary across the central 50 degrees in either the MM or LM eyes in individuals with anisomyopia. One of the possible reasons for this relative constancy has been attributed to a combined effect of lag of accommodation and change in curvature of field causing the peripheral refractive state to remain unchanged in myopes during accommodation [24]. It is noteworthy that as subjects accommodated at near (**Figure 5.2**), the MM eyes tended to show more lag of accommodation across the far periphery, which would imply more peripheral blur at near (50cm). Moreover, the MM eyes showed a larger lag of accommodation across the entire periphery during the accommodation response as compared to the LM eyes (**Figure 5.3**). The additional peripheral blur in the MM eyes may be associated with the development of more myopia in these eyes.

On the other hand, TA showed variation with ocular eccentricity. TA is larger temporally than central or nasal TA. And although we found no main effect of TA on eccentricity and eye (MM / LM), the MM eyes, but not the LM eyes, showed an effect of eccentricity, with significantly higher TA values temporally. The LM eyes on the other hand showed a flatter effect. This finding may be a mechanical consequence of the longer MM eyes or it may be a cause for these eyes becoming longer. TA on-axis shows a negative correlation with on-axis AXL, but since this correlation is similar between the MM and LM eyes, it is more likely that the peripheral eccentricity differences in TA noted in the MM eyes are a consequence of the eye shape. It is yet to be determined whether these variations of TA in the MM eyes of anisomyopes are associated with the development of myopia. Studies in children before and after they develop myopia are necessary to determine causality.

The lack of a main effect of eccentricity and eye (MM / LM) on TA may be due to there not being a high enough amount of anisomyopia in our subjects. However, since there was an effect of eccentricity in the MM eyes (as compared to the LM eyes), it is possible that higher amounts of myopia would result in more significant TA changes across the periphery. It would be important for future studies to not only increase the range of anisomyopia, but to increase the overall amount of myopia.

When we evaluated changes in SA during the accommodation response from 4m to 50cm we found that SA did not significantly change with accommodation response and it did not differ between the MM and LM eyes across the eccentricities tested in this study. However, when we compared both the MM and LM on-axis values, we found that both showed a positive correlation between SA and AXL, showing more positive SA while accommodating. These findings generally align with Wu and Jiang [86] who indirectly measured the effect of SA and found larger accommodative errors in progressing myopes than emmetropes and stable myopes. Buehren and Collins [93] also measured indirectly the effect of SA in a group of 10 subjects and found it was correlated with larger accommodation errors. Since the subjects wore soft contact lens correction during the aberrometer measurements, it is possible that some of the SA results found here are due to the inherent optics of the contact lenses. This may partly account for why we found SA values close to zero during accommodation whereas previous studies found a trend to more negative SA on-axis [94]. This is the first study to evaluate changes in SA with accommodation across the periphery. The use of optical correction was necessary for this experimental design, and soft contact lenses were preferred to glasses.

In addition, we report for the first time a significant effect of eccentricity in SA during the TA state. For the MM eyes, but not the LM eyes, SA increased with eccentricity temporally but not nasally. In the MM eyes, the resting state of accommodation results in more positive SA values. Whether this difference between the MM and LM eyes is a consequence of the ocular shape or is associated with the development of anisomyopia is yet to be determined.

6. General Discussion

In this thesis, the study of anisomyopia was divided into three sections. In the first study, the effect of central AXL on retinal thickness differences between the MM and LM eyes in anisomyopia at varying locations within the central 58 degrees were measured. The temporal retinae were found to be significantly thinner in both the MM and LM eyes compared to the nasal retinae. No differences in central (foveal) retinal thickness were found with increasing AXL. When comparing all the retinal thickness values between the fellow eyes in each individual subject, no significant differences between the MM and LM eyes were found, indicating a larger between-subjects than within-subjects effect. This intersubject variability suggests that retinal thickness is not associated with myopia development. It is possible that these results would be different if a group of subjects with greater anisomyopic differences had been tested.

In the second study, AXL across the central 40 degrees was evaluated. As expected, eccentricity had a significant effect on ocular length, with shorter AXL values in more peripheral locations for both the MM and LM eyes. Both eyes followed a quadratic fit with AXL. Surprisingly, AXL did not show any relationship with asphericity or curvature in the MM or LM eyes. Most eyes were prolate or close to spherical in shape as indicated by the small negative asphericity values. This may indicate that the shape of the eye is more likely a result of myopia rather than a factor in its development. Optical quality was evaluated - characterized by VSOTF values and optical shape (AXL) - across the central 50 degrees in the MM and LM eyes in anisomyopia. VSOTF values did not vary across the periphery, or individually between the MM and LM eyes. However, between-subjects analyses revealed that on-axis AXL negatively affected on-axis VSOTF in both the MM and LM eyes. Lower VSOTF values were found in longer eyes for different individuals, but the MM eye did not show worse optical quality compared to the LM eye within each subject. This again suggests a lack of association of peripheral optical quality with myopia development as our findings imply that it does not drive asymmetric myopization within an individual. It is more likely that the reduction in optical quality is due to the myopia, and there are other factors that allow the fellow eyes of anisomyopes to maintain relatively equal optical quality.

In the third study, accommodation responses and TA were evaluated across the central 50 degrees in the MM and LM eyes of a group of anisomyopes. The accommodation response did not significantly differ across the central 50 degrees in either the MM or LM eyes, which agreed with previous studies. TA values on the other hand varied with eccentricity, with higher TA values temporally than on-axis or nasally. This was noted in the MM eyes, but not the LM eyes. This finding may play a role in understanding myopia etiology and progression. It brings up the question of whether the increase in TA values seen only in MM eyes is a mechanical consequence of these eyes becoming longer or a cause. Although, when comparing on-axis AXL to on-axis accommodation responses and TA values, there were no differences between the MM and LM eyes. This suggests that the peripheral differences found in TA are more likely a result of ocular elongation and myopia rather than a driver of its development. Finally, SA did not vary across the retina during the accommodation response. When comparing the on-axis values of both the MM and LM eyes, there was a positive correlation between SA and accommodation response. Both the MM and LM eyes showed more positive SA during the accommodation response. Furthermore, SA did vary significantly during the TA state. When analyzed individually, the MM eyes only showed an increase in SA with eccentricity temporally, but not nasally. Overall, in the MM eyes, the TA state resulted in more positive SA values. More research is needed to better know whether this difference between the MM and LM eyes is a consequence of the eye’s shape or if it’s linked to the development of anisomyopia, and by extension myopia.

The main goal of this thesis was to gain a deeper understanding of anisomyopia and how different optical, biometric, functional and structural parameters are affected by it through an evaluation of differences between the MM and LM fellow eyes. Overall, while there were differences between subjects, there were few differences between the MM and LM eyes of a given individual. When these differences were present between the MM and LM eyes, secondary analyses indicated that neither of the factors investigated were causative, but rather a consequence of ocular elongation and myopia development.

It would be interesting to know if the myopia boom that has occurred over the past few decades is accompanied by an “anisomyopia boom”. We know that as the amount of myopia increases the risk of anisomyopia is greater [26,27,95]. However, currently there is not enough evidence to correlate the rate of increase in anisomyopia to that of regular myopia. If there was no correlation, that may indicate that the development of anisomyopia could have a different mechanism than the development of isomyopia.

Anisomyopia is a fascinating field of research because there is limited knowledge compared to other refractive states and understanding it further can help us understand the development of myopia in general. My original interest in this topic came from the fact that I have anisomyopia. I never really appreciated that I had a difference between my eyes, and once I started learning more about it, it served as a driver to want to understand why it happened. There is still a large amount of research that needs to be done, but with this project, I hope to have offered more to the discussion and understanding of this unique - and often challenging refractive condition.

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8. Appendix I – Raw Aberrometer data for the 4m cc condition

METRIC	MEASURE	EYE	ZERNIKE_ORDER	MEASURE_DIAMETER [mm]	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1
Sphere	R59436	OD	5	4	4.255625	3.90977	3.916737	3.75824	3.704672		3.441963	3.135411			2.223796	1.939805	1.927464	1.80141	1.655685	1.498453	1.420029	1.373107	1.332468	1.19284	1.032165	0.858603	0.729358	0.643878	0.458567	0.107986	-0.00012
Cylinder	R59436	OD	5	4	-2.93559	-2.329	-2.19809	-1.56095	-1.4632		-1.06519	-0.88796			-0.2295	-0.15626	-0.41292	-0.48259	-0.39567	-0.55416	-0.59517	-0.7997	-0.86475	-0.84261	-0.89207	-0.88254	-0.89156	-0.81567	-0.86771	-0.80344	-0.74636
Axis	R59436	OD	5	4	95	98	94	90	92		89	85			66	40	30	17	19	17	19	14	13	10	17	16	11	12	10	5	19
M	R59436	OD	5	4	2.787828	2.745271	2.81769	2.977765	2.973072		2.909368	2.691432			2.109049	1.861675	1.721006	1.560113	1.457849	1.221372	1.122444	0.973255	0.900094	0.771535	0.586132	0.417333	0.283578	0.236043	0.024713	-0.29373	-0.3733
J0	R59436	OD	5	4	-1.44891	-1.12287	-1.08761	-0.78004	-0.72993		-0.53149	-0.43722			-0.07494	0.013095	0.102869	0.197849	0.154222	0.232234	0.235074	0.353356	0.385183	0.397382	0.371226	0.372131	0.412673	0.372745	0.41031	0.395928	0.293299
J45	R59436	OD	5	4	-0.22999	-0.30883	-0.15834	0.009539	-0.04956		0.024207	0.080897			0.085347	0.076672	0.178925	0.138053	0.124046	0.150816	0.182055	0.187281	0.196494	0.138998	0.246394	0.236957	0.170864	0.165652	0.141536	0.072246	0.230588
RMSHOA	R59436	OD	5	4	0.840567	0.74972	0.712064	0.643834	0.589355		0.504322	0.409323			0.332695	0.293189	0.255903	0.199369	0.179386	0.151307	0.140195	0.140723	0.15615	0.12624	0.14887	0.117679	0.115553	0.139997	0.125418	0.154434	0.134136
Z12	R59436	OD	5	4	0.128231	0.102133	0.089983	0.071306	0.090197		0.05253	0.006994			-0.00318	-0.03038	-0.00144	0.011546	-0.00352	-0.0244	-0.01049	-0.01853	-0.01767	-0.02037	-0.02919	-0.0184	-0.0273	-0.01514	-0.03415	-0.06879	-0.01143
COMA	R59436	OD	5	4	0.637664	0.52183	0.476972	0.384635	0.356344		0.23538	0.1695			0.084386	0.062516	0.05068	0.014181	-0.0057	-0.01373	-0.0184	-0.03241	-0.03006	-0.03418	-0.03924	-0.04273	-0.03771	-0.07964	-0.07441	-0.05351	-0.0519
Z6	R59436	OD	5	4	0.095684	0.092237	0.118798	0.111229	0.106507		0.094115	0.066702			0.08434	0.065187	0.058454	0.068308	0.053565	0.010602	0.039354	0.026059	-0.01614	0.005448	0.008837	-0.01933	-0.0082	-0.01618	0.005331	-0.00829	-0.02604
Z7	R59436	OD	5	4	0.279266	0.286993	0.309341	0.296115	0.265344		0.293233	0.278651			0.2145	0.198472	0.176557	0.104161	0.101255	0.093267	0.089056	0.095773	0.09237	0.077377	0.087389	0.0606	0.073373	0.063521	0.045876	0.045451	0.042701
Z8	R59436	OD	5	4	0.637664	0.52183	0.476972	0.384635	0.356344		0.23538	0.1695			0.084386	0.062516	0.05068	0.014181	-0.0057	-0.01373	-0.0184	-0.03241	-0.03006	-0.03418	-0.03924	-0.04273	-0.03771	-0.07964	-0.07441	-0.05351	-0.0519
Z9	R59436	OD	5	4	0.365143	0.353804	0.300033	0.279354	0.279391		0.235567	0.155346			0.152007	0.094139	0.072966	0.079044	0.064538	0.067672	0.034763	0.040114	0.06656	0.032062	0.036051	-0.01127	-0.00643	0.006686	0.024171	0.02275	0.055189
Z10	R59436	OD	5	4	-0.08058	-0.00927	-0.00125	-0.0142	-0.00812		0.009353	0.012579			0.044272	0.054544	0.035184	0.045274	0.050903	0.036765	0.043911	0.027646	-0.01043	0.008074	-0.0016	-0.01682	-0.01023	-0.01178	-0.0134	-0.04249	-0.02114
Z11	R59436	OD	5	4	-0.0374	-0.02794	-0.02345	0.00623	0.000464		0.016817	0.025719			0.050421	0.059025	0.065354	0.053729	0.030325	0.03393	0.025101	0.033627	0.043615	0.036481	0.042056	0.029758	0.019044	0.044002	0.008326	-0.01261	0.025333
Z12	R59436	OD	5	4	0.128231	0.102133	0.089983	0.071306	0.090197		0.05253	0.006994			-0.00318	-0.03038	-0.00144	0.011546	-0.00352	-0.0244	-0.01049	-0.01853	-0.01767	-0.02037	-0.02919	-0.0184	-0.0273	-0.01514	-0.03415	-0.06879	-0.01143
Z13	R59436	OD	5	4	0.189222	0.193255	0.190853	0.186714	0.164356		0.161662	0.141066			0.087194	0.071473	0.074551	0.060402	0.025847	0.050987	0.019944	0.021884	0.032463	0.02854	0.023167	0.02341	0.02208	0.008633	0.01833	0.001168	-0.00153
Z14	R59436	OD	5	4	0.011388	0.051334	0.069623	0.080128	0.062404		0.03458	0.01326			0.04871	0.016882	0.018723	0.032606	0.02907	0.013432	0.034284	0.018098	0.027254	0.010203	0.03256	-0.0052	0.003285	0.006206	0.003277	-0.01525	0.007348
Z15	R59436	OD	5	4	-0.03922	-0.07544	-0.08939	-0.07163	-0.04925		-0.03579	-0.01728			0.005984	0.038836	0.028549	-0.00277	0.033592	0.021311	0.019756	0.019272	0.025302	0.01829	0.030562	0.027732	0.026737	0.000121	0.031073	0.004472	0.042669
Z16	R59436	OD	5	4	-0.0626	-0.05126	-0.06792	-0.06797	-0.05769		-0.0462	-0.04367			-0.0293	-0.0254	-0.00412	-0.0168	-0.01102	-0.00747	-0.01667	-0.008	-0.00306	-0.02065	-0.00591	-0.01689	-0.00992	0.010091	-0.01463	-0.00511	-0.01011
Z17	R59436	OD	5	4	0.000169	-0.0023	-0.00476	0.015832	-0.00464		-0.00386	0.007924			0.028317	0.004455	0.009347	0.061872	0.033953	0.015104	0.029601	0.011575	0.009243	0.02237	0.026082	0.013285	0.001189	0.001249	0.005959	0.010844	0.015303
Z18	R59436	OD	5	4	0.066041	0.078426	0.092642	0.09403	0.098459		0.088203	0.071587			0.037986	0.038854	0.03579	0.042785	0.022226	0.012444	-0.00516	-0.01216	-0.00885	-0.01252	-0.01031	0.007617	-0.00832	-0.00739	0.002361	-0.00025	0.027133
Z19	R59436	OD	5	4	-0.03855	0.00147	0.005526	0.040149	0.034054		0.033898	0.040753			0.028388	0.035692	0.030834	0.002529	0.0037	0.005777	0.019532	-0.00216	0.015415	0.006553	0.007781	-0.00444	-0.01165	-0.00658	-0.01258	-0.03416	-0.02513
Z20	R59436	OD	5	4	-0.02994	-0.0203	-0.01474	-0.03112	-0.02514		0.020821	0.006195			0.021685	0.028519	0.00626	0.026199	0.027116	0.028585	0.010598	0.005319	0.027492	0.027361	0.030702	0.030951	0.019869	0.045401	0.016619	0.005066	0.015018

METRIC	MEASURE	EYE	ZERNIKE_ORDER	MEASURE_DIAMETER [mm]	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Sphere	R59436	OD	5	4	-0.41836	-0.3693	-0.48142	-0.53304	-0.93511	-1.25356	-1.27996	-1.60425	-1.67652	-1.88614	-2.10266	-1.98403	-2.59964	-2.62137	-2.70328	-2.66815		-2.18643	-2.70023	-2.71828	-2.77393	-2.76298	-3.02085				-1.90043	-1.80374
Cylinder	R59436	OD	5	4	-0.55558	-0.48996	-0.42308	-0.45383	-0.20038	-0.14884	-0.09361	-0.097	-0.2429	-0.11365	-0.32369	-0.54267	-0.05762	-0.2993	-0.47321	-0.5445		-0.55001	-0.46741	-0.74173	-0.69664	-0.67743	-0.75705				-1.24059	-1.23122
Axis	R59436	OD	5	4	1	4	18	11	23	99	26	53	77	45	29	69	135	90	99	95		93	105	98	105	103	113				104	106
M	R59436	OD	5	4	-0.69615	-0.61428	-0.69296	-0.75995	-1.0353	-1.32799	-1.32677	-1.65275	-1.79798	-1.94297	-2.2645	-2.25536	-2.62845	-2.77102	-2.93988	-2.9404		-2.46143	-2.93394	-3.08915	-3.12225	-3.10169	-3.39937				-2.52072	-2.41935
J0	R59436	OD	5	4	0.278012	0.242141	0.170028	0.210861	0.07017	-0.07028	0.02855	-0.01358	-0.10873	-0.0008	0.085198	-0.20164	-5.29E-18	-0.14989	-0.22392	-0.26796		-0.2735	-0.20021	-0.35563	-0.30058	-0.30603	-0.25957				-0.55282	-0.52186
J45	R59436	OD	5	4	0.012548	0.034181	0.125285	0.083626	0.072209	-0.02569	0.036202	0.046564	0.053882	0.056979	0.138642	0.181559	-0.02881	0.000471	-0.07777	-0.0487		-0.02875	-0.12043	-0.10804	-0.1763	-0.14458	-0.27815				-0.28162	-0.32651
RMSHOA	R59436	OD	5	4	0.138095	0.209152	0.264736	0.196317	0.217285	0.114213	0.176846	0.140907	0.150263	0.183233	0.247207	0.226557	0.278393	0.272607	0.21403	0.236237		0.180568	0.165586	0.179514	0.245617	0.229971	0.241822				0.202024	0.194531
Z12	R59436	OD	5	4	-0.05732	-0.04766	-0.04006	-0.01614	-0.02249	-0.04524	-0.04007	-0.04158	-0.02744	-0.07076	-0.08393	-0.06959	-0.08287	-0.08228	-0.09363	-0.09989		-0.13373	-0.07344	-0.06728	-0.09134	-0.06948	-0.07028				-0.05751	-0.05795
COMA	R59436	OD	5	4	-0.03088	-0.09853	-0.15194	-0.13354	-0.13097	-0.0423	-0.10592	-0.0286	-0.01676	-0.03791	-0.06318	-0.02791	-0.11632	-0.05322	-0.07383	0.007054		0.011047	-0.01647	-0.02435	-0.04695	-0.07653	-0.04381				-0.06723	-0.08458
Z6	R59436	OD	5	4	-0.01411	-0.03798	-0.05314	-0.07687	-0.04482	-0.01554	-0.01958	0.013824	0.020577	0.02953	-0.02449	0.084019	-0.03661	0.068456	0.034189	0.118191		0.035827	0.020261	0.046282	0.103042	0.112408	0.017601				0.055583	0.033436
Z7	R59436	OD	5	4	0.052266	0.057782	0.011086	0.006219	0.01833	0.022921	0.044329	0.037095	0.007031	0.018353	0.011218	0.036915	0.023528	0.004582	0.029785	0.03691		0.057548	0.048066	0.067226	0.056328	0.048392	0.107006				0.128889	0.107259
Z8	R59436	OD	5	4	-0.03088	-0.09853	-0.15194	-0.13354	-0.13097	-0.0423	-0.10592	-0.0286	-0.01676	-0.03791	-0.06318	-0.02791	-0.11632	-0.05322	-0.07383	0.007054		0.011047	-0.01647	-0.02435	-0.04695	-0.07653	-0.04381				-0.06723	-0.08458
Z9	R59436	OD	5	4	0.003976	-0.03331	-0.12024	0.005804	0.028495	0.002986	-0.0569	0.004704	-0.05837	-0.07799	-0.11506	-0.09506	-0.09486	-0.13222	-0.06412	-0.01139		-0.03981	-0.00656	-0.02457	-0.01238	-0.02272	0.092655				0.053371	0.038298
Z10	R59436	OD	5	4	-0.06244	-0.00769	0.002017	0.009626	-0.01657	0.017666	-0.00973	0.00069	0.021619	-0.01074	0.023134	-0.03714	0.047826	-0.0235	-0.0214	-0.04545		-0.01571	-0.00146	0.001281	-0.03284	-0.02215	-0.02168				-0.00895	0.012306
Z11	R59436	OD	5	4	-0.00573	0.010851	0.030479	0.017363	0.024395	0.000522	0.0139	0.009694	0.010794	0.011002	0.031791	0.003458	0.048995	0.033092	0.011107	0.02444		0.004429	0.001409	0.004417	-0.01104	-0.00127	-0.00983				-0.02875	-0.0203
Z12	R59436	OD	5	4	-0.05732	-0.04766	-0.04006	-0.01614	-0.02249	-0.04524	-0.04007	-0.04158	-0.02744	-0.07076	-0.08393	-0.06959	-0.08287	-0.08228	-0.09363	-0.09989		-0.13373	-0.07344	-0.06728	-0.09134	-0.06948	-0.07028				-0.05751	-0.05795
Z13	R59436	OD	5	4	-0.01743	-0.03464	-0.06684	-0.00732	-0.04287	-0.03561	-0.05065	-0.06402	-0.0491	-0.06243	-0.0393	-0.12548	0.003191	-0.06619	-0.07071	-0.09253		-0.06801	-0.03591	-0.06708	-0.06776	-0.02682	0.004555				-0.03198	-0.00998
Z14	R59436	OD	5	4	0.003223	-0.00025	0.042805	-0.04429	-0.00651	0.022412	0.046947	0.058846	0.082025	0.088627	0.088499	0.032773	0.162936	0.11324	0.085134	0.046029		0.045237	0.062302	0.044487	0.066515	0.039584	-0.01304				0.001471	0.068535
Z15	R59436	OD	5	4	0.020002	0.010784	-0.00215	0.019194	0.0375	-0.00731	0.017707	-0.01464	-0.00952	0.026426	-0.02622	0.052058	0.040949	0.043032	0.02193	0.060289		-0.00576	0.014907	-0.00027	0.02538	0.018131	0.04063				0.019875	-0.02744
Z16	R59436	OD	5	4	-0.01012	-0.00477	-0.00846	-0.0242	-0.02752	-0.01386	-0.02102	-0.01319	-0.0293	-0.01941	-0.03496	-0.02181	-0.05796	-0.053	-0.03574	-0.03439		-0.01934	-0.00778	-0.03575	-0.03852	-0.04084	-0.04729				-0.03163	-0.02458
Z17	R59436	OD	5	4	0.008855	0.018872	0.024693	0.012505	-0.00458	0.004972	-0.00277	0.006136	0.012631	0.032911	0.020929	0.03507	-0.02629	0.009296	0.014161	0.003081		0.018896	0.013319	0.016456	0.022242	0.009938	0.019712				0.012931	0.012874
Z18	R59436	OD	5	4	0.008224	0.009162	0.023352	-0.00248	-0.01238	0.018379	0.004641	0.006436	-0.01223	0.011802	0.014163	0.007067	0.034403	0.0117	0.013913	0.011822		-0.01919	-0.04587	-0.01971	-0.02413	-0.01719	-0.04136				-0.02478	-0.03421
Z19	R59436	OD	5	4	-0.02592	-0.00691	0.018155	-0.0019	0.001902	0.005252	0.010124	0.001297	0.012898	0.024148	0.030695	0.044024	-0.05567	0.015779	0.006107	0.005055		0.010669	0.006117	0.027974	0.028289	0.004876	-0.03376				-0.00554	0.007681
Z20	R59436	OD	5	4	0.015125	0.012729	0.005257	0.04645	0.028398	0.00988	-0.02942	-0.03081	-0.02218	-0.0251	-0.00587	-0.06028	-0.07042	-0.04201	-0.03376	0.013471		0.01525	0.011311	0.008879	-0.0024	0.013129	0.029884				0.059511	0.029177

