EVALUATION OF THE RELIABILITY OF THE ANISEIKONIA INSPECTOR

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This paper is submitted in partial fulfillment of the
requirements for the degree of

Doctor of Optometry

Ferris State University
Michigan College of Optometry

May 2005

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May 2005

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Doctor of Optometry Senior Paper
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ABSTRACT

Background: Aniseikonia, a condition in which the eyes perceive different size images causing visual symptoms and complaints, is a neglected area in optometry. Much of this is due to the lack of simple yet accurate instrumentation with which to diagnose and measure aniseikonia. *Methods:* The Aniseikonia Inspector computer program was administered to subjects who have normal visual systems. The naturally occurring difference in magnification between the two eyes of each subject was first determined and then again, through different size magnification lenses, thereby inducing aniseikonia. *Results:* The Aniseikonia Inspector is valid and reliable based on the data collected and evaluated from this study. *Conclusions:* This software program is an efficient, cost effective, and worthwhile addition to clinical management of patients presenting with symptoms relating to aniseikonia.

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Introduction

Aniseikonia is a binocular condition in which the apparent sizes of the images seen with the two eyes are unequal. Because the sensitivity to symptoms due to aniseikonia is likely to vary significantly across individuals and across stimulus conditions, the question of the incidence of aniseikonia is perhaps more appropriately framed in terms of the incidence of symptoms attributable to aniseikonia.[1]

Table 1: *Characteristic Symptoms of Aniseikonia Patients* [2]

Symptom	**Percentage of patients**
Headaches	67%
Asthenopia (fatigue, burning, tearing, ache, pain, pulling, etc)	67%
Photophobia	27%
Reading difficulty	23%
Nausea	15%
Motility (diplopia)	11%
Nervousness	11%
Vertigo and dizziness	7%
General fatigue	7%
Distorted space perception	6%

Table 1 lists the characteristic symptoms of aniseikonia. Most symptoms are vague and these patients normally are suspected of having a non-organic cause for their complaints. It is becoming more important for optometrists to be able to recognize and treat these symptoms. The most notable cause of aniseikonia is anisometropia, when the two eyes have disparate refractive power by an amount equal to or greater than one diopter in one or more meridians.[1] Anisometropia has a prevalence of five to ten percent of the population above the age of twenty years.[3] The growing number of patients undergoing cataract or refractive surgery also increases the risk of developing aniseikonia, although the etiology of the aniseikonia after refractive surgery is not clear.

An estimated 1.3 million laser procedures were performed in 2004.[4] The United States has more than 1.5 million cataract surgeries performed each year. Kramer et al. found that forty percent of all patients who are pseudophakic and strabismic have ophthalmic complaints ascribable to aniseikonia.[5] Because the last two procedures are expected to only increase in number, aniseikonia is going to become a greater problem.

Many professionals are unsure of managing aniseikonia because there is a lack of accurate and efficient tests for aniseikonia. Furthermore, they are leery of treating aniseikonia because the calculations needed to find the aniseikonic corrected prescription by hand is very time consuming. A majority of professionals use a rough estimation, whereby each diopter of anisometropia causes a one percent difference in retinal image size. This estimation has been shown to have large error rates. Patients with pseudophakia and strabismus can have an error rate of approximately sixty to seventy percent when using the rule of thumb estimation.[6]

There are two methods of measuring aniseikonia—space perception eikonometry and direct comparison eikonometry. Space perception eikonometry seeks to neutralize distortions caused by aniseikonia and is very accurate in a laboratory setting but is impractical to use in a clinical setting. There are two direct comparison eikonometry tests currently available, the NAT (New Aniseikonia Test, Handaya, Tokyo, Japan) and the Aniseikonia Inspector software (Optical diagnostics, Culemborg, Netherlands). The direct comparison eikonometry tests use different size targets presented to each eye. The two targets must be made equal in size by either using size lenses in front of one eye or by changing the size of the target. The direct comparison methods gain in clinical applicability at the cost of some accuracy.

Few studies have been performed on the reliability of the Aniseikonia Inspector since it was made available in 2003. Because of this scarcity of clinical data, a study was initiated to determine how reliable this version of a direct comparison eikonometry test is in a clinical setting. The goal was to determine the minimum number of runs needed for a clinically acceptable estimate of the aniseikonia.

Methods

The Aniseikonia Inspector ("The Aniseikonia Inspector 1.1", Optical Diagnostics, Netherlands, 2003) was administered to six subjects, aged 23-26 years of age, with normal visual acuity, ocular health, and vision history in order to evaluate the reliability and validity of this device. Four were female and two were male. One of the males has a color deficiency. Five of the subjects were without the need for refractive error correction, being essentially emmetropic, while one subject had an astigmatic correction and wore her glasses during the testing procedures.

To obtain baseline findings, these subjects initially were tested on the Aniseikonia Inspector without any afocal size lenses in place. A consent form was signed prior to any testing. All testing was done in low illumination with the fixation target on and seated one meter away from the computer monitor. With the subjects situated, red/green glasses were placed over their eyes with the green lens over the right eye.

The testing sequence is a relatively simple procedure using direct comparison of two half-circles, each half being red or green, respectively. During the test, the subjects were instructed to focus on the fixation target, and with the mouse, move one side of the colored half-circle to match the unmoving opposite colored half-circle's size. The

computer brackets each series of horizontal, vertical, and diagonal measurements. In each direction, the measurement is done twice. During each presentation of the unequal targets, the computer presents half of the circle with –25% aniseikonia and again on the opposite side with +25% aniseikonia. The subjects align each half-circle (one half-circle is red and the other is green), independently and an average of these two measurements, called the aniseikonia value, is calculated at the end. Overall, the subjects align the half-circles six times during each run of the test – twice vertically, twice horizontally, and twice diagonally.

Once the baseline data was collected and the learning curve established, the subjects were scheduled to return on a different day. When they returned, they were tested using afocal size lenses of different magnification in front of each eye (1% OD, 1% OS, 3% OD, 3% OS) in a random order to induce aniseikonia, one run with each size lens in place. The subjects did not know which lens they were using during the testing. Although the thickness of the lens and weight of the glasses could possibly have given the subjects a clue about the magnification of the lens, this was thought unlikely to yield a bias in the testing results.

Results

After all of the data was collected from the subjects without any magnification lenses, the base aniseikonia level over six trials was analyzed to evaluate if a learning curve had been established. The data varied between the subjects, but overall it was consistent. A few extreme outliers can be pinpointed that skew the overall data. Knowing this, it would have been better if we could have calculated the statistics by

ignoring the data from these outliers. However, the data is still reliable even with these outliers included. From there, it was determined that the testing could proceed by adding magnification lenses. Each subject was brought back and was tested with the Aniseikonia Inspector three different times with each size magnification lens. Twelve separate tests were run on each patient with magnification lenses being worn over the red-green glasses. The data was averaged for each patient (one through six) in each meridian (vertical, horizontal, and diagonal) with each magnification lens (3% OS, 1% OS, 3% OD, 1% OD, and zero). From there, the standard deviation was taken. Again, the data varied between patients, but it consistently showed that the three percent lenses produced more measured aniseikonia than the one percent lenses and the subjects without size lenses worn. The results showing the spread of the data can be found in Appendix A—Main Data Table.

The next step taken in analyzing the data was to compute the average of all the standard deviations at the three meridians for each of the magnification levels. The average of the individual averages was also computed. This was done so that the data from each of the individual subjects would be hidden. From this, it was determined that the data was sufficiently reliable, having the majority of the standard deviations ranging from