A1.1a. Raw data for the 4m viewing condition. This is the data for the right eye of subject ANI001. This data was successfully collected for most subjects, and for the 50cm and DF viewing conditions.

METRIC	MEASURE	EYE	ZERNIKE _ORDER	MEASURE_ DIAMETER [mm]	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1
Sphere	R59741	OS	5	4	0.069454	-0.12149	-0.18615	-0.25983	-0.42766	-0.55394	-0.66937	-0.68839	-0.37183	-0.39036	-0.84271	-1.39169	-1.02262	-1.03529	-1.29922	-1.01635	-0.85886	-0.80606	-0.70739	-0.54013	-0.53651	-0.40266	-0.35589	-0.44648	-0.43063	-0.46	-0.51481
Cylinder	R59741	OS	5	4	-0.93159	-0.71773	-0.66075	-0.45213	-0.33595	-0.25857	-0.22974	-0.09282	-0.07522	-0.16056	-0.22321	-0.28284	-0.25307	-0.5895	-0.48063	-0.61222	-0.56038	-0.51436	-0.53753	-0.55626	-0.50296	-0.57035	-0.58005	-0.51348	-0.58611	-0.59229	-0.54689
Axis	R59741	OS	5	4	79	78	76	70	69	63	98	101	124	132	151	133	170	179	180	176	175	177	171	167	172	169	169	168	172	170	173
M	R59741	OS	5	4	-0.39634	-0.48036	-0.51653	-0.48589	-0.59563	-0.68323	-0.78424	-0.7348	-0.40944	-0.47064	-0.95432	-1.53312	-1.14915	-1.33004	-1.53954	-1.32246	-1.13905	-1.06324	-0.97616	-0.81827	-0.78799	-0.68784	-0.64592	-0.70322	-0.72369	-0.75614	-0.78825
J0	R59741	OS	5	4	-0.432	-0.32573	-0.29017	-0.17457	-0.1255	-0.07702	-0.11046	-0.0432	-0.01408	-0.00884	0.060969	-0.00804	0.119322	0.294593	0.240211	0.303096	0.275933	0.255354	0.257085	0.250252	0.242755	0.263725	0.268703	0.235921	0.281598	0.27765	0.264898
J45	R59741	OS	5	4	0.17373	0.149871	0.157987	0.14366	0.111925	0.103338	-0.03057	-0.01751	-0.03469	-0.08043	-0.09346	-0.14028	-0.04249	-0.01125	-0.00356	-0.04211	-0.04598	-0.02782	-0.07979	-0.12126	-0.06717	-0.1093	-0.10933	-0.10153	-0.08184	-0.10308	-0.06858
RMSHOA	R59741	OS	5	4	0.265432	0.248437	0.2252	0.21293	0.206944	0.205365	0.20953	0.21549	0.2274	0.367965	0.246819	0.274182	0.234259	0.234699	0.229783	0.233453	0.222038	0.224886	0.204398	0.225434	0.205136	0.195198	0.192183	0.195087	0.178278	0.183425	0.189688
Z12	R59741	OS	5	4	-0.008	-0.01348	-0.01085	-0.00253	0.001324	0.002103	0.000228	0.002201	-0.00663	0.028558	0.017283	0.003759	0.008985	0.002176	-0.00483	-0.01682	-0.02228	-0.02671	-0.03543	-0.03539	-0.03604	-0.03447	-0.03967	-0.03659	-0.03523	-0.04129	-0.04387
COMA	R59741	OS	5	4	0.006667	-0.02551	-0.02251	-0.03494	-0.03629	-0.04297	-0.0573	-0.07648	-0.08873	-0.10882	-0.10916	-0.09756	-0.11191	-0.11405	-0.12714	-0.11536	-0.11579	-0.11237	-0.10982	-0.12009	-0.10984	-0.10593	-0.09213	-0.08478	-0.08862	-0.08107	-0.07504
Z6	R59741	OS	5	4	-0.05554	-0.05884	-0.05827	-0.06307	-0.07352	-0.05659	-0.07399	-0.08921	-0.08573	-0.19788	-0.09604	-0.1368	-0.10595	-0.10375	-0.09138	-0.0992	-0.07224	-0.08041	-0.05595	-0.07753	-0.05965	-0.05902	-0.06274	-0.042	-0.0454	-0.05976	-0.04
Z7	R59741	OS	5	4	0.190687	0.189386	0.174154	0.160937	0.155015	0.159343	0.14679	0.14533	0.153405	0.167698	0.166585	0.185849	0.140756	0.155073	0.134145	0.144935	0.146957	0.142529	0.12431	0.135261	0.128776	0.122982	0.125066	0.139404	0.121644	0.12654	0.137435
Z8	R59741	OS	5	4	0.006667	-0.02551	-0.02251	-0.03494	-0.03629	-0.04297	-0.0573	-0.07648	-0.08873	-0.10882	-0.10916	-0.09756	-0.11191	-0.11405	-0.12714	-0.11536	-0.11579	-0.11237	-0.10982	-0.12009	-0.10984	-0.10593	-0.09213	-0.08478	-0.08862	-0.08107	-0.07504
Z9	R59741	OS	5	4	0.127001	0.088452	0.086407	0.072078	0.057836	0.053041	0.035954	0.035816	0.007447	-0.11524	0.039849	0.006079	-0.00381	0.004982	-0.00842	-0.01719	-0.00598	-0.01099	0.000639	-0.01224	-0.00143	0.002629	-0.00017	0.001631	-0.00214	0.010205	0.014298
Z10	R59741	OS	5	4	0.030271	0.014472	0.010758	-0.00958	-0.00499	0.00243	-0.01779	-0.02061	-0.00816	0.082828	-0.00642	-0.0213	-0.04168	-0.04239	-0.0364	-0.03692	-0.01656	-0.03235	-0.03527	-0.03816	-0.03263	-0.03469	-0.03763	-0.03568	-0.04077	-0.02853	-0.02794
Z11	R59741	OS	5	4	0.037075	0.028317	0.019325	0.012393	0.003263	-0.0084	-0.01933	-0.01727	-0.02863	-0.05117	-0.02484	-0.05414	-0.03529	-0.0204	-0.02725	-0.02823	-0.03164	-0.02567	-0.03198	-0.02698	-0.02388	-0.01419	-0.02148	-0.00935	-0.0102	-0.0146	0.003711
Z12	R59741	OS	5	4	-0.008	-0.01348	-0.01085	-0.00253	0.001324	0.002103	0.000228	0.002201	-0.00663	0.028558	0.017283	0.003759	0.008985	0.002176	-0.00483	-0.01682	-0.02228	-0.02671	-0.03543	-0.03539	-0.03604	-0.03447	-0.03967	-0.03659	-0.03523	-0.04129	-0.04387
Z13	R59741	OS	5	4	0.013764	0.028691	0.024647	0.018224	0.017673	0.024525	0.018018	0.019554	0.032606	0.05723	0.027713	0.032584	0.017059	0.033177	0.007521	0.006935	0.002827	-0.00648	-0.01254	-0.02307	-0.02687	-0.02531	-0.0232	-0.02256	-0.0197	-0.01756	-0.02247
Z14	R59741	OS	5	4	0.016148	0.029869	0.018504	-0.00796	0.003076	0.021202	0.033242	0.025695	0.034447	0.00736	0.025403	0.012006	0.004565	-0.00762	-0.02036	-0.01383	0.000827	-0.00483	-0.00381	-0.01428	-0.01362	-0.00091	-0.00133	0.00138	0.011396	0.012504	0.002078
Z15	R59741	OS	5	4	-0.06609	-0.05165	-0.04697	-0.03088	-0.03934	-0.02064	-0.0266	-0.013	-0.01559	-0.03415	-0.00087	-0.01383	-0.0066	-0.00077	-0.00744	0.003828	-0.00218	-0.00867	0.003237	-0.00553	-0.00914	-0.01466	0.004435	0.004076	-0.00084	0.018119	-0.00133
Z16	R59741	OS	5	4	-0.00757	0.002094	0.006151	0.018347	0.015278	0.029193	0.041798	0.046116	0.03456	0.006409	0.019602	0.034808	0.024726	0.009006	0.01012	0.019619	0.009175	0.016832	0.010355	0.007043	0.007726	0.001551	-0.00731	-0.00693	-0.00679	-0.00911	-0.00967
Z17	R59741	OS	5	4	-0.00668	0.000733	0.003456	0.017366	0.013498	0.01714	0.023392	0.012477	0.029277	-0.00475	0.018057	0.008205	0.005415	-0.00441	-0.00529	-0.00971	-0.02113	-0.01223	-0.01464	-0.01897	-0.0145	-0.02052	-0.01113	-0.02129	-0.01391	-0.02211	-0.02758
Z18	R59741	OS	5	4	0.007527	0.012062	0.007759	0.006895	0.006995	-0.00403	0.001924	0.002213	0.007418	0.023911	0.013385	0.021896	0.036031	0.039067	0.05035	0.042011	0.043296	0.039288	0.022241	0.033697	0.022521	0.014591	0.009698	0.009637	0.009999	-0.00066	-0.01453
Z19	R59741	OS	5	4	0.007652	0.008935	-0.00195	-0.0026	0.004409	-0.01545	-0.02338	-0.0153	-0.004	-0.06839	-0.01151	-0.00667	-0.00822	0.003135	-0.0122	-0.00507	-0.00473	-0.00612	-0.00865	-0.01038	-0.0062	-0.00278	-0.01401	-0.00987	-0.00458	-0.00872	-0.01358
Z20	R59741	OS	5	4	0.005656	0.008252	0.008223	-0.00122	0.004241	-0.00405	-0.0158	-0.00441	-0.00473	0.007212	-0.00353	-0.01171	-0.00549	0.000886	0.006931	-0.00196	0.020225	0.003366	-0.00336	0.000693	0.011184	-0.00177	-0.00226	0.00687	0.006136	0.002239	0.002013

METRIC	MEASURE	EYE	ZERNIKE _ORDER	MEASURE_ DIAMETER [mm]	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Sphere	R59741	OS	5	4	-0.45513	-0.38303	-0.28417	-0.25167	-0.19417	-0.2773	-0.23438	-0.2742	-0.35261	-0.29858	-0.41494	-0.3495	-0.41024	-0.39349	-0.44557	-0.35068	-0.32947	-0.23678	-0.17484	-0.06989	0.085519	0.21363	0.228554	0.448872	0.538507	0.632846	0.759455	0.827202
Cylinder	R59741	OS	5	4	-0.6713	-0.66769	-0.65058	-0.64564	-0.69296	-0.54504	-0.58034	-0.50314	-0.55798	-0.53304	-0.35668	-0.37103	-0.26364	-0.13473	-0.07265	-0.14796	-0.07052	-0.1006	-0.11789	-0.13584	-0.26441	-0.31531	-0.26836	-0.37666	-0.47403	-0.53702	-0.66581	-0.74889
Axis	R59741	OS	5	4	173	168	166	169	164	176	3	5	1	3	6	178	178	175	16	155	7	155	161	146	126	136	114	121	123	116	115	112
M	R59741	OS	5	4	-0.79078	-0.71688	-0.60946	-0.57449	-0.54065	-0.54982	-0.52456	-0.52577	-0.6316	-0.5651	-0.59328	-0.53501	-0.54206	-0.46085	-0.4819	-0.42466	-0.36473	-0.28708	-0.23378	-0.13781	-0.04669	0.055973	0.094375	0.260541	0.301494	0.364337	0.426548	0.452755
J0	R59741	OS	5	4	0.327254	0.307481	0.286736	0.298861	0.293596	0.2689	0.289083	0.247624	0.278015	0.265841	0.175022	0.18512	0.131334	0.066927	0.030835	0.047313	0.03461	0.032204	0.046325	0.024678	-0.04436	0.005136	-0.08886	-0.09112	-0.09938	-0.16651	-0.21875	-0.27456
J45	R59741	OS	5	4	-0.07446	-0.12983	-0.1531	-0.12357	-0.18485	-0.04401	0.031695	0.039799	0.009973	0.028999	0.032802	-0.01026	-0.01098	-0.01125	0.018953	-0.05721	0.009431	-0.0384	-0.03712	-0.06328	-0.1253	-0.15782	-0.10073	-0.16486	-0.21514	-0.21077	-0.25101	-0.25439
RMSHOA	R59741	OS	5	4	0.16554	0.179634	0.183014	0.167838	0.184655	0.148533	0.152751	0.163513	0.150946	0.127151	0.133805	0.128937	0.141943	0.137342	0.152105	0.13982	0.138721	0.13997	0.134363	0.137351	0.146671	0.156957	0.123461	0.138402	0.141418	0.160935	0.190978	0.209515
Z12	R59741	OS	5	4	-0.04229	-0.04071	-0.04833	-0.04531	-0.0512	-0.04332	-0.04471	-0.04253	-0.05842	-0.04511	-0.04213	-0.03523	-0.03798	-0.05024	-0.04645	-0.04641	-0.05059	-0.04306	-0.05043	-0.03068	-0.02846	-0.04211	-0.03046	-0.01636	-0.02444	-0.01291	-0.001	-0.00588
COMA	R59741	OS	5	4	-0.06025	-0.05624	-0.07379	-0.0456	-0.06621	-0.0032	-0.02351	-0.03639	-0.02485	-0.00046	0.003503	0.02124	-0.01478	-0.02579	-0.03602	-0.01773	-0.02221	-0.01219	-0.00776	0.0047	-0.00307	-0.01174	-0.02384	-0.02343	-0.02601	-0.05462	-0.08686	-0.09826
Z6	R59741	OS	5	4	-0.03653	-0.04379	-0.04458	-0.02625	-0.03689	-0.02367	-0.01248	-0.00632	-0.02354	-0.00534	-0.02163	-0.03256	-0.0208	-0.01026	-0.01701	-0.0182	-0.01504	-0.02819	-0.02486	-0.04709	-0.04379	-0.02352	-0.04215	-0.02526	-0.01535	-0.02064	0.014107	0.00978
Z7	R59741	OS	5	4	0.122256	0.130722	0.130193	0.119881	0.123329	0.114082	0.114597	0.093715	0.098339	0.077979	0.068815	0.074221	0.086121	0.085828	0.092145	0.08452	0.082189	0.073063	0.069556	0.07414	0.073085	0.07427	0.07048	0.068465	0.064761	0.073414	0.080343	0.085199
Z8	R59741	OS	5	4	-0.06025	-0.05624	-0.07379	-0.0456	-0.06621	-0.0032	-0.02351	-0.03639	-0.02485	-0.00046	0.003503	0.02124	-0.01478	-0.02579	-0.03602	-0.01773	-0.02221	-0.01219	-0.00776	0.0047	-0.00307	-0.01174	-0.02384	-0.02343	-0.02601	-0.05462	-0.08686	-0.09826
Z9	R59741	OS	5	4	0.021343	0.022423	0.028473	0.022105	0.033508	0.019665	0.021647	0.030951	0.021927	0.037798	0.043395	0.034578	0.041476	0.04101	0.033419	0.037452	0.025851	0.054855	0.042957	0.050238	0.060795	0.043873	0.020129	0.028252	0.009759	0.004831	-0.01352	-0.03532
Z10	R59741	OS	5	4	-0.0329	-0.03209	-0.01199	-0.02313	-0.02293	-0.01336	-0.00808	-0.01389	0.004499	-0.00062	-0.00297	0.002486	0.008947	-0.01993	-0.005	-0.01709	0.00761	-0.02487	-0.0398	-0.03911	-0.04217	-0.07545	-0.0454	-0.05715	-0.07561	-0.08828	-0.08665	-0.0948
Z11	R59741	OS	5	4	-0.00275	0.001139	0.003656	0.025511	0.013166	0.028881	0.044903	0.042997	0.041523	0.033871	0.036276	0.028146	0.050186	0.042374	0.061628	0.043286	0.051827	0.047686	0.035362	0.022559	0.003072	0.018582	0.00612	-0.00618	-0.02418	-0.01838	-0.03536	-0.02823
Z12	R59741	OS	5	4	-0.04229	-0.04071	-0.04833	-0.04531	-0.0512	-0.04332	-0.04471	-0.04253	-0.05842	-0.04511	-0.04213	-0.03523	-0.03798	-0.05024	-0.04645	-0.04641	-0.05059	-0.04306	-0.05043	-0.03068	-0.02846	-0.04211	-0.03046	-0.01636	-0.02444	-0.01291	-0.001	-0.00588
Z13	R59741	OS	5	4	-0.02281	-0.01772	-0.02489	-0.01157	-0.01715	-0.00435	-0.00258	-0.01168	-0.00638	-0.009	-0.01442	-0.00949	-0.01236	-0.01575	-0.01753	-0.01867	-0.01223	-0.01	-0.00099	0.024399	0.030764	0.024826	0.017447	0.017441	0.036689	0.050709	0.070007	0.080786
Z14	R59741	OS	5	4	0.0108	0.02152	0.023317	0.01165	0.024547	0.008823	-0.00353	-0.0065	-0.00522	0.000705	-0.00133	-0.00816	0.013574	0.003618	0.007689	0.001005	0.000707	-0.009	0.001987	0.021583	0.012992	0.006729	0.004175	0.019089	0.008447	0.003904	0.01662	0.002185
Z15	R59741	OS	5	4	-0.00227	-0.02214	-0.02148	-0.01307	-0.02368	-0.01021	0.005641	-0.00049	0.002241	0.020265	0.033261	0.034973	0.00575	0.008487	0.018227	0.026193	0.023042	0.020519	0.011384	-0.004	-0.01255	-0.02601	0.002458	0.006882	-0.01411	-0.01283	-0.01791	-0.01431
Z16	R59741	OS	5	4	-0.00286	-0.00644	-0.00672	-0.0036	-0.0024	-3.89E-05	-0.00525	0.002648	0.01566	0.020224	0.032812	0.036898	0.029324	0.018282	0.032983	0.027698	0.033461	0.035232	0.032384	0.021727	0.021637	0.026201	0.0214	0.030699	0.025003	0.018179	-0.00729	0.008677
Z17	R59741	OS	5	4	-0.0191	-0.01847	-0.02077	-0.01576	-0.02029	-0.00263	0.003501	-0.00284	0.009412	0.009765	0.009626	0.009192	0.004537	-0.00864	0.000979	-0.00045	0.011668	0.009135	0.009427	0.007575	0.0052	0.008478	0.006648	-0.00506	-0.00333	0.005941	-0.007	0.004483
Z18	R59741	OS	5	4	-0.00534	-0.01273	-0.01014	-0.01214	-0.01809	-0.0055	0.000989	-0.00663	5.55E-06	-0.01511	-0.00632	-0.00839	-0.01124	-0.0219	-0.00747	-0.01439	-0.01679	-0.0225	-0.00914	-0.01152	-0.00496	-0.00604	-0.00578	-0.00314	-0.01345	-0.01861	-0.02709	-0.03602
Z19	R59741	OS	5	4	-0.00128	-0.0107	-0.00849	-0.00311	-0.0116	0.004496	0.003499	0.0007	0.001913	-0.00467	-0.00316	0.00235	0.010287	-0.01124	-0.00362	-0.00287	-0.00734	0.005282	0.000102	0.010721	0.01843	0.016566	-0.004	4.55E-05	0.000894	0.008702	-0.0122	-0.02216
Z20	R59741	OS	5	4	0.011398	0.006576	0.00305	0.003516	0.024015	0.019477	0.012484	0.017626	0.002928	0.008592	0.006806	0.016874	0.011014	-0.00245	0.009142	-0.00264	-0.00843	-0.00521	-0.01082	-0.00608	0.010754	-0.00241	-0.0032	-0.00792	-0.02546	-0.02549	-0.02987	-0.02948

A1.1b. Raw data for the 4m viewing condition. This is the data for the left eye of subject ANI001. This data was successfully collected for most subjects, and for the 50cm and DF viewing conditions.

METRIC	MEASURE	EYE	ZERNIKE_ORDER	MEASURE_DIAMETER [mm]	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1
M	R28387	OD	5	4	-0.47776	-0.44691	-0.43527	-0.4032	-0.33625	-0.30347	-0.2872	-0.28432	-0.2565	-0.28744	-0.27942	-0.31968	-0.22759	-0.22202	-0.21766	-0.28039	-0.31725	-0.36656	-0.40043	-0.48548	-0.51339	-0.50041	-0.53136	-0.55369	-0.54456	-0.55777	-0.52025
J0	R28387	OD	5	4	-1.70356	-1.62535	-1.56537	-1.46998	-1.31626	-1.26134	-1.16704	-1.10016	-0.95213	-0.87185	-0.81692	-0.69143	-0.60769	-0.5666	-0.48312	-0.4136	-0.3025	-0.27077	-0.2597	-0.17828	-0.11852	-0.1204	-0.04997	0.031229	0.007782	-0.05922	0.04757
J45	R28387	OD	5	4	-0.12086	-0.103	-0.09649	-0.07734	-0.11617	-0.09972	-0.11596	-0.11616	-0.10017	-0.12381	-0.08053	-0.12226	-0.05218	-0.01108	-0.02716	0.000765	-0.03387	-0.02199	-0.05988	0.016126	-0.02531	-0.11805	-0.1783	-0.14638	-0.14517	-0.0934	-0.0833
Z12	R28387	OD	5	4	-0.00184	0.001077	-0.00117	0.000841	-0.0138	-0.00432	-0.00633	-0.00398	-0.00311	-0.00259	0.00254	-0.00033	0.030745	0.037336	0.048353	0.037618	0.032725	0.018237	0.014327	-0.00274	-0.00947	-0.00563	-0.0313	-0.03907	-0.0264	-0.02726	-0.04226

METRIC	MEASURE	EYE	ZERNIKE_ORDER	MEASURE_DIAMETER [mm]	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
M	R28387	OD	5	4	-0.5967	-0.55619	-0.58158	-0.4429	-0.39891	-0.39395	-0.21961	-0.45441	-0.32639	-0.28344	-0.08279	-0.01729	-0.12012	-0.06479	-0.03566	-0.16152	-0.33841	-0.5546	-0.55594	0.191743	1.630069	1.145621	0.704102	1.033372	1.132761	1.16666	1.255895	1.301582
J0	R28387	OD	5	4	0.062153	0.167801	0.092652	0.107739	0.105481	0.101733	0.037508	0.240168	0.261082	0.099148	0.167701	0.084178	0.02451	-0.03395	0.155873	0.150583	0.002253	-0.12547	-0.07878	-0.12482	-0.20862	-0.17746	-0.25593	-0.33514	-0.4592	-0.39724	-0.48508	-0.51696
J45	R28387	OD	5	4	-0.24014	-0.16777	-0.14827	-0.26224	-0.12742	-0.15952	-0.17646	-0.01825	-0.06972	-0.12899	-0.034	-0.11712	-0.08881	-0.13889	-0.11182	-0.07885	-0.12069	-0.12761	-0.14783	-0.04557	-0.16657	-0.21532	-0.09952	-0.19627	-0.23781	-0.27626	-0.29628	-0.26198
Z12	R28387	OD	5	4	-0.06551	-0.04852	-0.06499	-0.04155	-0.0444	-0.05304	-0.02613	-0.08566	-0.07799	-0.08197	-0.06047	-0.07274	-0.08116	-0.09293	-0.06722	-0.06622	-0.10718	-0.11708	-0.11582	-0.09601	-0.07306	-0.10788	-0.12333	-0.09825	-0.11496	-0.1281	-0.11296	-0.11725

METRIC	MEASURE	EYE	ZERNIKE_ORDER	MEASURE_DIAMETER [mm]	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1
M	R28448	OS	5	4	1.121151	1.058587	1.064319	1.110649	1.089025	1.105987	1.101692	1.064261	1.043588	1.008859	1.169027	1.17619	1.221314	0.582829	0.019544	-0.15105	-0.06615	0.219502	0.265608	0.34425	0.401011	0.330196	0.361101	0.330592	0.270182	0.197395	0.170476
J0	R28448	OS	5	4	-1.02215	-0.96534	-0.83317	-0.82885	-0.74244	-0.72281	-0.67331	-0.59951	-0.53366	-0.50631	-0.32516	-0.28068	-0.22078	-0.24232	-0.22637	-0.10727	-0.05377	-0.00692	0.048254	0.029742	0.079944	0.129732	0.117592	0.133696	0.106751	0.20831	0.112331
J45	R28448	OS	5	4	0.009633	-0.03419	0.004535	-0.04118	-0.11085	-0.03941	-0.06946	-0.0098	-0.03715	-0.04026	-0.0365	-0.01446	0.00341	0.186966	0.058743	0.086319	0.055545	0.144014	0.079638	0.10023	0.09928	0.167134	0.13235	0.114931	0.109737	0.165621	0.152732
Z12	R28448	OS	5	4	-0.02626	-0.0368	-0.0381	-0.02272	-0.03801	-0.0202	-0.01783	-0.01347	-0.01362	-0.0106	-0.00844	-0.0152	0.002937	0.040233	0.040614	0.026264	0.017802	0.030474	0.042805	0.051765	0.055474	0.052031	0.055866	0.062448	0.050391	0.027916	0.043549

METRIC	MEASURE	EYE	ZERNIKE_ORDER	MEASURE_DIAMETER [mm]	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
M	R28448	OS	5	4	0.082236	-0.08647	-0.1188	-0.04789	0.018695	0.092022	-0.00027	-0.12907	0.113539	0.07491	-0.15325	-0.03241	0.016458	0.074917	-0.10452	0.110518	0.100317	0.11106	0.126463	0.134649	0.011321	0.012967	-0.05339	-0.09235	-0.21415	-0.26419	-0.40303	-0.29259
J0	R28448	OS	5	4	0.0687	0.123022	0.007137	-0.07114	-0.08651	0.018036	-0.1779	-0.21762	-0.06032	-0.10264	-0.084	-0.13344	-0.18253	-0.2239	-0.24282	-0.27545	-0.376	-0.40364	-0.47617	-0.59805	-0.57786	-0.67245	-0.67494	-0.85584	-0.90759	-0.96914	-1.14336	-1.18806
J45	R28448	OS	5	4	0.101613	0.093066	0.118773	0.074553	0.213611	0.073483	0.249025	-0.02448	0.132533	0.191588	0.350788	0.179214	0.215646	0.248484	-0.00087	0.112649	0.201301	0.222794	0.187788	0.155713	0.132404	0.154839	0.131767	0.118447	0.137437	0.113071	0.106685	0.020317
Z12	R28448	OS	5	4	0.03068	0.004268	0.013773	0.02313	0.027595	0.01947	0.035804	0.030849	0.03754	0.034753	-0.00659	0.036694	0.031937	0.034752	0.021624	0.022582	0.02876	0.038618	0.031262	0.026184	0.021311	0.021799	0.008116	-0.02095	-0.00557	-0.00645	-0.0165	-0.00412

A1.2. The specific data from the 4m viewing condition used for each subject. This is subject ANI002. The data on top is the right eye, while the bottom is the left eye. Z12 is spherical aberration (SA).

METRIC	MEASURE	EYE	ZERNIKE_ORDER	MEASURE_DIAMETER [mm]	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1
M	R38452	OD	5	4	-1.02336	-0.62808	-0.53907	-0.39047	-0.26846	-0.23373	-0.21252	-0.12029	-0.10112	-0.15802	-0.08462	-0.16121	-0.18375	-0.16687	-0.20281	-0.24313	-0.245	-0.27294	-0.2641	-0.24521	-0.22411	-0.2376	-0.18436	-0.12983	-0.05266	-0.18166	-0.18567
J0	R38452	OD	5	4	-1.51389	-1.39487	-1.20915	-1.08312	-0.88557	-0.7601	-0.73384	-0.62031	-0.58571	-0.45412	-0.37019	-0.26946	-0.20533	-0.11945	-0.0742	-0.04105	0.018865	0.073728	0.16352	0.166465	0.169855	0.218175	0.286669	0.330578	0.3613	0.319811	0.340607
J45	R38452	OD	5	4	-0.56678	-0.30978	-0.23187	-0.2061	-0.14446	-0.14591	-0.15521	-0.04626	-0.04052	0.014887	-0.00178	-0.02783	-0.01917	-0.0519	-0.02027	-0.07874	-0.049	-0.03079	-0.05733	-0.04552	-0.04852	-0.01877	0.025986	-0.00047	0.028213	0.087986	0.113514
Z12	R38452	OD	5	4	0.19519	0.203771	0.172081	0.160026	0.121401	0.13246	0.12265	0.112228	0.131091	0.04803	0.07801	0.103428	0.068477	0.07186	0.044351	0.005119	-0.01939	-0.00875	-0.0097	-0.01295	0.001427	0.000609	-0.00521	0.010449	0.001553	-0.02138	-0.017

METRIC	MEASURE	EYE	ZERNIKE_ORDER	MEASURE_DIAMETER [mm]	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
M	R38452	OD	5	4	-0.18656	-0.12298	-0.17901	-0.07113	0.094735	0.110505	0.270088	0.30443	0.382074	0.4233	0.518484	0.70101	0.54045	0.835048	0.695256	0.475682	0.307713	0.181894			2.040237	1.768674	2.007693	2.190809	2.28586	2.40032	2.462101	2.623316
J0	R38452	OD	5	4	0.302392	0.352955	0.403058	0.418861	0.315085	0.465688	0.332108	0.239235	0.31571	0.130028	0.255911	0.187011	0.198735	0.19137	0.452893	0.601131	0.196938	0.333714			0.274622	0.234544	0.22044	0.271745	0.211725	0.150938	0.210985	0.197175
J45	R38452	OD	5	4	0.103477	0.051931	0.130209	0.087472	0.100809	0.109157	0.132828	0.103769	0.129182	0.179194	0.066162	-0.07556	0.191916	0.175238	0.129865	0.105996	0.178015	0.183888			-0.04842	0.059967	-0.01017	-0.02295	-0.01966	-0.01892	-0.14679	-0.11806
Z12	R38452	OD	5	4	-0.04209	-0.0072	-0.04529	-0.07726	-0.04697	-0.07065	-0.04801	-0.05847	-0.07898	-0.05099	-0.06011	-0.02158	-0.09328	-0.02706	-0.05665	-0.09812	-0.07012	-0.08616			-0.08814	-0.07274	-0.06294	-0.03618	-0.06624	-0.05705	-0.0649	-0.04566

METRIC	MEASURE	EYE	ZERNIKE_ORDER	MEASURE_DIAMETER [mm]	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1
M	R38513	OS	5	4	3.269502	3.504138	3.464395	3.352816	3.096178	2.865947	2.683507	2.555995	2.374592	2.278921	2.056186	1.920481	2.289282	2.157829	2.313318	1.612719	0.965966	0.752168	0.658435	0.834647	0.609866	0.31135	0.228695	0.355227	0.203954	0.023552	0.074482
J0	R38513	OS	5	4	-0.11045	0.152268	0.22627	0.222734	0.16215	0.226343	0.050182	0.203576	0.235341	0.243001	0.127222	0.315167	0.214001	0.425514	0.407196	0.325669	0.390289	0.376224	0.373936	0.395867	0.415686	0.188127	0.269248	0.276389	0.148501	0.163623	0.206551
J45	R38513	OS	5	4	0.331496	0.086902	0.004443	0.053787	0.034511	0.014193	0.025519	0.090732	0.237971	0.119171	0.143759	0.141257	0.054951	0.092203	0.113638	0.103094	-0.08768	-0.05775	-0.07542	-0.07019	-0.00951	-0.05322	-0.03017	-0.01269	-0.10428	-0.1655	-0.07706
Z12	R38513	OS	5	4	-0.09113	-0.01838	-0.02357	-0.02531	-0.04157	-0.04533	-0.06318	-0.04596	-0.05674	-0.05889	-0.05275	-0.0431	-0.05181	-0.04154	-0.02021	-0.03929	-0.05295	-0.05634	-0.05072	-0.02522	-0.04283	-0.07031	-0.0602	-0.04195	-0.0442	-0.06331	-0.05766

METRIC	MEASURE	EYE	ZERNIKE_ORDER	MEASURE_DIAMETER [mm]	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
M	R38513	OS	5	4	-0.00662	-0.18297	-0.31066	-0.26819	-0.32334	-0.2964	-0.25853	-0.25823	-0.29541	-0.32204	-0.38036	-0.38979	-0.45446	-0.46834	-0.32042	-0.27509	-0.11541	-0.40119	-0.34817				-0.28219				-0.1173	-0.48253
J0	R38513	OS	5	4	0.119775	0.158247	0.146672	0.065064	0.100876	0.1576	0.054173	0.059137	-0.00054	0.092355	-0.03677	-0.0526	-0.00259	-0.21903	-0.18997	-0.01353	0.00501	-0.24755	-0.16588				-0.45735				-0.38536	-0.84335
J45	R38513	OS	5	4	-0.11374	-0.17768	-0.1943	-0.14051	-0.29114	-0.11143	-0.09777	-0.09445	-0.12688	-0.10467	-0.08226	-0.0603	-0.13551	-0.20147	0.04867	-0.14877	0.134684	0.142921	0.047566				-0.03198				-0.02891	-0.29768
Z12	R38513	OS	5	4	-0.05158	-0.05311	-0.05661	-0.03917	-0.05717	-0.04901	-0.03789	-0.02761	-0.02883	-0.02027	-0.01287	-0.01509	0.036439	-0.03209	0.028436	0.018314	0.02313	0.028704	0.041296				0.13607				0.070721	0.0449

A1.3. The specific data from the 4m viewing condition used for each subject. This is subject ANI003. The data on top is the right eye, while the bottom is the left eye. Z12 is spherical aberration (SA).

METRIC	MEASURE	EYE	ZERNIKE_ORDER	MEASURE_DIAMETER [mm]	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1
M	R38696	OD	5	4	-1.12806	-1.26675	-1.29068	-1.43714	-1.47802	-1.53902	-1.57805	-1.70993	-1.66404	-1.6661	-1.66822	-1.77824	-1.77142	-1.65932	-1.61525	-1.62515	-1.64669	-1.57006	-1.26569	-1.64787	-1.37924	-1.50203		-1.19216		-1.19955	
J0	R38696	OD	5	4	-0.33423	-0.32736	-0.26353	-0.3354	-0.28612	-0.09018	-0.066	-0.14791	0.016096	-0.02042	-0.01099	0.058262	0.14844	0.16131	0.073633	-0.08316	0.154105	0.230187	0.193491	0.094061	0.259085	0.287066		0.316389		0.507468	
J45	R38696	OD	5	4	-0.16521	-0.13959	-0.14876	0.06442	-0.0273	0.098167	-0.14763	0.091056	0.048495	0.062461	-0.0255	0.207399	0.214461	0.084478	0.109244	0.062402	0.254042	0.143591	-0.04087	0.290579	0.046875	-0.02007		-0.10294		-0.14551	
Z12	R38696	OD	5	4	0.00653	-0.00958	-0.02073	0.004443	0.013374	-0.01195	0.019025	-0.00729	0.00843	0.016551	0.036773	0.014634	-0.00536	0.020087	0.024031	0.025841	0.001686	0.021562	0.072526	-0.01961	-0.00442	-0.05405		-0.00972		0.018154	

METRIC	MEASURE	EYE	ZERNIKE_ORDER	MEASURE_DIAMETER [mm]	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
M	R38696	OD	5	4											0.015852	-0.30324	-0.54641	-0.25272	0.482335	0.921056	0.324242	0.108443	0.267251	0.214352	0.302578	0.2784	0.357714	0.329105	0.35444	0.464036	0.389902	0.39264
J0	R38696	OD	5	4											-0.15286	0.044015	-0.18523	-0.05013	-0.21232	-0.07562	-0.01226	-0.05768	-0.08674	-0.10873	-0.06906	-0.19001	-0.21728	-0.21297	-0.2117	-0.30474	-0.27943	-0.32974
J45	R38696	OD	5	4											0.111058	-0.0234	0.121189	0.213554	0.103557	0.420083	0.08005	0.125681	0.236791	0.127242	0.174598	0.132354	0.142211	0.11935	0.11225	0.089538	0.055036	0.111708
Z12	R38696	OD	5	4											-0.03196	-0.01777	-0.01862	0.001101	0.019386	0.034005	-0.01328	-0.0209	-0.00192	-0.04075	-0.0338	-0.03851	-0.04179	-0.05118	-0.06417	-0.04984	-0.0634	-0.06517

METRIC	MEASURE	EYE	ZERNIKE_ORDER	MEASURE_DIAMETER [mm]	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1
M	R38757	OS	5	4	0.386996	0.408226	0.303047	0.174001	-0.10378	-0.27981	-0.06266	0.204986	-1.11833	-0.83487	-0.52584	-0.47796	-0.20521	-0.10226	-0.17473	-0.16155	-0.09734	-0.16471	-0.10991	-0.15289	-0.35174	-0.37465	-0.45883	-0.58828	-0.65959	-0.82969	-0.83505
J0	R38757	OS	5	4	-0.11734	-0.04735	-0.03291	-0.03037	-0.11403	0.010652	0.029454	0.048858	-0.09427	-0.16809	-0.02215	0.091784	0.211002	0.223935	0.243855	0.212554	0.266856	0.187094	0.090078	0.156729	0.10079	0.131502	0.159819	0.007061	0.020591	0.113923	0.127543
J45	R38757	OS	5	4	-0.26847	-0.31862	-0.29758	-0.22323	-0.20987	-0.2495	-0.20055	-0.22221	-0.03015	-0.00293	-0.09342	-0.07794	-0.09671	-0.10668	-0.08257	-0.14877	-0.05579	-0.056	-0.0761	-0.00908	-0.09584	-0.02935	0.013184	0.081369	0.009566	-0.03789	0.012592
Z12	R38757	OS	5	4	-0.014	-0.02327	-0.0163	-0.00836	0.007241	0.005907	-0.00759	0.00261	0.01941	0.014909	0.019837	0.012169	0.021117	0.004935	-0.00239	0.011821	0.003273	0.002545	0.033874	0.043	0.022768	0.013467	0.042483	0.068447	0.081404	0.051159	0.051807

METRIC	MEASURE	EYE	ZERNIKE_ORDER	MEASURE_DIAMETER [mm]	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
M	R38757	OS	5	4	-0.76171	-0.85372	-1.0577	-1.1659	-1.22663	-1.23718	-1.36169	-1.25738	-1.26287	-1.26493	-1.20297	-1.31261	-1.38622	-1.41944	-1.48947	-1.3998	-1.35275	-1.31356	-1.39922	-1.34579	-1.27143	-1.1105	-1.12347	-1.05877	-0.97988	-0.94591	-0.81167	-0.80951
J0	R38757	OS	5	4	0.174356	-0.02059	0.004072	0.044224	0.096228	0.115654	-0.11464	-0.10511	-0.03756	-0.08384	-0.09863	-0.03493	-0.19644	-0.20625	-0.21324	-0.19247	-0.18651	-0.31132	-0.31395	-0.49646	-0.48647	-0.51882	-0.54781	-0.56306	-0.60017	-0.68608	-0.76417	-0.76802
J45	R38757	OS	5	4	-0.02421	-0.00795	-0.07673	-0.01214	0.005284	0.009548	-0.09064	-0.10033	-0.03754	0.035036	-0.03513	0.011916	0.036258	0.035368	0.063145	0.10316	0.052403	0.027755	0.039885	-0.04755	-0.05337	-0.12612	-0.00825	-0.03937	-0.10583	-0.07536	-0.08925	-0.13542
Z12	R38757	OS	5	4	0.075127	0.086891	0.053475	0.034846	0.041052	0.055851	0.025517	0.0478	0.05087	0.048422	0.049703	0.036849	0.040977	0.02943	0.014813	0.014544	0.04106	0.00695	-0.00166	-0.02381	-0.01918	-0.00058	-0.0121	-0.00875	-0.00815	-0.00293	-0.04444	-0.0169

A1.4. The data from the 4m viewing condition used for each subject. This is subject ANI005. The data on top is the right eye, while the bottom is the left eye. Z12 is spherical aberration (SA).

METRIC	MEASURE	EYE	ZERNIKE_ORDER	MEASURE_DIAMETER [mm]	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1
M	R58826	OD	5	4	-0.36085	-0.3181	-0.29682	-0.25262	-0.28072	-0.40109	-0.34764	-0.3957	-0.38919	-0.41973	-0.41741	-0.50498	-0.51021	-0.539	-0.46425	-0.38083	-0.54952	-0.42904	-0.52923	-0.426	-0.40634	-0.292	-0.14763	-0.22038	-0.01426	0.281435	0.182045
J0	R58826	OD	5	4	-1.37016	-1.26285	-1.1156	-1.08368	-0.94161	-0.80584	-0.80877	-0.74375	-0.60625	-0.63255	-0.58472	-0.57215	-0.5453	-0.53359	-0.45945	-0.48105	-0.50104	-0.45717	-0.48679	-0.3389	-0.33022	-0.30708	-0.19933	-0.24493	-0.08865	0.092395	0.005443
J45	R58826	OD	5	4	-0.46226	-0.43562	-0.38508	-0.41514	-0.31882	-0.37285	-0.30997	-0.28724	-0.26494	-0.25115	-0.31629	-0.18024	-0.22424	-0.33201	-0.34382	-0.37584	-0.32063	-0.3096	-0.2471	-0.35884	-0.31771	-0.35165	-0.27956	-0.34891	-0.29167	-0.13181	-0.17913
Z12	R58826	OD	5	4	0.021071	0.013936	0.015388	0.018116	-0.00169	-0.00532	-0.01602	-0.04334	0.017742	0.049535	0.060841	0.060144	0.017163	-0.00964	-0.00959	0.009132	-0.03604	-0.03853	-0.05309	-0.04885	-0.04646	-0.05181	-0.11668	-0.07581	-0.03768	0.016776	-0.05123

METRIC	MEASURE	EYE	ZERNIKE_ORDER	MEASURE_DIAMETER [mm]	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
M	R58826	OD	5	4	0.274476	0.370835	0.440116	0.784828	0.867313	0.892959	0.967661	0.897305	0.928836	0.99984	0.837732	0.906457	1.015046	0.939023	0.887395	0.996855	1.310907	1.251473	1.18365	1.175297	1.147072	0.986098	1.067508	1.092325	1.128634	1.151744	1.084087	1.061406
J0	R58826	OD	5	4	0.042146	-0.02581	0.061953	0.284694	0.368766	0.302282	0.32038	0.284081	0.259832	0.292465	0.273719	0.132682	0.097065	0.105144	0.066133	0.003793	-0.04293	-0.09215	-0.06874	-0.04775	-0.1576	0.009183	-0.22488	-0.34069	-0.40394	-0.43468	-0.57002	-0.74077
J45	R58826	OD	5	4	-0.16548	-0.15139	-0.10966	0.022088	0.109941	0.17623	0.21576	0.229183	0.209069	0.328293	0.152214	0.196241	0.233914	0.333513	0.181504	0.207369	0.196617	0.237246	0.11512	0.269274	0.219359	0.247697	0.342142	0.340984	0.398461	0.262563	0.324776	0.300859
Z12	R58826	OD	5	4	-0.04915	-0.01805	-0.00414	0.073454	0.101006	0.098177	0.118915	0.1056	0.121818	0.121707	0.09378	0.074426	0.094236	0.096679	0.083098	0.09776	0.133585	0.111617	0.111854	0.106156	0.097853	0.077202	0.079343	0.084203	0.105203	0.115169	0.094956	0.087117

METRIC	MEASURE	EYE	ZERNIKE_ORDER	MEASURE_DIAMETER [mm]	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1
M	R59131	OS	5	4	0.462429			0.409095	0.372117	0.488389	0.500848	0.528537	0.403869	-0.01751	0.500361	-0.13532	-0.11258	-0.44304	-0.20078	-0.33593	-0.07117	-0.11649	-0.11502		-0.02677		-0.35517	-0.43014	-0.62408	-0.26611	-0.4158
J0	R59131	OS	5	4	-0.62714			-0.61007	-0.53267	-0.40902	-0.43119	-0.12827	-0.34382	-0.64407	-0.48125	-0.29687	-0.18479	-0.30358	-0.21021	-0.15866	-0.05194	0.074989	0.058391		0.168413		-0.15579	0.195194	0.412362	-0.22895	-0.21836
J45	R59131	OS	5	4	-0.15636			-0.17493	-0.51439	-0.25558	-0.10751	0.205273	-0.10596	-0.31779	-0.16294	0.137027	-0.03555	0.061498	0.052408	-0.15442	-0.08996	-0.35279	-0.13115		-0.41684		0.332401	0.249837	0.278142	-0.25427	-0.32373
Z12	R59131	OS	5	4	0.01105			-0.00322	-0.01041	-0.00027	0.037923	0.015865	0.004731	0.034051	0.128267	0.036412	0.013858	-0.02421	-0.02399	-0.05112	-0.02404	0.007048	-0.04979		-0.01066		-0.00015	-0.07536	-0.07947	-0.03155	-0.07269

METRIC	MEASURE	EYE	ZERNIKE_ORDER	MEASURE_DIAMETER [mm]	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
M	R59131	OS	5	4		-0.1746	-0.36589	-0.52934	-0.34683	-0.33637	-0.31018	-0.16687	-0.5689	-0.57813	-0.59247	-0.63365	-0.79181	-0.62866	-0.72755				-0.79839			-0.74605	-0.87856	-0.77813	-0.76776	-0.74057		
J0	R59131	OS	5	4		-0.20219	-0.23349	-0.11716	-0.28419	-0.22915	-0.21924	-0.20128	-0.43826	-0.38927	-0.49961	-0.47989	-0.68333	-0.50521	-0.60731				-0.88599			-0.99594	-1.10888	-1.14856	-1.321	-1.39091		
J45	R59131	OS	5	4		-0.02842	0.058215	-0.16125	-0.01987	-0.01602	0.038658	-0.00843	0.061593	0.027221	-0.09017	0.016758	-0.04778	0.042196	0.072927				0.073443			-0.10468	-0.11655	-0.12072	-0.04613	-0.09726		
Z12	R59131	OS	5	4		-0.00906	-0.01721	-0.02205	-0.00975	-0.00225	0.006752	0.112117	-0.02961	-0.01423	0.00516	-0.02162	-0.01803	0.029665	0.008839				0.01419			0.021223	0.016344	-0.00209	-0.01763	-0.00506		

A1.5. The data from the 4m viewing condition used for each subject. This is subject ANI006. The data on top is the right eye, while the bottom is the left eye. Z12 is spherical aberration (SA).

METRIC	MEASURE	EYE	ZERNIKE _ORDER	MEASURE_ DIAMETER [mm]	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1
M	R28631	OD	5	4	0.165356	0.243793	0.072508	0.028924	-0.11851	-0.09946	-0.14495	-0.12122	-0.10702	-0.14741	-0.16713	-0.07638	-0.04957	-0.10354	-0.29806	-0.22981	-0.37718	-0.09448	-0.19701	-0.21215	-0.18048	-0.48079	-0.24697	-0.29885	-0.47922	-0.18261	-0.20362
J0	R28631	OD	5	4	-0.69362	-0.6296	-0.6527	-0.6806	-0.59823	-0.53409	-0.5319	-0.47971	-0.43777	-0.39538	-0.41479	-0.32531	-0.25689	-0.17086	-0.14472	-0.14286	0.056316	-0.0361	-0.08311	0.017702	0.073131	0.259039	0.182039	0.146449	0.258924	0.102853	-0.06798
J45	R28631	OD	5	4	-0.73462	-0.76739	-0.7179	-0.68191	-0.7181	-0.70766	-0.65396	-0.56769	-0.60342	-0.53417	-0.45041	-0.45805	-0.33415	-0.34377	-0.17628	-0.27791	-0.21394	-0.28037	-0.21723	-0.27099	-0.18855	-0.31596	-0.24791	-0.25049	-0.19876	-0.29754	-0.2777
Z12	R28631	OD	5	4	0.006111	0.012384	0.000696	0.01557	-0.00164	-0.00149	-0.01468	-0.0242	-0.01095	-0.01984	-0.01886	-0.00099	-0.0204	-0.02868	-0.07703	-0.06306	-0.08426	-0.04689	-0.06068	-0.07439	-0.05907	-0.09863	-0.04927	-0.03989	-0.05775	-0.0203	-0.00968

METRIC	MEASURE	EYE	ZERNIKE _ORDER	MEASURE_ DIAMETER [mm]	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
M	R28631	OD	5	4	-0.27545	-0.30211	-0.34593	-0.52694	-0.66735	-0.57311	-0.29094	-0.51246	-0.42153	-0.48907	-0.55581	-0.57507	-0.99777	-0.70168	-0.34118	-0.40529	-0.64127	-0.93813	-1.0123	-1.05553	-1.22125	-1.20197	-1.25844	-1.41849	-1.43167	-1.56339	-1.48908	-1.58972
J0	R28631	OD	5	4	-0.12735	-0.11118	-0.18348	0.36696	-0.11352	0.347588	0.251839	0.363044	0.218462	0.232667	0.185102	0.156427	0.038962	-0.1731	-0.24012	-0.08214	-0.10449	0.093671	-0.18684	-0.10707	-0.22704	-0.28425	-0.28515	-0.44752	-0.53157	-0.49628	-0.62537	-0.64097
J45	R28631	OD	5	4	-0.36021	-0.29102	-0.30987	-0.47504	-0.23281	-0.44026	-0.59653	-0.46607	-0.37309	-0.35741	-0.31887	-0.29233	-0.38423	-0.13289	-0.07896	0.021399	-0.33929	-0.30255	-0.38761	-0.36453	-0.46898	-0.50688	-0.52756	-0.49012	-0.58241	-0.57048	-0.5673	-0.53943
Z12	R28631	OD	5	4	-0.00749	-0.01738	-0.0085	-0.02024	-0.03811	-0.01239	0.043456	-0.0052	0.018911	0.013325	0.013687	0.016726	-3.57E-05	0.052273	0.095974	0.056123	0.052718	0.015184	-0.00024	-0.00781	-0.0147	-0.00918	-0.01569	-0.02839	-0.03605	-0.04439	-0.04425	-0.03552

METRIC	MEASURE	EYE	ZERNIKE _ORDER	MEASURE_ DIAMETER [mm]	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1
M	R28692	OS	5	4	-0.68265	-0.45821	-0.67344	-0.59087	-0.57148	-0.52488	-0.51636	-0.56441	-0.39186	-0.36622	-1.37613	-1.16243	-1.4324	-1.36051	-1.0174	-0.90393	-0.83603	-0.75534	-0.70614	-0.71949	-0.68672	-0.54845	-1.05388	-0.89583	-0.97396	-0.79994	-1.04471
J0	R28692	OS	5	4	-1.32447	-1.24007	-1.29767	-1.11982	-0.96318	-0.89323	-0.94891	-0.89304	-0.99115	-0.81014	-0.70475	-0.67103	-0.55882	-0.50201	-0.38178	-0.25859	-0.33821	-0.29664	-0.31961	-0.30877	-0.31762	-0.52062	0.084649	-0.15623	-0.06007	-0.31694	-0.4206
J45	R28692	OS	5	4	0.147158	0.153322	0.118925	0.13573	0.195847	0.255926	0.270104	0.272061	0.309239	0.380121	0.455103	0.316184	0.494477	0.4321	0.463155	0.458457	0.495986	0.56961	0.431495	0.37947	0.386901	0.395917	0.28811	0.405119	0.626965	0.446582	0.394414
Z12	R28692	OS	5	4	0.02195	0.00898	0.029028	0.020159	-0.00516	0.010489	0.02145	0.001725	0.014295	0.02601	0.039376	0.060275	0.026014	0.04476	0.038201	0.040126	0.037888	0.040153	0.058056	0.053896	0.054239	0.076444	-0.00773	0.022559	0.03907	0.093396	0.02516

METRIC	MEASURE	EYE	ZERNIKE _ORDER	MEASURE_ DIAMETER [mm]	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
M	R28692	OS	5	4	-0.92762	-0.82669	-0.66789	-0.94341	-0.96501	-1.10073	-0.95992	-0.99578	-1.08044	-0.94261	-0.94884	-0.9596	-0.85876	-0.85982	-0.82964	-0.73366	-0.9531	-0.83175	-0.73376	-0.68722	-0.65957	-0.63269	-0.42619	-0.33016	-0.40983	-0.32302	-0.19307	-0.12799
J0	R28692	OS	5	4	-0.39375	-0.38577	-0.30506	-0.11638	-0.34531	-0.23251	-0.36924	-0.35595	-0.32733	-0.45393	-0.50716	-0.54831	-0.59954	-0.66253	-0.67439	-0.68087	-0.84941	-0.94956	-1.0351	-1.0446	-1.18692	-1.27206	-1.34069	-1.45598	-1.50036	-1.55561	-1.64133	-1.78845
J45	R28692	OS	5	4	0.202451	0.503079	0.270057	0.457236	0.311156	0.387519	0.360774	0.369085	0.340225	0.28201	0.242959	0.268772	0.329391	0.318869	0.222116	0.202188	0.322238	0.296876	0.26025	0.279167	0.24045	0.275376	0.174428	0.229047	0.157068	0.115419	-0.00045	-0.01731
Z12	R28692	OS	5	4	0.059405	0.039152	0.072487	0.022891	0.043679	-0.01895	-0.0046	-0.01013	-0.03842	-0.00716	-0.01424	-0.0133	-0.01011	-0.01638	-0.02297	-0.02778	-0.03159	-0.02808	-0.03616	-0.02811	-0.0216	-0.0087	-0.00949	-0.00685	-0.03303	-0.02156	-0.05235	-0.03697

A1.6. The specific data from the 4m viewing condition used for each subject. This is subject ANI007. The data on top is the right eye, while the bottom is the left eye. Z12 is spherical aberration (SA).

METRIC	MEASURE	EYE	ZERNIKE _ORDER	MEASURE_ DIAMETER [mm]	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1
M	R38818	OD	5	4	0.340783	0.225577	0.166598	0.086068	-0.12756	-0.03091	-0.09965	-0.12612	-0.07019	-0.09369	-0.05832	-0.03622	-0.00643	0.086263	0.078437	0.088893	0.121333	0.251089	0.230448	0.26242	0.352693	0.315919	0.266645	0.352338	0.353708	0.379405	0.403212
J0	R38818	OD	5	4	-0.13366	-0.12499	-0.07218	-0.07459	-0.01106	0.020897	0.041655	0.110815	0.204818	0.123526	0.151189	0.224949	0.233407	0.272499	0.310072	0.27777	0.336846	0.337544	0.391141	0.389644	0.461282	0.46877	0.431542	0.443854	0.407849	0.405511	0.500033
J45	R38818	OD	5	4	-0.8843	-0.80864	-0.79826	-0.81925	-0.63941	-0.75304	-0.64141	-0.65109	-0.5665	-0.57677	-0.55854	-0.47514	-0.50195	-0.43033	-0.42185	-0.36265	-0.28721	-0.29012	-0.26448	-0.27226	-0.19095	-0.14755	-0.12844	-0.12784	-0.09498	-0.06623	-0.06284
Z12	R38818	OD	5	4	0.047319	0.045253	0.037364	0.032235	0.025298	0.055922	0.050754	0.06434	0.068796	0.037158	0.02366	0.024853	0.025193	0.010177	0.023387	0.005649	0.026951	0.032408	0.025138	0.025652	0.038818	0.002098	0.018249	0.027291	0.026749	0.007191	0.019224

METRIC	MEASURE	EYE	ZERNIKE _ORDER	MEASURE_ DIAMETER [mm]	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
M	R38818	OD	5	4	0.439326	0.509357	0.621992	0.729804	0.718342	0.826316	0.888812	0.936931	1.009559	1.015002	0.935323	0.877395	0.376522	0.358613	1.080476	1.975996	1.880789	2.131718	1.565531	1.191682	1.640249	2.015255	2.091162		2.540517	2.385581	2.486524	2.760654
J0	R38818	OD	5	4	0.505734	0.492007	0.515793	0.499727	0.482421	0.563154	0.473704	0.418598	0.429739	0.450122	0.445367	0.32852	0.219667	0.207303	0.470475	0.306867	0.37464	0.405824	0.148621	0.029881	0.197242	0.227633	0.202547		0.20209	-0.09177	0.150371	0.095225
J45	R38818	OD	5	4	0.000316	-0.0004	-0.0251	0.103166	0.067196	0.170065	0.075392	0.143351	0.214585	0.22085	0.246555	0.293426	0.285621	0.207688	0.233607	0.383298	0.406539	0.580152	0.626884	0.405713	0.527998	0.403435	0.429402		0.33878	0.591328	0.543268	0.655211
Z12	R38818	OD	5	4	0.008801	0.011854	0.013687	0.011508	0.008511	-0.00241	0.003345	-0.00477	-0.00023	0.01162	-8.56E-05	0.008297	-0.00881	0.003012	0.035242	0.064323	0.018983	0.033961	-0.00409	0.001527	0.004701	0.067291	0.034063		0.041655	0.017338	0.033916	0.021787

METRIC	MEASURE	EYE	ZERNIKE _ORDER	MEASURE_ DIAMETER [mm]	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1
M	R38879	OS	5	4	0.765308	0.718942	0.811998	0.719505	0.611274	0.462987	0.474799	0.428943	0.638017	0.662936	1.076297	0.227026	-0.15604	-0.12736	-0.18342	-0.2106	-0.25656	-0.28157	-0.25087	-0.39204	-0.42231	-0.45014	-0.53327	-0.59837	-0.62861	-0.75722	-0.73165
J0	R38879	OS	5	4	-0.03941	-1.85E-16	-0.09331	0.000631	0.030245	0.00213	0.037356	0.194438	0.309742	0.243809	0.349241	0.341544	0.370526	0.366191	0.370118	0.382919	0.431202	0.464808	0.458588	0.390718	0.396078	0.416514	0.527775	0.458624	0.517293	0.492684	0.395064
J45	R38879	OS	5	4	-1.12867	-1.00772	-1.05469	-1.01592	-0.9628	-0.97471	-0.83182	-0.80194	-0.72776	-0.83788	-0.92428	-0.63868	-0.61165	-0.62002	-0.57995	-0.62243	-0.59553	-0.5284	-0.50896	-0.48449	-0.5602	-0.53555	-0.44573	-0.43212	-0.48193	-0.39249	-0.38504
Z12	R38879	OS	5	4	-0.00704	-0.00843	-0.00755	-0.00688	-0.0435	-0.03261	0.004677	0.014604	-0.0069	-0.01466	-0.0044	-0.00088	0.004704	0.007456	-0.01146	0.000249	-0.01609	-0.01036	-0.00741	-0.02201	-0.00608	8.39E-05	-0.00768	0.002509	0.00205	0.01071	0.00786

METRIC	MEASURE	EYE	ZERNIKE _ORDER	MEASURE_ DIAMETER [mm]	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
M	R38879	OS	5	4	-0.71294	-0.63759	-0.65234	-0.53752	-0.57506	-0.91908	-0.71398	-0.93924	-1.0567	-0.99077	-0.78238	-0.84453	-0.3874	-1.01083		-0.50189	-0.97969		-0.90239	-0.99938	-0.65585	-0.96038	-0.91322	-0.5364	-0.72533	-0.67962	-0.61114	-0.37785
J0	R38879	OS	5	4	0.434507	0.453979	0.452317	0.437736	0.517026	0.392111	0.604351	0.441548	0.634521	0.259632	0.201672	0.480958	0.147996	0.645693		0.296169	-0.04944		-0.03438	-0.1951	-0.18447	-0.25282	-0.32526	-0.30336	-0.38714	-0.59937	-0.55775	-0.68193
J45	R38879	OS	5	4	-0.33145	-0.25809	-0.28285	-0.13347	-0.09241	-0.1523	0.0287	0.159595	0.322696	0.1042	0.093923	0.31471	-0.40661	0.067865		-7.25E-17	0.150929		0.055021	0.268538	-0.41432	0.087027	0.140658	0.025004	0.125789	0.144385	0.083228	0.25902
Z12	R38879	OS	5	4	0.012209	0.012245	-7.89E-05	0.025362	0.011802	-0.05953	-0.00487	-0.03297	-0.01614	-0.07024	0.002258	-0.04194	0.136733	-0.00357		0.17407	-0.00602		0.041412	0.027873	0.050674	-0.05192	-0.07714	-0.0262	-0.08244	-0.11371	-0.09377	-0.06499

A1.7. The specific data from the 4m viewing condition used for each subject. This is subject ANI008. The data on top is the right eye, while the bottom is the left eye. Z12 is spherical aberration (SA).

METRIC	MEASURE	EYE	ZERNIKE _ORDER	MEASURE_ DIAMETER [mm]	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1
M	R38940	OD	5	4	2.473049	2.426953	2.438085	2.237994	2.270869	2.338378	2.239908	2.267444	2.109667	2.166386	1.842789	1.794212	1.686916	1.659208	1.523131	1.444349	1.348048	1.26512	1.195692	1.003148	0.972342	0.870625	0.696573	0.600558	0.204205	0.310194	0.360033
J0	R38940	OD	5	4	-1.2815	-1.47156	-1.27814	-1.20699	-1.18423	-1.1262	-1.11781	-1.1091	-0.84533	-0.97767	-0.68618	-0.66573	-0.65275	-0.60215	-0.58634	-0.5968	-0.56655	-0.57638	-0.61476	-0.5717	-0.56613	-0.58235	-0.55621	-0.5046	-0.58211	-0.41656	-0.42023
J45	R38940	OD	5	4	0.850024	0.813239	0.654621	0.640389	0.592863	0.625018	0.520162	0.679873	0.621844	0.579965	0.537858	0.522216	0.499974	0.511035	0.467746	0.390592	0.278821	0.428282	0.349571	0.347524	0.383665	0.275123	0.2985	0.321094	0.081102	0.280974	0.262589
Z12	R38940	OD	5	4	0.000707	-0.01764	-0.01228	-0.02744	-0.0028	-0.02044	-0.0304	-0.02189	-0.03293	-0.00598	-0.0178	-0.02285	-0.03018	-0.03491	-0.03805	-0.03295	-0.05254	-0.03538	-0.03676	-0.05774	-0.04931	-0.05188	-0.05387	-0.06196	-0.15785	-0.07027	-0.08625

METRIC	MEASURE	EYE	ZERNIKE _ORDER	MEASURE_ DIAMETER [mm]	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
M	R38940	OD	5	4	0.392487	0.414076	0.343952	0.100106	0.123589	0.232601	0.178816	0.17352	0.064073	0.077114	0.032525	-0.10242	-0.52948	-0.42311	0.247381	0.540209	0.196648	-0.08592	-0.07498	-0.14319	-0.06308	-0.08745	0.084526	0.025142				
J0	R38940	OD	5	4	-0.48184	-0.44812	-0.46636	-0.3335	-0.53454	-0.48392	-0.39561	-0.44641	-0.40196	-0.47534	-0.47137	-0.44967	-0.56699	-0.62145	-0.67372	-0.60795	-0.73543	-0.67843	-0.80357	-0.765	-0.84611	-0.93571	-0.85723	-0.95991				
J45	R38940	OD	5	4	0.350081	0.350112	0.247969	0.522605	0.288079	0.336878	0.31478	0.330383	0.306301	0.368709	0.277793	0.327158	0.363925	0.426284	0.458131	0.407785	0.432163	0.3315	0.282	0.232856	0.342115	0.251519	0.455798	0.311895				
Z12	R38940	OD	5	4	-0.09836	-0.08727	-0.08638	-0.09343	-0.07132	-0.05617	-0.05132	-0.04438	-0.05166	-0.03927	-0.04239	-0.0412	-0.06633	-0.06225	-0.04758	-0.05217	-0.05512	-0.07774	-0.03218	-0.03739	-0.04377	-0.04027	-0.0031	-0.01027				

METRIC	MEASURE	EYE	ZERNIKE _ORDER	MEASURE_ DIAMETER [mm]	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1
M	R39001	OS	5	4	1.955734	1.927879	1.82692	1.6989	1.55983	1.465588	1.529476	1.758929	1.48039	1.091093	0.948771	0.737135	0.651081	0.691768	0.553924	0.415795	0.352508	0.334357	0.344445	0.24055	0.279084	0.362113	0.261834	0.146519	0.188333	0.148516	0.188825
J0	R39001	OS	5	4	-0.95615	-0.90924	-0.92803	-0.80253	-0.92342	-0.85852	-0.73482	-0.76618	-0.71388	-0.5817	-0.75074	-0.54982	-0.50648	-0.49185	-0.59139	-0.44916	-0.43421	-0.47741	-0.44756	-0.41864	-0.52044	-0.60805	-0.56699	-0.32807	-0.62634	-0.67634	-0.47832
J45	R39001	OS	5	4	0.017083	0.037755	0.059025	0.1116	0.107135	0.066223	0.126992	0.18919	0.096201	0.158815	-0.07204	0.23685	0.193941	0.127642	0.143575	0.193221	0.262782	0.311736	0.272533	0.310199	0.314085	0.385965	0.289395	0.379653	0.304956	0.286866	0.198213
Z12	R39001	OS	5	4	-0.01721	-0.02399	-0.03619	-0.01841	-0.01597	-0.03899	-0.018	-0.01934	-0.03054	-0.0302	-0.07087	-0.04123	-0.04941	-0.02282	-0.0458	-0.05288	-0.06168	-0.08337	-0.07404	-0.0669	-0.06312	-0.09625	-0.07935	-0.08379	-0.09237	-0.09526	-0.06712

METRIC	MEASURE	EYE	ZERNIKE _ORDER	MEASURE_ DIAMETER [mm]	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
M	R39001	OS	5	4	0.304622	0.225457	0.438069	0.344106	0.32105	0.127775	0.469091	0.496227	0.524593	0.07223	0.46689	0.554245	0.437373	0.502778	0.370525	0.465208	0.53203	0.549472	0.570706	0.564407	0.705422	0.740468	0.674383	0.699877	0.755332	0.825433	0.82	0.844999
J0	R39001	OS	5	4	-0.60764	-0.45736	-0.60802	-0.52955	-0.64342	-0.65816	-0.55971	-0.70098	-0.71663	-0.8641	-0.671	-0.67402	-0.63598	-0.71714	-0.88242	-0.86973	-0.86266	-0.81083	-0.9364	-1.0366	-1.07981	-1.15951	-1.2223	-1.28059	-1.40245	-1.4404	-1.47681	-1.56506
J45	R39001	OS	5	4	0.274286	0.318429	0.291192	0.240318	0.342738	0.440419	0.333574	0.393808	0.297679	0.19412	0.357092	0.342465	0.226765	0.343694	0.425575	0.339927	0.316423	0.275795	0.235215	0.237935	0.13125	0.129936	0.213266	0.169116	0.084935	0.137604	0.077835	0.022485
Z12	R39001	OS	5	4	-0.06525	-0.04272	-0.03707	-0.02193	-0.03594	-0.06414	-0.0199	-0.01629	0.00128	-0.03088	-0.00076	0.005294	-0.0064	-0.00225	-0.01265	0.008199	0.000451	0.029865	-0.00456	-0.00214	0.007425	0.005751	-0.01246	-0.01655	-0.01771	-0.02115	-0.02731	-0.04242

A1.8. The specific data from the 4m viewing condition used for each subject. This is subject ANI009. The data on top is the right eye, while the bottom is the left eye. Z12 is spherical aberration (SA).

METRIC	MEASURE	EYE	ZERNIKE _ORDER	MEASURE_ DIAMETER [mm]	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1
M	R28875	OD	5	4	-0.8425	-0.98019	-0.95863	-0.94584	-0.85649	-0.94143	-0.96195	-0.8289	-0.74322	-0.68328	-0.72179	-0.68609	-0.68071	-0.69847	-0.64115	-0.59832	-0.59717	-0.5655	-0.51684	-0.44085	-0.47946	-0.54755	-0.44645	-0.38355	-0.42986	-0.45634	-0.48393
J0	R28875	OD	5	4	-1.88593	-1.98214	-1.81866	-1.74315	-1.51403	-1.52362	-1.46146	-1.32493	-1.14951	-1.02404	-1.01057	-0.86061	-0.96122	-0.9343	-0.75051	-0.66507	-0.60795	-0.57357	-0.55006	-0.47244	-0.42134	-0.31494	-0.31484	-0.15915	-0.26533	-0.26412	-0.25704
J45	R28875	OD	5	4	-0.22975	-0.47623	-0.45241	-0.41545	-0.37419	-0.35127	-0.24563	-0.25739	-0.22276	-0.17881	-0.11402	-0.24435	-0.00403	-0.04054	-0.03221	-0.09266	-0.05875	-0.03896	-0.0083	0.002525	0.000793	0.012685	0.03886	0.030139	0.086977	0.051791	0.068824
Z12	R28875	OD	5	4	-0.01291	-0.05133	-0.0218	0.001113	0.008418	0.002053	-0.00636	0.002566	0.011681	0.011175	-0.00015	-0.00131	0.030974	0.024444	0.033497	0.044756	0.033331	0.038517	0.043313	0.054982	0.047739	0.027112	0.046296	0.045618	0.050755	0.024839	0.017409

METRIC	MEASURE	EYE	ZERNIKE _ORDER	MEASURE_ DIAMETER [mm]	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
M	R28875	OD	5	4	-0.43685	-0.38645	-0.33335	-0.26569	-0.25887	-0.25737	-0.1529	-0.12101	-0.13219	-0.13212	-0.02961	-0.17195	-0.65223	-0.88514	-0.4352	0.255434	0.537136	0.36623	-0.01529	-0.00379	0.081955	0.053881	0.022181	-0.03361	-0.0512	0.003629	-0.0372	-0.06996
J0	R28875	OD	5	4	-0.12959	-0.1345	-0.17349	-0.2022	-0.2043	-0.12356	-0.13203	-0.16519	-0.16206	-0.13902	-0.08565	0.041027	-0.2906	-0.37692	-0.25482	-0.24658	-0.1975	-0.25963	-0.35186	-0.37872	-0.31324	-0.37192	-0.40209	-0.4711	-0.52438	-0.56239	-0.62037	-0.68746
J45	R28875	OD	5	4	0.074134	0.132555	0.150405	0.162802	0.113655	0.058199	0.137721	0.17134	0.184679	0.184982	0.244468	0.15121	0.278955	-0.05147	0.129018	0.150877	0.2704	0.298568	0.2136	0.259915	0.255629	0.2823	0.252832	0.245735	0.223639	0.219364	0.179575	0.227048
Z12	R28875	OD	5	4	0.021696	0.027516	0.019914	0.01856	0.011951	0.00425	0.019132	0.016586	0.020134	0.021785	0.018807	0.005825	-0.02862	-0.05562	0.022767	0.069094	-0.01711	-0.00247	-0.02825	-0.01894	-0.00726	-0.01268	-0.00461	-0.0068	-0.0105	0.000909	-0.00394	-0.00468

METRIC	MEASURE	EYE	ZERNIKE _ORDER	MEASURE_ DIAMETER [mm]	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1
M	R28936	OS	5	4	0.52311	0.517498	0.651029	0.506907	0.603337	0.613079	0.550357	0.680793	0.553218	0.714439	1.329794	0.192822	-0.97578	-0.75489	-0.59456	-0.48977	0.11871	0.066387	0.132464	0.030728	0.091805	0.052876	-0.03371	-0.08112	-0.11622	-0.18032	-0.18982
J0	R28936	OS	5	4	-0.86966	-0.76711	-0.50952	-0.55471	-0.40443	-0.45807	-0.41153	-0.23499	-0.24467	-0.45297	-0.34751	-0.095	0.057586	0.073409	0.075589	0.145648	0.187457	0.204916	0.257608	0.233136	0.247354	0.299929	0.21345	0.248239	0.201455	0.23399	0.229815
J45	R28936	OS	5	4	-0.56748	-0.56469	-0.4302	-0.56481	-0.39572	-0.43768	-0.3099	-0.21536	-0.26328	-0.48556	-0.20711	-0.17289	-0.10792	-0.01258	-0.05894	-0.12629	-0.09079	-0.00676	-0.04312	-0.03897	-0.07101	0.059417	0.028713	0.040418	0.013621	0.085724	0.104632
Z12	R28936	OS	5	4	0.010744	0.000178	0.012925	0.003437	0.002934	0.013296	-0.00312	-0.00384	-0.01783	-0.03009	0.003546	-0.00496	-0.03299	-0.01782	-0.02968	-0.02837	-0.02163	-0.03693	-0.03564	-0.04198	-0.01746	-0.02813	-0.04095	-0.03734	-0.02614	-0.0129	-0.00065

METRIC	MEASURE	EYE	ZERNIKE _ORDER	MEASURE_ DIAMETER [mm]	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
M	R28936	OS	5	4	-0.1924	-0.1242	-0.18348	-0.16571	-0.20182	-0.35863	-0.11664	-0.24526	-0.2663	-0.29237	-0.29534	-0.25784	-0.28135	-0.15576	-0.19804	-0.09053	0.046704	0.049081	0.075472	-0.03465	0.106047	0.078951	-0.19795	-0.1838	-0.15081	-0.23408	-0.09105	-0.18757
J0	R28936	OS	5	4	0.145938	0.180859	0.095032	0.024324	0.140585	-0.09918	-0.035	-0.11942	-0.20148	-0.16781	-0.2562	-0.19902	-0.21515	-0.12247	-0.3188	-0.31724	-0.39578	-0.44752	-0.5285	-0.48537	-0.66064	-0.70281	-0.87104	-1.07409	-1.17852	-1.38197	-1.1568	-1.27417
J45	R28936	OS	5	4	0.118116	0.101569	0.214974	0.230696	0.23154	0.389398	0.354416	0.311335	0.317791	0.309618	0.385343	0.271564	0.265793	0.206881	0.22658	0.226597	0.146306	0.104791	9.70E-05	0.017487	0.118284	0.141758	0.323237	0.243188	0.239069	0.144525	0.351826	0.387149
Z12	R28936	OS	5	4	0.017277	-0.0197	-0.02174	0.00357	-0.02098	-0.00148	0.044063	0.027849	0.038012	0.026644	0.026841	0.019541	-0.00029	0.012522	0.021645	0.029144	0.010657	0.01997	0.012232	0.01238	0.017761	0.005578	-0.01018	-0.0777	-0.06397	0.010739	-0.02005	-0.008

A1.9. The specific data from the 4m viewing condition used for each subject. This is subject ANI010. The data on top is the right eye, while the bottom is the left eye. Z12 is spherical aberration (SA).

METRIC	MEASURE	EYE	ZERNIKE _ORDER	MEASURE_ DIAMETER [mm]	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1
M	R61388	OD	5	4	-0.36458	-0.44574	-0.44022	-0.53753	-0.5821	-0.58996	-0.57636	-0.65148	-0.72648	-0.80897	-0.73002	-0.8037	-0.82507	-0.82461	-0.77747	-0.75771	-0.77565	-0.69307	-0.71355	-0.67266	-0.68186	-0.66971	-0.53953	-0.57161	-0.57415	-0.56613	-0.39135
J0	R61388	OD	5	4	-0.78311	-0.76027	-0.72427	-0.68226	-0.65523	-0.58197	-0.57145	-0.43609	-0.35225	-0.24794	-0.21948	-0.13433	-0.16879	-0.15033	-0.146	-0.11802	-0.01174	-0.0038	-0.00972	0.008173	0.0229	-0.0328	-0.01276	0.074103	0.016907	-0.01858	-0.07665
J45	R61388	OD	5	4	-0.1456	-0.10367	-0.13203	-0.1222	-0.14576	-0.16635	-0.13902	-0.1094	-0.07607	-0.12798	-0.09328	-0.124	-0.10473	-0.09831	-0.08255	-0.07406	-0.0445	-0.02526	-0.06559	-0.08766	-0.05401	-0.01622	-0.08928	-0.01877	-0.04606	-0.00978	-0.08389
Z12	R61388	OD	5	4	-0.06245	-0.05098	-0.04295	-0.0569	-0.04561	-0.04653	-0.03527	-0.03469	-0.03387	-0.03787	-0.02757	-0.03394	-0.0344	-0.03162	-0.03451	-0.02718	-0.03415	-0.02053	-0.03708	-0.03902	-0.02309	-0.02501	0.000282	-0.00761	-0.02161	-0.03425	-0.0098

METRIC	MEASURE	EYE	ZERNIKE _ORDER	MEASURE_ DIAMETER [mm]	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
M	R61388	OD	5	4	-0.30419	-0.30371	-0.27137	0.08255	-0.45494	-0.14215	0.132903	0.13392	0.325759	0.296513	-0.06913	-0.27676	-0.50274	-0.83283	-0.14796	1.179044	1.293782	1.164738	1.058899	1.191292								
J0	R61388	OD	5	4	-0.00793	-0.01175	-0.04355	-0.07742	-0.47952	0.373462	0.050277	0.088476	-0.09239	-0.07591	-0.15476	-0.28666	-0.32496	-0.39962	-0.27298	-0.21229	-0.33978	-0.3851	-0.41837	-0.49666								
J45	R61388	OD	5	4	-0.02504	0.038974	0.048376	0.165784	0.102354	0.155949	0.215315	0.202584	0.164772	0.170726	0.216803	0.178823	0.172348	0.116406	0.190467	0.338361	0.341082	0.324075	0.275035	0.260812								
Z12	R61388	OD	5	4	-0.01757	-0.03468	-0.03347	-0.03148	-0.10073	-0.0807	-0.03313	-0.03351	-0.00577	0.006451	-0.0084	-0.00696	-0.02692	-0.02629	-0.01438	-0.0346	-0.04742	-0.04389	-0.03434	-0.03616								

METRIC	MEASURE	EYE	ZERNIKE _ORDER	MEASURE_ DIAMETER [mm]	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1
M	R61693	OS	5	4			0.171753	0.171486	0.160048	0.193953	0.133235	0.126117	0.108342	-0.34088	-0.28845	-0.3352	-0.37788	-0.32782	-0.42744	-0.45811	-0.45909	-0.49865	-0.62414	-0.64008	-0.74774	-0.80688		-1.05045	-1.09009		-1.09942
J0	R61693	OS	5	4			-0.28567	-0.09994	-0.14763	-0.11553	-0.06218	0.001742	0.037862	-0.06404	-0.03474	0.012777	0.003907	0.024201	0.030073	0.081376	0.047935	0.033229	-0.00848	-0.05439	-0.0491	-0.03009		-0.23098	-0.17219		-0.29713
J45	R61693	OS	5	4			-0.06072	-0.10206	-0.0249	-0.10966	-0.05935	-0.16544	-0.12638	-0.08384	-0.07342	-0.04189	-0.06406	0.011636	0.03252	0.003804	0.004845	-0.04433	8.19E-05	-0.03014	-0.02547	0.023601		0.130147	0.043651		-0.05239
Z12	R61693	OS	5	4			-0.06162	-0.02805	-0.00581	-0.01175	-0.00177	0.016012	-0.00146	0.005998	-0.00382	0.009498	0.001836	0.019338	0.001817	0.004386	-0.00477	0.005598	-0.00799	-0.00848	-0.00969	-0.01527		-0.05108	-0.0163		-0.00104

METRIC	MEASURE	EYE	ZERNIKE _ORDER	MEASURE_ DIAMETER [mm]	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
M	R61693	OS	5	4	-1.14912	-1.15498	-1.13835	-1.20946	-1.21726	-1.30037	-1.31446	-1.33186	-1.34502	-1.34047	-1.76106	-1.34245		-1.36717						-1.36707		-1.15849	-1.21598	-1.12968	-0.76237	-0.9205	-1.00697	
J0	R61693	OS	5	4	-0.1851	-0.22205	-0.12537	-0.19456	-0.24641	-0.21856	-0.35278	-0.38207	-0.3489	-0.33245	-0.39283	-0.5165		-0.53698						-0.75955		-0.8107	-0.8367	-0.85773	-0.99331	-1.01875	-1.04623	
J45	R61693	OS	5	4	0.04325	-0.01793	-0.07695	-0.01922	-0.0876	-0.01086	-0.11142	-0.12449	-0.08975	-0.13849	-0.05521	-0.09022		-0.15998						-0.2178		-0.24662	-0.27186	-0.29471	-0.32275	-0.38905	-0.3808	
Z12	R61693	OS	5	4	-0.02648	-0.01987	-0.0133	-0.04347	-0.04297	-0.0414	-0.03523	-0.02549	-0.02587	-0.02047	-0.09593	-0.01681		-0.02458						-0.05977		-0.03807	-0.05727	-0.05137	-0.01524	-0.06136	-0.08394	

A1.10. The specific data from the 4m viewing condition used for each subject. This is subject ANI011. The data on top is the right eye, while the bottom is the left eye. Z12 is spherical aberration (SA).

METRIC	MEASURE	EYE	ZERNIKE _ORDER	MEASURE_ DIAMETER [mm]	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1
M	R109634	OD	5	4		-1.893	-1.79052	-1.71088	-1.56982	-1.55703	-1.51051	-1.45454	-1.445	-1.44752	-1.46964	-1.42698	-1.42323	-1.45525	-1.35422	-1.38893	-1.32938	-1.27637	-1.37718	-1.16088	-1.26536	-1.05677	-1.02675	-1.05009	-1.1248	-1.22078	-0.98631
J0	R109634	OD	5	4		-1.1996	-1.20981	-1.0939	-0.97977	-0.90918	-0.84931	-0.81429	-0.64426	-0.56891	-0.4265	-0.3337	-0.32956	-0.21892	-0.21945	-0.1299	-0.13439	-0.13877	-0.0325	-0.03592	-0.13819	0.04463	0.037189	-0.05314	-0.06886	-0.14239	0.064577
J45	R109634	OD	5	4		0.665875	0.60314	0.582973	0.554374	0.565252	0.571294	0.497392	0.501909	0.57407	0.539579	0.544948	0.477797	0.429582	0.303152	0.435685	0.447263	0.262801	0.574898	0.423912	0.496182	0.412205	0.413891	0.433583	0.392149	0.3687	0.259003
Z12	R109634	OD	5	4		0.000245	0.029132	0.026968	0.037704	0.03033	0.031848	0.040114	0.042161	0.045699	0.045301	0.05168	0.037381	0.028284	0.068109	0.033686	0.039198	0.043497	0.016711	0.043181	0.014194	0.02825	0.029264	0.03236	0.000173	-0.00944	0.026991

METRIC	MEASURE	EYE	ZERNIKE _ORDER	MEASURE_ DIAMETER [mm]	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
M	R109634	OD	5	4	-0.97331		-0.973	-1.12769	-0.8524		-1.09734			-1.17418					-1.66666			-0.82729	-1.31941	-1.33872		-1.46501	-1.47289	-1.46933		-1.4236		-1.72045
J0	R109634	OD	5	4	-0.08462		0.076108	-0.01417	0.052467		-0.25923			-0.05669					-0.19629			-0.21202	-0.1916	-0.31556		-0.4632	-0.45194	-0.58754		-0.25421		-0.79576
J45	R109634	OD	5	4	0.279384		0.170941	0.108998	0.499187		0.384321			-0.03273					0.251246			0.339298	0.284066	0.217288		0.236507	0.154463	0.061753		0.054033		9.74E-17
Z12	R109634	OD	5	4	0.023799		0.014935	-0.01391	0.03129		-0.00522			0.038037					0.102143			0.011119	0.016051	0.025994		0.034142	0.023155	0.033472		0.06233		0.002978

METRIC	MEASURE	EYE	ZERNIKE _ORDER	MEASURE_ DIAMETER [mm]	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1
M	R109939	OS	5	4	-2.38897	-2.30099	-2.27598	-2.29893	-2.08956	-1.94342	-1.84837	-1.90159	-1.79552	-1.64599	-1.84106	-1.27251	-1.75359	-1.98821	-1.93833	-1.80538	-1.43225	-1.56684	-1.45698	-1.43545	-1.39362	-1.41156	-1.51993	-1.36569	-1.31096	-1.06154	
J0	R109939	OS	5	4	-0.4627	-0.47654	-0.42388	-0.3536	-0.22885	-0.24272	0.034883	-0.16214	-0.07216	-0.02803	0.327488	0.386809	0.085115	0.277629	0.26027	0.383395	0.163718	0.145366	0.068587	0.33323	0.258258	0.218419	0.340255	0.117261	0.148417	-0.00395	
J45	R109939	OS	5	4	0.176835	0.11464	0.043919	0.091727	0.155678	0.079223	0.022935	-0.03893	-0.06562	-0.12217	-0.01	-0.09706	-0.21653	-0.19581	-0.1106	-0.14895	-0.16351	0.042114	-0.24747	-0.22948	-0.22443	-0.34363	-0.26584	-0.23306	-0.25707	-0.37152	
Z12	R109939	OS	5	4	0.0171	0.01854	0.015394	0.003667	0.026156	0.05011	0.036644	0.039748	0.036301	0.060774	0.031121	0.081345	0.031492	0.033574	0.0438	0.028117	0.070942	0.026728	0.021045	0.038195	0.03938	0.029967	-0.01626	-0.01808	-0.03592	0.022172	

METRIC	MEASURE	EYE	ZERNIKE _ORDER	MEASURE_ DIAMETER [mm]	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
M	R109939	OS	5	4	-1.45279	-1.75746	-1.12998	-1.22531	-1.14345	-1.17172	-1.27457	-1.28302	-1.35348	-1.3632	-1.34268	-1.41136	-1.49313	-1.4653	-1.48223	-1.4861	-1.47751	-1.34244	-1.39315	-1.37652	-1.38387	-1.35565	-1.35837	-1.43648	-1.42569	-1.41944	-1.45796	-1.52113
J0	R109939	OS	5	4	0.286374	0.234994	0.029498	0.050709	0.11299	-8.85E-17	0.066542	0.009761	-0.10389	-0.13017	-0.13143	-0.06233	-0.24893	-0.25485	-0.06631	-0.31583	-0.3486	-0.33222	-0.42516	-0.4331	-0.51518	-0.55162	-0.58105	-0.66178	-0.7339	-0.81809	-0.87333	-0.96011
J45	R109939	OS	5	4	-0.53007	-0.90747	-0.42185	-0.28828	-0.23529	-0.48156	-0.34828	-0.29477	-0.17402	-0.24017	-0.20984	-0.26095	-0.22828	-0.22294	-0.35788	-0.31557	-0.33494	-0.25172	-0.40345	-0.43426	-0.46706	-0.51421	-0.52761	-0.59862	-0.6419	-0.58246	-0.67137	-0.6628
Z12	R109939	OS	5	4	-0.03551	-0.0539	0.02912	-0.00209	-0.00285	-0.00144	-0.00476	-0.00707	0.011067	0.025009	0.044462	0.004043	-0.00953	0.005251	0.00679	0.007402	-0.00207	0.015992	0.01888	0.015159	0.007039	0.027031	0.020057	0.014293	0.01633	0.031002	0.048756	0.047624

A1.11. The specific data from the 4m viewing condition used for each subject. This is subject ANI012. The data on top is the right eye, while the bottom is the left eye. Z12 is spherical aberration (SA).

METRIC	MEASURE	EYE	ZERNIKE_ORDER	MEASURE_DIAMETER [mm]	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1
M	R66207	OD	5	4	-1.78048	-1.93765	-1.93192	-1.97708	-1.99483	-2.018	-1.986	-1.973	-1.94055	-1.93278	-1.85212	-1.85191	-1.83225	-1.77027	-1.73372	-1.72558	-1.69065	-1.56573	-1.48579	-1.39271	-1.34381	-1.25163	-1.13665	-1.04215	-0.84145	-0.88131	
J0	R66207	OD	5	4	-1.41253	-1.45074	-1.27126	-1.16991	-1.10475	-1.03184	-0.99621	-0.84298	-0.83167	-0.74396	-0.66912	-0.5868	-0.58467	-0.44451	-0.48095	-0.40286	-0.37186	-0.37583	-0.2426	-0.28158	-0.22449	-0.13691	-0.13159	-0.09454	-0.04391	0.035922	
J45	R66207	OD	5	4	-0.16034	-0.10196	-0.06674	-0.03929	-0.03989	-0.02443	-0.00029	0.070505	0.115076	0.118418	0.148376	0.109401	0.140857	0.151824	0.161699	0.134674	0.173948	0.132477	0.178934	0.17115	0.156565	0.26156	0.24653	0.207286	0.264938	0.255229	
Z12	R66207	OD	5	4	0.001961	-0.0075	-0.00912	-0.00502	0.01031	0.007462	0.011222	0.014113	0.01951	0.036391	0.042514	0.043118	0.038694	0.041811	0.050611	0.035369	0.030632	0.037353	0.042278	0.053178	0.044377	0.0397	0.04308	0.040044	0.047244	0.07946	

METRIC	MEASURE	EYE	ZERNIKE_ORDER	MEASURE_DIAMETER [mm]	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
M	R66207	OD	5	4	-0.61208	-0.40556	-0.35766	-0.20761	-0.11443	-0.17677	-0.10096	-0.1494	-0.03955	-0.26113	-0.33612	-0.34358	-0.33711	-0.69876	-0.81788	-1.01585	-0.89871	-0.42672	-0.10097	-0.22735	-0.47117	-0.75925	-0.98864	-1.11452	-1.13774	-1.21073	-1.18388	-1.20634
J0	R66207	OD	5	4	0.015365	0.028075	0.076032	0.103248	0.13448	0.090091	0.071161	0.044	0.05316	0.00341	-0.08498	-0.06962	-0.03013	0.079083	-0.07138	-0.26241	-0.2991	-0.25738	-0.1214	-0.13141	-0.13887	-0.16542	-0.5119	-0.58837	-0.6591	-0.71288	-0.74603	-0.73995
J45	R66207	OD	5	4	0.219724	0.159219	0.296955	0.33336	0.388131	0.299155	0.372105	0.246946	0.36513	0.291473	0.371857	0.401721	0.611117	0.582857	0.532106	0.566026	0.487193	0.431243	0.320096	0.498529	0.393662	0.409463	0.34705	0.341968	0.289867	0.29029	0.283307	0.327461
Z12	R66207	OD	5	4	0.098054	0.0652	0.079323	0.073139	0.082191	0.043876	0.054258	0.046185	0.064503	0.050538	0.045781	0.048191	0.068898	0.055729	0.061515	0.035151	0.028903	0.007484	0.010914	0.003294	0.032209	0.017799	-0.01212	-0.01489	-0.00885	-0.01576	-0.01654	-0.01286

METRIC	MEASURE	EYE	ZERNIKE_ORDER	MEASURE_DIAMETER [mm]	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1
M	R66512	OS	5	4	-0.80535	-0.88427	-0.95505	-0.87414	-0.85308	-0.84344	-0.79417	-0.72514	-0.33205	-0.22614	-0.44542	-0.45162	-0.92812	-1.08442	-0.87372	-0.71838	-0.63727	-0.46282	-0.93552	-0.33007	-0.50463	-0.65155	-0.47929	-0.41367	-1.26487		
J0	R66512	OS	5	4	-0.46218	-0.42699	-0.33605	-0.36283	-0.2618	-0.26747	-0.10496	-0.13635	0.111285	0.106199	0.102062	0.379116	0.293001	0.307326	0.371271	0.313478	0.357978	0.478916	0.458613	0.440326	0.460403	0.411373	0.420775	-0.15511	0.982755		
J45	R66512	OS	5	4	-0.12447	-0.10225	-0.06007	-0.10713	-0.11009	-0.14956	-0.0502	-0.0582	-0.12509	-0.02223	0.023146	0.047859	0.057307	0.211111	0.05278	0.076608	-0.0861	-0.01996	-0.11418	0.001844	-0.2448	0.268711	-0.30571	-0.29171	0.397059		
Z12	R66512	OS	5	4	0.002103	0.012156	-0.00388	0.014551	0.039385	0.030648	0.010757	0.020066	0.057437	0.024789	0.028483	0.039582	0.039518	0.01439	0.041076	0.026716	0.025558	0.052864	-0.05681	0.066204	0.040538	-0.00787	0.085741	0.056767	-0.09779		

METRIC	MEASURE	EYE	ZERNIKE_ORDER	MEASURE_DIAMETER [mm]	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
M	R66512	OS	5	4				-1.41439		-1.49257		-1.80846	-2.69851	-1.54511	-1.25932	-1.66426	-2.12244	-1.8112	-1.73901	-1.7963	-1.77309	-1.81603	-1.75518	-1.799	-1.83484	-1.8044	-1.76114	-1.79836	-1.7817	-1.76556	-1.70045	-1.59337
J0	R66512	OS	5	4				0.317667		0.510781		-0.18165	-0.63469	0.085817	-0.00716	0.15537	-0.2568	0.063743	0.029704	-0.06876	-0.12767	-0.14571	-0.2234	-0.28791	-0.33476	-0.44797	-0.50297	-0.54101	-0.69669	-0.75232	-0.78851	-0.89612
J45	R66512	OS	5	4				0.141435		0.703029		0.290706	0.75768	0.161399	-0.20509	0.237966	0.310401	0.175047	0.064419	0.149866	0.139287	0.179325	0.161664	0.12842	0.072451	0.138047	0.067575	0.087429	0.064495	0.096558	0.011033	-0.05494
Z12	R66512	OS	5	4				-0.10703		0.008619		0.016435	-0.12416	0.092797	0.093455	0.04273	-0.002	0.040058	0.028365	0.04264	0.044236	0.033858	0.036383	0.03496	0.023406	0.035169	0.026735	0.021979	0.018008	0.011812	0.022464	0.024784

A1.12. The specific data from the 4m viewing condition used for each subject. This is subject ANI015. The data on top is the right eye, while the bottom is the left eye. Z12 is spherical aberration (SA).

METRIC	MEASURE	EYE	ZERNIKE_ORDER	MEASURE_DIAMETER [mm]	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1
M	R68159	OD	5	4	1.064344	0.964345	0.808412	0.681601	0.649615	0.567264	0.533877	0.317673	0.22512	0.195667	0.059289	-0.03765	-0.12805	-0.21149	-0.41012	-0.51772	-0.68884	-0.64983	-0.66319	-0.69229	-0.78407	-0.80412	-0.84705	-0.97696	-0.98944	-1.04866	-1.15999
J0	R68159	OD	5	4	-1.04081	-0.82335	-0.77469	-0.69855	-0.68129	-0.56478	-0.56653	-0.47826	-0.45751	-0.48383	-0.47488	-0.44417	-0.4161	-0.35965	-0.36675	-0.3435	-0.42277	-0.27604	-0.31469	-0.277	-0.26242	-0.23521	-0.23451	-0.20005	-0.26211	-0.28682	-0.21592
J45	R68159	OD	5	4	0.298446	0.168701	0.219632	0.165638	0.161268	0.254388	0.222328	0.171979	0.16207	0.14224	0.062118	0.057772	0.095182	-0.01256	0.091442	0.016711	-0.01152	0.0915	0.011299	0.022496	0.025159	0.012797	0.010824	0.021045	0.04417	-0.02633	-0.11706
Z12	R68159	OD	5	4	0.078845	0.086484	0.045853	0.040827	0.020836	0.0109	0.021438	6.83E-05	-0.00221	0.009264	-0.001	-0.01723	-0.00797	0.000625	-0.0353	-0.03027	-0.03945	-0.02185	-0.01284	-0.02152	-0.02509	-0.02795	-0.02088	-0.03625	-0.02799	-0.02681	-0.02199

METRIC	MEASURE	EYE	ZERNIKE_ORDER	MEASURE_DIAMETER [mm]	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
M	R68159	OD	5	4	-1.14366	-1.14003	-1.16714	-1.32308	-1.1267	-1.29794	-0.92018	-0.87161	-0.8739	-0.81458	-0.75199	-1.19956	-1.06495	-0.95044	-0.26608	0.13142		0.567506	0.032609	-0.38951	-0.40877	-0.50934		-0.45826	-0.45969	-0.45198	-0.4251	-0.3883
J0	R68159	OD	5	4	-0.09605	-0.30362	-0.37711	-0.2134	-0.57074	-0.34199	-0.36213	-0.45607	-0.39613	-0.41092	-0.26874	-0.33142	-0.25506	-0.32066	-0.42708	-0.45086		-0.47019	-0.57949	-0.61942	-0.65915	-0.66504		-0.81128	-0.84404	-0.89146	-0.85297	-0.96688
J45	R68159	OD	5	4	-0.08266	-0.16144	-0.15225	-0.15505	-0.05648	-0.09922	-0.21558	-0.12643	-0.16622	-0.11706	-0.03777	-0.00289	-0.12261	-0.14389	0.027511	-0.0103		0.082907	-0.04052	-0.11827	-0.19618	-0.18314		-0.18185	-0.20788	-0.23119	-0.27854	-0.22189
Z12	R68159	OD	5	4	-0.02138	-0.06178	-0.05288	-0.04509	-0.02196	-0.06474	-0.01224	-0.01042	-0.01384	-0.01099	-0.01509	-0.10827	-0.09554	-0.1168	-0.05242	-0.05514		-0.08512	-0.0138	-0.07024	-0.06458	-0.07372		-0.07224	-0.08063	-0.07796	-0.09359	-0.07935

METRIC	MEASURE	EYE	ZERNIKE_ORDER	MEASURE_DIAMETER [mm]	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1
M	R68464	OS	5	4	-0.7696	-0.82298	-0.64829	-0.71553	-0.74681	-0.57867	-0.599	-0.44721	-0.40401	-0.16395	0.27717	0.04019	-0.41756	-0.71864	-0.95688	-0.56903	-0.48535	-0.35979	-0.27314	-0.39474	-0.29892	-0.20222	-0.20698	-0.14272	-0.14739	-0.08659	-0.02995
J0	R68464	OS	5	4	-0.59684	-0.4924	-0.45452	-0.49745	-0.59054	-0.37273	-0.51598	-0.32632	-0.42196	-0.30561	-0.32537	-0.0992	-0.20238	-0.16589	-0.16591	-0.0175	8.80E-05	-0.02873	-0.04496	0.012408	0.043588	0.144075	0.103163	-0.01201	-0.0471	-0.11989	-0.07094
J45	R68464	OS	5	4	-0.06137	-0.02556	-0.05781	-0.01599	-0.05679	-0.0104	-0.0886	-0.14	-0.05578	-0.03546	-0.10168	-0.0605	-0.04649	-0.07091	-0.11647	-0.17817	-0.17004	-0.17936	-0.13889	-0.06693	-0.17725	-0.15003	-0.14876	-0.14286	-0.10377	-0.09796	-0.13272
Z12	R68464	OS	5	4	-0.10578	-0.11836	-0.09422	-0.07437	-0.07687	-0.07391	-0.06533	-0.05631	-0.07096	-0.06591	-0.03842	-0.0528	-0.05036	-0.05107	-0.03479	-0.02192	-0.02435	-0.01622	-0.00862	-0.03752	-0.00656	-0.00882	-0.00328	0.001297	-0.01095	-0.01476	-0.00959

METRIC	MEASURE	EYE	ZERNIKE_ORDER	MEASURE_DIAMETER [mm]	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
M	R68464	OS	5	4	0.096257		0.047594	0.174867	0.363167	0.315275	0.199237		0.34457	0.641548	0.440554	0.590818	0.726286	0.758282	0.865977	0.845709	0.895558		1.007296	1.188589	1.151667	1.275377	1.251102	1.491682	1.460014	1.574349	1.586862	1.575833
J0	R68464	OS	5	4	-0.09445		-0.23288	-0.30691	-0.12922	-0.22025	-0.24262		-0.33095	-0.25008	-0.30816	-0.3736	-0.4396	-0.475	-0.55737	-0.61168	-0.59892		-0.74884	-0.67736	-0.80319	-0.80418	-0.84652	-0.6413	-0.81196	-0.90829	-0.89882	-1.09377
J45	R68464	OS	5	4	-0.12917		-0.08476	-0.17305	-0.12041	-0.12802	-0.02396		-0.19107	0.03943	-0.05434	-0.07941	0.077513	-0.06518	-0.22325	-0.18111	-0.2063		-0.2503	-0.60989	-0.33639	-0.43478	-0.32087	-0.57749	-0.37575	-0.51206	-0.61833	-0.73776
Z12	R68464	OS	5	4	-0.00744		-0.01485	-0.04094	-0.01118	-0.01506	-0.07217		-0.05768	-0.00466	-0.05876	-0.02518	-0.02547	-0.03488	-0.02932	-0.03722	-0.03799		-0.04571	-0.02509	-0.0678	-0.00672	-0.0684	0.0063	-0.04125	-0.0311	-0.06469	-0.08409

A1.13. The specific data from the 4m viewing condition used for each subject. This is subject ANI016. The data on top is the right eye, while the bottom is the left eye. Z12 is spherical aberration (SA).

METRIC	MEASURE	EYE	ZERNIKE_ORDER	MEASURE_DIAMETER [mm]	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1
M	R112196	OD	5	4	-1.32557	-1.17071	-1.22484	-1.26903	-1.32735	-1.31956	-1.35152	-1.37206	-1.42993	-1.33004	-1.10245	-1.12388	-1.1549	-1.23741	-1.20993	-1.41311	-1.2212	-1.22172	-1.18603	-0.98919	-1.4729	-0.88474	-1.33971	-1.10022	-1.22869	-1.2654	-1.07779
J0	R112196	OD	5	4	-1.39167	-1.10257	-1.13219	-1.04415	-1.0012	-0.9284	-0.93581	-0.83276	-0.75736	-0.61151	-0.49574	-0.48894	-0.62969	-0.48138	-0.28802	-0.70245	-0.4147	-0.42939	-0.51691	-0.3407	-0.6105	-0.3984	-0.34706	-0.33035	-0.25337	1.08E-17	0.122911
J45	R112196	OD	5	4	0.332456	0.314607	0.345653	0.400453	0.4159	0.354262	0.365269	0.402574	0.405107	0.344952	0.413236	0.414822	0.258834	0.318865	0.320525	0.336399	0.253522	0.248238	0.126617	0.130014	0.469332	0.12645	-0.17243	0.107074	0.262377	0.175785	0.212889
Z12	R112196	OD	5	4	0.024241	0.016029	0.022544	0.005349	0.000345	0.006922	-0.00569	-0.0089	-0.02321	-0.00507	0.006585	0.003134	-0.00126	-0.015	0.012674	-0.0115	-0.00925	-0.00156	-0.02317	-0.00369	-0.08527	-0.02184	-0.1079	-0.06236	-0.09281	-0.07499	-0.08584

METRIC	MEASURE	EYE	ZERNIKE_ORDER	MEASURE_DIAMETER [mm]	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
M	R112196	OD	5	4	-0.77849	-1.1047	-0.85172	-0.93578	-0.7032	-0.69472	-0.21133	-0.39483	-0.47029	-0.1717	-0.57849	-0.3009	-0.28854	-0.52881	-0.33535	-0.00927	0.264185	1.506611	-0.3729	-0.12461	-0.07487	-0.11509	-0.08562	0.177313	0.178428	0.137859	-0.13881	0.022194
J0	R112196	OD	5	4	-0.27601	-0.26214	-0.08514	0.180601	-0.07746	0.122032	0.170293	0.137068	0.121494	0.09684	0.051091	0.29213	-0.13911	-0.17085	0.039534	0.100122	0.138537	0.027707	-0.12207	0.01432	-0.11448	0.129546	-0.05397	0.19664	0.088567	0.059216	-0.16419	-0.08918
J45	R112196	OD	5	4	-0.10046	-0.21438	-0.03082	-0.37029	-0.17398	-0.48945	-0.23439	0.053817	-0.15551	0.006772	-0.43545	-0.12042	0.033609	-0.1403	-0.29233	-0.28922	-0.0643	-0.19715	-0.02595	-0.14908	-0.26393	-0.30502	-0.15968	-0.23257	-0.03851	-0.18371	-0.15436	-0.19328
Z12	R112196	OD	5	4	-0.04269	-0.08179	-0.05978	-0.12627	-0.07531	-0.10399	-0.01342	-0.04584	-0.02477	0.029585	-0.05025	-0.01447	-0.04249	0.035545	0.000155	0.001795	-0.02105	0.157126	-0.02991	0.044946	0.004591	-0.00383	-0.0122	-0.03832	-0.01746	-0.03264	-0.07802	-0.06593

METRIC	MEASURE	EYE	ZERNIKE_ORDER	MEASURE_DIAMETER [mm]	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1
M	R112501	OS	5	4	0.107039	-0.02124	-0.11724	-0.17663	-0.2938	-0.23137	-0.38398	-0.18312	-0.35761	-0.7742	-0.34948	-1.11476	-1.09322	-1.00079	-0.90619	-0.77852	-0.76605	-0.71524	-0.8767	-0.82795	-0.90225	-1.01785	-1.26869	-1.33773	-1.19738	-0.9549	-1.48372
J0	R112501	OS	5	4	-0.14797	-0.14497	-0.10786	-0.08697	-0.04632	0.027156	0.004762	0.006309	0.029664	-0.22259	-0.31691	-0.24086	0.019073	0.041045	0.025306	0.128777	0.023228	0.118661	0.063225	0.06189	0.027199	0.014858	-0.05596	0.074727	0.041213	0.028985	-0.3592
J45	R112501	OS	5	4	-0.02231	-0.07446	-0.07661	-0.10018	-0.10897	-0.04681	-0.08894	-0.08771	0.001076	-0.01428	0.022161	0.075703	0.088495	0.151627	0.14379	0.126474	0.094924	0.067311	0.033339	0.016968	-0.05483	-0.16171	-0.28993	-0.10001	-0.15755	0.022075	0.103397
Z12	R112501	OS	5	4	-0.05103	-0.04772	-0.04267	-0.0413	-0.03827	-0.00829	-0.01818	-0.00461	-0.03883	-0.05399	-0.00411	0.011319	0.012623	0.026137	0.011753	0.014609	0.014255	0.019658	-0.0042	0.007982	-0.00875	-0.03955	-0.05128	-0.06551	-0.04938	-0.03106	-0.08756

METRIC	MEASURE	EYE	ZERNIKE_ORDER	MEASURE_DIAMETER [mm]	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
M	R112501	OS	5	4	-1.33186	-1.40717	-1.41255	-1.67038							-1.05257	-1.16119	-1.09874	-1.15099	-1.17362	-1.17014	-1.09307	-1.15682	-1.0664	-1.00152	-0.96544	-0.96375	-0.91831	-0.85215	-0.83339	-0.7981	-0.80738	-0.77038
J0	R112501	OS	5	4	-0.0844	-0.13114	-0.22062	-0.23117							-0.32984	-0.44674	-0.53455	-0.48068	-0.57749	-0.63428	-0.65436	-0.64443	-0.71437	-0.62442	-0.75648	-0.81258	-0.78654	-0.87498	-1.03211	-1.049	-1.1369	-1.27174
J45	R112501	OS	5	4	-0.18957	-0.24664	-0.14611	0.016165							-0.05816	0.049898	-0.00297	-0.09622	-0.1651	-0.16811	-0.16974	-0.18166	-0.23211	-0.25781	-0.3048	-0.29553	-0.29927	-0.27596	-0.32605	-0.34851	-0.31256	-0.34366
Z12	R112501	OS	5	4	-0.06867	-0.10663	-0.09563	-0.08284							-0.02211	0.010445	0.025474	-0.01838	-0.03618	-0.0031	-0.01234	-0.03902	-0.03554	-0.02074	-0.02574	-0.01569	-0.01536	-0.00585	-0.01019	-0.01294	-0.018	-0.00013

A1.14. The specific data from the 4m viewing condition used for each subject. This is subject ANI020. The data on top is the right eye, while the bottom is the left eye. Z12 is spherical aberration (SA).

METRIC	MEASURE	EYE	ZERNIKE_ORDER	MEASURE_DIAMETER [mm]	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1
M	R114087	OD	5	4	-1.71416	-1.71613	-1.79621	-1.70821	-1.58643	-1.59445	-1.54239	-1.46793	-1.41896	-1.25909	-1.26714	-1.19113	-1.13934	-1.09101	-1.15537	-1.06793	-1.12776	-1.02381	-1.00336	-0.96649	-0.93807	-0.87928	-0.81516	-0.8133	-0.81411	-0.82723	-0.8022
J0	R114087	OD	5	4	-0.91461	-0.84889	-0.81724	-0.66566	-0.5947	-0.54165	-0.54382	-0.39536	-0.3545	-0.2707	-0.18356	-0.0926	-0.08565	-0.02218	0.011529	0.117046	0.199084	0.198866	0.252061	0.210508	0.249582	0.273714	0.32138	0.219783	0.249555	0.30197	0.264388
J45	R114087	OD	5	4	0.0163	-0.0325	0.001638	-0.0155	-0.05486	-0.19579	-0.12454	-0.09285	-0.18078	-0.13976	-0.23633	-0.11302	-0.06565	-0.06803	-0.00566	-0.0042	-0.02914	-0.07919	-0.1341	-0.20712	-0.09738	-0.10938	-0.2066	-0.20021	-0.17754	-0.18517	-0.19003
Z12	R114087	OD	5	4	0.055142	0.058011	0.057563	0.056856	0.057814	0.059662	0.057052	0.049492	0.053224	0.070453	0.076764	0.084635	0.089274	0.08837	0.085255	0.095282	0.087386	0.08032	0.073739	0.090995	0.081267	0.067042	0.084518	0.056559	0.036243	0.008527	0.019934

METRIC	MEASURE	EYE	ZERNIKE_ORDER	MEASURE_DIAMETER [mm]	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
M	R114087	OD	5	4	-1.02735	-0.77008	-0.58705	-0.6193	-0.57012	-0.41397	-0.29142	-0.3064	-0.23365	-0.24112	-0.23407	-0.18549	-0.36201	-0.35001	-0.56891	-0.81019	-1.67993	-1.32724		-0.61998	-0.50457	-0.4242	-0.38875	-0.50608	-0.55376	-0.68389	-0.57462	-0.65599
J0	R114087	OD	5	4	0.62887	0.317157	0.166717	0.277095	0.317802	0.22448	0.291449	0.155656	0.196543	0.280385	0.331976	0.337835	0.142628	0.132306	0.255609	0.138318	-0.20924	-0.1147		0.027437	0.067312	0.170036	0.019142	0.044393	-0.07806	-0.05911	-0.05646	-0.12343
J45	R114087	OD	5	4	0.003045	-0.13197	-0.16892	-0.2943	-0.12785	-0.12306	-0.15445	-0.20809	-0.18852	-0.12358	-0.21471	-0.16573	-0.19451	-0.24649	-0.1728	-0.34235	-0.31021	-0.37708		-0.39236	-0.29345	-0.37383	-0.33549	-0.33616	-0.28174	-0.32592	-0.32887	-0.39472
Z12	R114087	OD	5	4	0.000133	0.024942	0.033448	-0.01476	-0.01698	-0.02512	-0.00771	0.007191	0.009942	0.020861	0.032029	0.01912	-0.03202	-0.02531	0.021989	0.13953	0.006823	0.005122		0.016746	0.015672	0.007826	0.027088	0.019011	0.040123	0.015713	0.042208	0.051852

METRIC	MEASURE	EYE	ZERNIKE_ORDER	MEASURE_DIAMETER [mm]	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1
M	R114392	OS	5	4	0.430884	0.12026	0.386925	0.192102	0.128783	0.060199	-0.14209	-0.26066	-0.15879		-0.89617	-2.33022	-2.03198	-1.75713	-1.32081	-1.04861	-1.00833	-0.61185	-0.91337	-1.25756	-0.86287	-0.96371	-0.93415	-1.40818	-1.0793	-1.25791	-1.32906
J0	R114392	OS	5	4	-0.62194	-0.66045	-0.4871	-0.43927	-0.28088	-0.55063	-0.42317	-0.36873	-0.23029		-0.31714	-0.15649	-0.62121	-0.41388	-0.12032	-0.07799	-0.02869	-0.0076	0.025028	0.036273	0.184705	0.036473	0.08686	0.015483	0.041853	0.107199	0.180835
J45	R114392	OS	5	4	0.307854	0.177859	0.348271	0.259598	0.183241	0.352066	0.249721	0.270461	0.309837		0.727875	0.428377	0.48123	0.655337	0.327146	0.269349	0.377474	-0.04308	0.282173	0.750983	0.234054	0.115996	0.023137	0.462082	0.22042	0.242139	0.215371
Z12	R114392	OS	5	4	-0.03807	-0.07623	0.010585	-0.03374	-0.01176	-0.03989	-0.05069	-0.06758	-0.04014		-0.14733	-0.03829	-0.01838	-0.01735	-0.00991	-0.08094	-0.05755	-0.00416	-0.04127	-0.03473	-0.02061	-0.01986	-0.00199	-0.07868	-0.00928	-0.04087	-0.02168

METRIC	MEASURE	EYE	ZERNIKE_ORDER	MEASURE_DIAMETER [mm]	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
M	R114392	OS	5	4	-1.36613	-1.53172	-1.44221	-1.49814	-1.46523	-1.17341	-1.12245	-1.14135	-1.13233	-1.11771	-1.09124	-0.95242	-1.27538	-1.21112	-0.83202	-0.83248	-1.03613	-0.96673	-0.88829	-0.81595	-0.7936	-0.81478	-0.71121	-0.76856	-0.61068	-0.48541	-0.3747	-0.35976
J0	R114392	OS	5	4	0.026287	0.126697	0.107426	0.113808	0.077481	0.193553	0.195522	0.101453	0.085114	0.023909	0.077247	0.080125	-0.08544	-0.13388	-0.0307	-0.15329	-0.30922	-0.31615	-0.35937	-0.38642	-0.40693	-0.52577	-0.57543	-0.68569	-0.66257	-0.70275	-0.8173	-0.81635
J45	R114392	OS	5	4	0.212439	0.238822	0.195018	0.23015	0.247936	0.02769	0.086355	0.128757	0.06089	0.097884	0.134403	0.099471	0.195911	0.137978	0.104195	0.078349	0.135075	0.151141	0.118201	0.135272	0.123385	0.090711	0.10142	0.165908	0.205443	0.211062	0.203775	0.12477
Z12	R114392	OS	5	4	-0.02819	-0.02435	-0.0148	-0.02277	-0.03375	-0.0115	0.006921	0.010215	-0.00212	0.014764	0.017156	0.02614	0.00172	0.000447	0.031804	0.029641	0.013446	0.014168	0.010802	0.007052	-0.0002	-0.01106	-0.00042	-0.00444	-0.01274	-0.00261	0.005551	-0.00135

A1.15. The specific data from the 4m viewing condition used for each subject. This is subject ANI021. The data on top is the right eye, while the bottom is the left eye. Z12 is spherical aberration (SA).

METRIC	MEASURE	EYE	ZERNIKE _ORDER	MEASURE_ DIAMETER [mm]	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1
M	R116039	OD	5	4	-0.49802	-0.4788	-0.55604	-0.506	-0.54694	-0.44351	-0.38895	-0.35068	-0.34907	-0.27578	-0.15115	-0.32312	-0.37517	-0.23113	-0.20267	-0.29378	-0.21565	-0.16468	-0.15175	-0.15938	-0.12542	-0.13587	-0.0085	-0.03046	-0.02359	0.072805	0.033386
J0	R116039	OD	5	4	-2.00549	-1.98388	-1.80228	-1.7198	-1.51892	-1.4256	-1.3291	-1.26998	-1.06311	-1.08	-0.96914	-0.68085	-0.60368	-0.52905	-0.49519	-0.34808	-0.30563	-0.22308	-0.16457	-0.14607	-0.09207	0.013516	0.02919	0.061194	0.034911	0.084362	0.061572
J45	R116039	OD	5	4	0.088084	0.069345	0.000886	0.013375	0.001002	-0.03791	-0.03101	-0.01155	-0.00373	-0.00031	0.010738	-0.04478	-0.0864	-0.05461	-0.06197	-0.13383	-0.11242	-0.03557	-0.06372	-0.06207	-0.05289	-0.04955	-0.04046	0.066765	0.048262	0.096248	0.12053
Z12	R116039	OD	5	4	-0.01851	-0.00784	-0.02563	-0.0125	-0.03211	-0.01588	-0.00558	-0.00845	-0.01227	-0.00261	0.008854	-0.00909	-0.01307	-0.00664	-0.00371	-0.01585	-0.01903	-0.0137	0.003295	-0.00557	-0.01049	-0.01345	-0.00723	-0.01818	-0.00147	0.007547	0.003763

METRIC	MEASURE	EYE	ZERNIKE _ORDER	MEASURE_ DIAMETER [mm]	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
M	R116039	OD	5	4	0.021999	0.044323	0.071382	0.17132	0.194828	0.090373	0.08072	-0.00979	-0.15235	-0.1777	-0.18936	-0.29203	-0.74721	-0.61152	-0.56116	-0.01486	0.171538	-0.12151	-0.41387	-0.57552	-0.63747	-0.73305	-0.64547	-0.52869	-0.50037	-0.41956	-0.29886	-0.26147
J0	R116039	OD	5	4	0.156229	0.12807	0.101436	0.124364	0.12315	0.200644	0.206205	0.11308	0.274534	0.073934	0.122069	0.088705	0.118476	-0.00419	-0.07477	-0.0814	-0.06841	-0.10508	-0.13395	-0.15503	-0.17338	-0.21251	-0.20166	-0.24835	-0.28262	-0.37156	-0.37313	-0.36215
J45	R116039	OD	5	4	0.188918	0.105541	0.168313	0.17177	0.129705	0.185544	0.155277	0.149109	0.302676	0.25947	0.251504	0.1898	0.180582	0.146054	0.183954	0.22871	0.271883	0.287705	0.225263	0.228542	0.151833	0.156238	0.18562	0.195929	0.199456	0.089392	0.178589	0.193232
Z12	R116039	OD	5	4	-0.01334	-0.01699	-0.02381	-0.02352	-0.00577	-0.02845	-0.01799	-0.02241	-0.05404	-0.03972	-0.05297	-0.04869	-0.06318	-0.05867	-0.05201	-0.04322	-0.05895	-0.06405	-0.06519	-0.07099	-0.07677	-0.08434	-0.07386	-0.06826	-0.06316	-0.05287	-0.04314	-0.04852

METRIC	MEASURE	EYE	ZERNIKE _ORDER	MEASURE_ DIAMETER [mm]	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1
M	R116344	OS	5	4	-0.51069	-0.54916	-0.65195	-0.63441	-0.56494	-0.72305	-0.70006	-0.68246	-0.51393	-0.30864	-0.16578	-0.05972	-0.45815	-0.57391	-0.90021	-0.64007	-0.48827	-0.22265	-0.51612	-0.53602	-0.24494	-0.34569	-0.58768	-0.36907	-0.35386	-0.57779	-0.484
J0	R116344	OS	5	4	-0.06872	-0.08307	0.006712	0.047747	0.219079	0.203082	0.213863	0.321539	0.451553	0.604404	0.992351	0.66985	0.508705	0.67985	0.539876	0.685957	0.647085	0.558271	0.460228	0.372948	0.469944	0.405822	0.567289	0.352501	0.381742	0.327818	0.274739
J45	R116344	OS	5	4	0.144879	0.041586	0.135453	0.121931	0.040197	0.096514	0.287417	0.208946	0.137595	0.130369	0.242222	0.383523	0.154598	0.263021	0.035642	0.074893	0.036234	-0.08569	0.151866	0.178197	-0.03869	0.047647	0.05854	0.053191	-0.14242	0.041495	-0.0909
Z12	R116344	OS	5	4	-0.02226	-0.03563	-0.04912	-0.03258	-0.01906	-0.05009	-0.04819	-0.04314	-0.04498	-0.03853	-0.07	-0.07494	-0.09483	-0.02395	-0.0502	-0.04695	-0.0341	-0.01497	-0.11544	-0.12132	-0.04676	-0.08923	-0.13034	-0.09921	-0.0745	-0.11925	-0.09723

METRIC	MEASURE	EYE	ZERNIKE _ORDER	MEASURE_ DIAMETER [mm]	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
M	R116344	OS	5	4	-0.57039	-0.52759	-0.40771	-0.29092	-0.27723	-0.43203	-0.32912	-0.4232	-0.49653	-0.53085	-0.46493	-0.52018	-0.53038	-0.65193	-0.66957	-0.5956	-0.69004	-0.74298	-0.81318	-0.87586	-1.00174	-1.0262	-1.07607	-1.14368	-1.0583	-0.97899	-1.02141	-1.04987
J0	R116344	OS	5	4	0.411621	0.186682	0.311605	0.282349	0.168652	0.215735	0.255596	0.090949	0.080512	0.025138	-0.03139	-0.04879	-0.02365	-0.13211	-0.15196	-0.21242	-0.33176	-0.34284	-0.40985	-0.49578	-0.58123	-0.70545	-0.69082	-0.78287	-0.868	-1.04406	-1.0294	-1.11559
J45	R116344	OS	5	4	-0.02356	0.001837	-0.14933	0.053337	0.032538	0.025829	0.04224	0.038798	-0.05921	0.039471	0.032163	0.044925	-0.00241	-0.15098	0.01688	-0.05207	-0.20547	-0.1368	-0.17381	-0.23678	-0.14279	-0.08847	-0.04311	0.001246	-0.05914	-0.06573	-0.05223	-0.11889
Z12	R116344	OS	5	4	-0.10236	-0.10645	-0.07964	-0.06518	-0.06824	-0.08576	-0.07223	-0.06127	-0.05134	-0.06571	-0.03614	-0.04768	-0.07067	-0.06697	-0.04935	-0.03374	-0.03787	-0.02102	-0.01016	-0.0157	-0.0126	-0.02724	-0.01112	-0.02343	-0.01087	0.001815	0.003942	0.018768

A1.16. The specific data from the 4m viewing condition used for each subject. This is subject ANI022. The data on top is the right eye, while the bottom is the left eye. Z12 is spherical aberration (SA).

METRIC	MEASURE	EYE	ZERNIKE _ORDER	MEASURE_ DIAMETER [mm]	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1
M	R117991	OD	5	4	-1.20427	-1.21682	-1.09095	-1.00503	-0.94312	-0.89431	-0.81827	-0.75652	-0.6927	-0.70345	-0.73579	-0.66208	-0.7024	-0.63446	-0.66328	-0.69907	-0.57744	-0.49253	-0.63742	-0.54238	-0.64252	-0.4816	-0.37612	-0.35929	-0.35703	-0.41207	-0.44965
J0	R117991	OD	5	4	-1.24937	-1.10761	-1.07052	-0.95648	-0.78776	-0.6874	-0.54201	-0.488	-0.34633	-0.31092	-0.21411	-0.16903	-0.12367	-0.09094	-0.0232	0.008605	0.071052	0.062294	0.05459	0.188908	0.116612	0.244685	0.201574	0.174704	0.285809	0.314674	0.299852
J45	R117991	OD	5	4	0.037723	-0.06573	-0.02248	0.018981	-0.01159	0.009945	0.065969	0.122165	0.11866	0.143627	0.096403	0.117275	0.151849	0.118526	0.139912	0.12295	0.160935	0.120775	0.21647	0.143965	0.121218	0.179124	0.154543	0.102929	0.150892	0.115795	0.091159
Z12	R117991	OD	5	4	-0.00573	0.023321	0.021608	0.052758	0.06493	0.060107	0.072839	0.077943	0.081818	0.099031	0.07764	0.08152	0.087128	0.072128	0.061741	0.055076	0.060705	0.060398	0.022576	0.011158	-0.01911	-0.00226	0.015566	0.007953	0.009136	-0.00402	0.005583

METRIC	MEASURE	EYE	ZERNIKE _ORDER	MEASURE_ DIAMETER [mm]	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
M	R117991	OD	5	4	-0.56553	-0.51387	-0.4481	-0.44621	-0.48316	-0.5866	-0.6897	-0.569	-0.64934	-0.62798	-0.61316	-0.93179	-1.47343	-1.48383	-1.35274	-0.63135		-0.70619	-1.03068	-0.87165	-0.87688	-0.89912	-1.04228	-1.04219	-1.127	-1.11056	-1.23374	-1.22609
J0	R117991	OD	5	4	0.254591	0.318521	0.309953	0.299001	0.214279	0.282628	0.178887	0.21888	0.1891	0.178354	0.160415	0.097317	0.047892	-0.03548	-0.04771	0.12695		0.023307	-0.14515	-0.11636	-0.24938	-0.21825	-0.34167	-0.37946	-0.44453	-0.58005	-0.52535	-0.46421
J45	R117991	OD	5	4	-0.00229	0.146426	0.029627	0.035009	0.002114	-0.07844	-0.08355	-0.10663	-0.05987	-0.13797	-0.09139	0.046231	-0.0588	-0.06553	-0.22444	0.061918		0.060762	-0.0481	-0.00201	-0.05167	0.008629	-0.12444	-0.19993	-0.21822	-0.27404	-0.29629	-0.57395
Z12	R117991	OD	5	4	-0.00796	-0.01083	-0.01351	-0.01719	-0.01965	-0.02066	-0.02976	-0.00428	-0.01295	0.002968	0.008693	-0.02362	-0.02322	-0.01574	0.035042	-0.01506		-0.01961	-0.01272	-0.01194	-0.00761	0.000743	-0.0207	-0.01116	-0.00737	-0.00912	-0.00215	0.000503

METRIC	MEASURE	EYE	ZERNIKE _ORDER	MEASURE_ DIAMETER [mm]	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1
M	R118296	OS	5	4	-1.79186	-1.62589	-1.64088	-1.57684	-1.60472	-1.57695	-1.40405	-1.3977	-1.39242	-1.33959	-1.31606	-1.2138	-1.20401	-1.32334	-1.48117	-1.53172	-1.23835	-1.11443	-0.92051	-0.71472	-0.81906	-0.85482	-0.68509	-0.57675	-0.49702	-0.47696	-0.68064
J0	R118296	OS	5	4	-0.67698	-0.60537	-0.55485	-0.51793	-0.46982	-0.44354	-0.38474	-0.33709	-0.31456	-0.19109	-0.12649	-0.10749	0.021875	-0.06873	0.053771	0.011213	-0.03719	-0.23117	0.154071	0.063212	0.171855	0.003503	0.222937	0.045366	-0.05419	0.164672	-0.01206
J45	R118296	OS	5	4	0.175487	0.099867	0.000352	0.099584	0.101684	0.072735	0.053645	0.021385	0.085755	0.016837	0.056447	0.082641	0.122088	0.126762	0.114765	0.084334	0.036553	0.169026	-0.06846	-0.07396	0.071053	0.011378	-0.18707	0.050385	-0.01761	-0.09507	0.142394
Z12	R118296	OS	5	4	0.01987	0.037853	0.027429	0.010026	-0.00341	-0.00341	0.023947	0.002204	-0.00894	-0.00556	0.001575	0.007664	0.006158	-0.00344	0.028928	0.030149	0.013939	-0.00089	-0.00261	0.042517	0.003125	-0.00837	0.008649	0.043573	0.028522	0.033173	0.032344

METRIC	MEASURE	EYE	ZERNIKE _ORDER	MEASURE_ DIAMETER [mm]	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
M	R118296	OS	5	4	-0.71116	-0.66753	-0.66477	-0.69916	-0.67357	-0.55045	-0.63842	-0.5261			-0.70672	-0.51232	-0.70017	-0.78621	-0.6273	-0.86707	-0.89842	-0.85721	-0.88491	-0.72834	-0.74106	-0.84614	-0.87753	-0.91959	-0.92402	-0.86543	-0.95186	-0.90176
J0	R118296	OS	5	4	0.028544	0.034688	0.008566	0.429156	0.042736	-0.05893	0.040451	-0.68549			-0.15976	-0.01127	-0.16685	-0.1478	-0.1726	-0.38898	-0.42297	-0.42443	-0.37443	-0.42276	-0.35161	-0.48884	-0.53562	-0.55018	-0.69529	-0.73202	-0.78155	-0.83346
J45	R118296	OS	5	4	-0.2209	-0.10565	-0.0815	-0.22819	-0.09948	-0.03683	0.055675	0.498039			-0.02817	0.008187	-0.06224	0.027916	0.079794	-0.13516	-0.12643	-0.07447	-0.08341	-0.12771	-0.09874	-0.10423	-0.16724	-0.21982	-0.23832	-0.21819	-0.32462	-0.27916
Z12	R118296	OS	5	4	0.019672	0.020933	0.030926	0.022154	-0.04511	0.013629	-0.02792	-0.04485			-0.01676	0.017431	0.02085	-0.00522	0.033897	0.007268	0.015746	0.015346	0.003348	0.017533	0.012545	0.001664	-0.01281	-0.01369	-0.01625	-0.00659	-0.01805	-0.00147

A1.17. The specific data from the 4m viewing condition used for each subject. This is subject ANI023. The data on top is the right eye, while the bottom is the left eye. Z12 is spherical aberration (SA).

9. Appendix II – ARVO Posters

Peripheral Retinal Profiles and Thickness in Anisomyopia

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Background

In myopia, the globe expands in a prolate shape(1), causing stretching and subsequent thinning of the retina(2,3). Anisomyopia is the difference in the amount of myopia between the two eyes due to a difference in axial length(4).

There is limited data on the effects of anisomyopia on retinal thickness. Vincent et al (4) found that the more myopic eyes in anisometropia have thicker central foveas in Asian subjects. However there was no significant difference in Caucasian subjects. There is no available information on retinal thickness across the retina in anisomyopia.

Knowledge of the physical effects of anisomyopia will bring us one step closer to better understanding this condition.

Purpose

To evaluate retinal thickness variations across the central 56 degrees and compare between the two eyes of anisomyopes.

Hypothesis

Eyes with longer axial lengths will have a thinner retina at (1) the nasal foveal shoulder, (2) the temporal retina, and (3) nasal retina, and (4) will exhibit no difference in foveal pit thickness.

Methods

Subjects

- n=19 young adults (n=38 eyes) with anisomyopia (difference in SE of 1.00D or more); average SE difference: 1.79±1.01D.
- SE refractive error -0.13D to -11.38D, mean: -4.50±2.80D.
- AL 22.27 to 29.42 mm, mean: 25.17±1.64 mm.

Retinal Thickness

- OptoVUE OCT was used to measure retinal thickness across the central 56 degrees.
- Three OCT measurements: (1) fixating at a central target, (2) a target at +18deg, and (3) a target at -18deg eccentricity. Each 6-mm long B-scan provided 1020 samples of thickness.
- Using the full retinal thickness data, we analyzed the following dimensions:
  1. Foveal Pit thickness, defined as the thinnest point within the foveola (average 20 points).
  2. Nasal Foveal Shoulder thickness, defined as the thickest value nasal to the fovea (average of 20 points).
  3. Temporal Retina, defined as the slope and intercept of the area 10 to 28deg temporal to the fovea.
  4. Nasal Retina, defined as the average thickness of the nasal retina from 70 data points past the optic nerve head and up to 28deg eccentricity.

Axial Length

- Central and peripheral axial length measurements were taken using a LenStar LS900 (Haag Streit) on-axis, and at ± 30, 20, 16, 12, 8, and 4 degrees horizontally (average central AL difference: 0.68±0.41mm).

Statistics

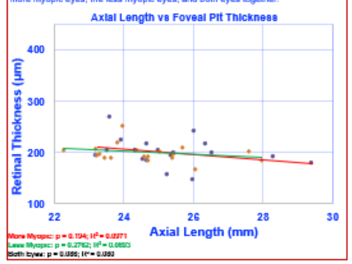
- Pearson Correlation statistical tests and two-sample t-tests were performed using Rstudio and SPSS.

Discussion/Conclusions

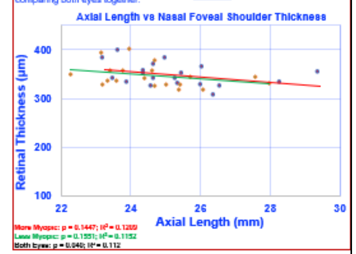
- Significant retinal thickness differences were found among individual eyes unlike the differences between the two eyes in anisomyopia.
- Retinal thickness differences between the more and less myopic eyes were found only in the area nasal to the ONH.
- Central retinal thickness does not appear to be affected by axial length.
- Further investigation of the physical effects of anisomyopia is essential to understanding its intricacies. Measuring subjects with a greater anisomyopic difference is the next step.

Results – Retinal Thickness

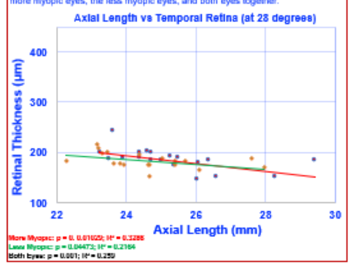
Central axial length was not correlated with Foveal Pit thickness for the more myopic eyes, the less myopic eyes, and both eyes together.



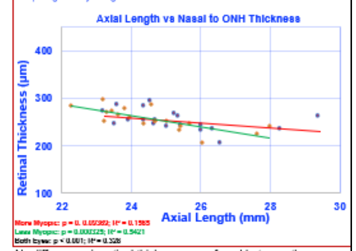
Central axial length was not correlated with Nasal Foveal Shoulder thickness for the more myopic eyes and the less myopic eyes, but was correlated when comparing both eyes together.



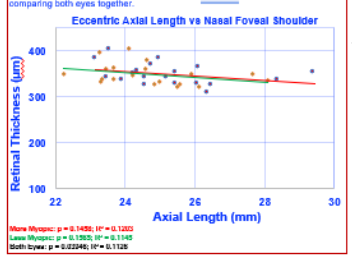
Central axial length was correlated with Temporal Retinal thickness for the more myopic eyes, the less myopic eyes, and both eyes together.



Central axial length was not correlated with Nasal to ONH thickness for the more myopic eyes, but was correlated for the less myopic eyes, and when comparing both eyes together.



Eccentric axial length was not correlated with Nasal Foveal Shoulder thickness for the more myopic eyes and the less myopic eyes, but was correlated when comparing both eyes together.



- No differences in retinal thickness were found between the more and less myopic eyes in anisomyopia (Foveal Pit: t=-0.02, p=0.98; Nasal Foveal Shoulder: t=0.06, p=0.95; Temporal Retina Thickness: t=0.08, p=0.94; or Nasal Retina thickness: t=-0.60, p=0.55).
- Comparing the difference between axial lengths and the thicknesses of the area nasal to the ONH of the more and less myopic eyes revealed a significant positive correlation (p=0.0364, R^2=0.2328).

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Acknowledgements/Commercial Relationships

- American Academy of Optometry Research Career Development Award to Vera-Diaz.
- Enian Kallamata was supported by an NEI T35 EY007149 grant to the New England College of Optometry.
- None of the authors have commercial relationships.

Peripheral retinal contours in emmetropia and myopia using biometric and optical quality parameters.

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Background

Knowledge of the peripheral retinal contour is important to understand refractive development and ultimately for the development of individualized myopia control methods.

The most commonly used method to compute retinal shape use peripheral eye length measurements. These give accurate results but oversimplified models, as they do not consider optical contributions, e.g., ocular indices or intraocular ray deviation[3,4].

While expensive and with limited resolution in the detection of retinal boundaries, MRI is the standard method to image retina shape and useful to validate alternative methods[3].

Peripheral refraction is also related to eye shape and has been suggested as a method to infer retinal contours[3].

None of these methods provide a comprehensive retinal contour model. Alternative methods that consider combining sensitive metrics of interaction between optics, refraction and biometric data are necessary.

Previous studies show less oblate and more prolate retinal shapes with increasing myopia, forming prolate ellipsoid surfaces that are greatest at the posterior pole[1,2]. Ocular surfaces, both the eye and retina, may be described by concoids with varying asphericity[1].

Purpose

To fit conical functions to biometric (axial length) and optical quality (monochromatic aberrations) data across the eye and analyze their correlations with myopia.

Hypotheses

- *We will find individual variability of retinal profiles and retinal image quality, with a refractive group effect.*
- *Significant effects of refractive error will be observed in the near peripheral retina, between 10-20 degrees eccentricity, where the human retina decoding system for blur appears to be.*

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Acknowledgements / Commercial Relationships

This research was supported by AAO Career Development Award to Vera-Diaz. Gabriella Velonias was supported by NEI T35 program and additional funds provided by graduate studies program at New England College of Optometry. Commercial Relationships: No Commercial Relationships.

Methods

Subjects

- A group of young adults with healthy eyes, were divided in three refractive groups. Each group had no differences in BCVA or age.
  - * High Myopes, defined as SE between -5.00D and -12.00D: n=13, *mean central SE: -7.68±1.93D, central AL: 26.32±1.61mm*
  - * Low Myopes, defined as SE between -0.75D and -4.00D: n=24, *mean central SE: -2.45±1.02D, central AL: 24.17±0.75mm*
  - * Emmetropes, defined as SE between +0.75D and -0.50D: n=13, *mean central SE: -0.04±0.25 D, central AL: 23.45±0.60mm*

Biometry

- AL measurements (Lenstar LS900, Haag Streit) were taken across the central 60 degrees (at 13 eccentricities) of the transverse (axial) section.
- A conic function was used to fit retinal contours obtained from AL raw values, as described by Verkicharla et al, 2015 method[3]: $y_i=AL'_p-r_{cv}\sin\theta$ and $\Delta z_3=r_{cv}/(1-\cos\theta)+AL'_p\cos\theta-AL'_a$. The equation used:

$$y = C * \frac{(x)^2}{(1+\sqrt{1-(1+Q)*C^2*(x)^2})}$$

- Where y is surface sag co-ordinate, C is vertex curvature, Q is asphericity, x is co-ordinate along the X-axis.

Optical Quality

- Monochromatic aberrations (scanning peripheral aberrometer, VopticaSL) were obtained for every degree across 60 degrees of the transverse (axial) section while subjects looked at 4m.
- Optical quality was defined as the RMS (Root Mean Square) for each eye computed up to the 5th order for a 4mm pupil. RMS profiles were correlated with AL and also fitted using conic functions.
- A conic function was used to fit retinal contours obtained from aberrations raw values for parameters M, J0, J45, SA, RMSHoa, RMSall:

$$y = C * \frac{(x-x_0)^2}{(1+\sqrt{1-(1+Q)*C^2*(x-x_0)^2})} + y_0$$

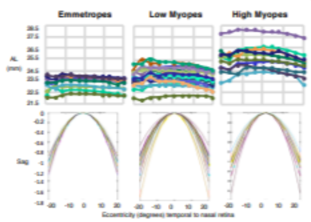
- Two-sample t-tests and regression analysis were applied to biometric and optical quality retinal contour metrics. Right eye data are presented.

Conclusions

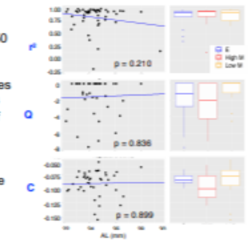
Both biometric and optical quality data across the retina may be accurately fitted to conic functions to evaluate retinal contours in emmetropia and myopia. Fitting conic functions to the RMS values across the retina simplifies the use of peripheral optical quality data and may be used in future studies as a peripheral optical quality metric.

Results

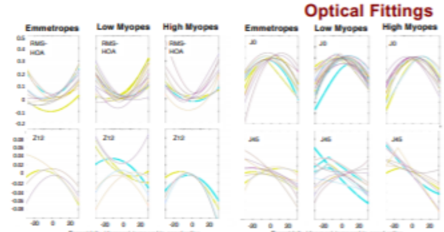
Biometric Data



- Accurate biometric fitting were achieved for the 41/50 subjects.
- Low Myopes significantly smaller Q than High Myopes (p = 0.049), indicating less prolate shape. No effect of refractive group in r^2 or C.
- No effect of AL in the goodness of fit (r^2), asphericity (Q) or curvature (C) of the retinal contour fittings using biometric parameters.

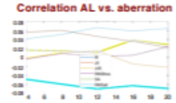


Optical Fittings

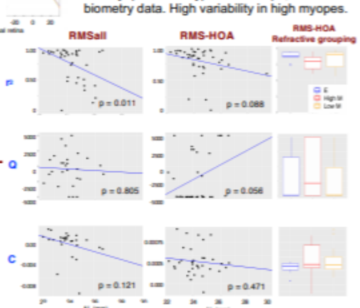


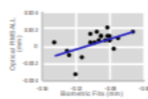
- Optical fittings for RMSall could be achieved for 27/50 and RMS-HOA for 36/50 subjects.
- With RMSall, goodness of fit (r^2) worsens with increased AL (p=0.01), with a high myopes having a higher r^2 (p=0.02) and greater curvature (C) (p=0.01) than emmetropes.
- There is a refractive error effect in the RMS-HOA fittings, with (r^2) worse for myopes (p=0.08) and more positive Q for high myopes (p=0.057).
- For asphericity (C), emmetropes have oblate and low myopes have hyperbolic shape, as seen in biometry data. High variability in high myopes.

Correlation AL vs. aberration



- RMSall and M best correlates with AL beyond 12deg eccentricity (r>0.6, p<0.05)
- J0 best correlates with AL within the central 8deg (r=0.56-0.60, p<0.05)





Correlation C optics vs. C biometry

- Spearman correlation of curvature (C) from biometric parameters compared to that of RMSALL revealed a positive relationship (r=0.441, p=0.018).
- Correlation of C from biometric parameters compared to that of RMSHOA revealed a small negative relationship (r=-0.311, p=0.05).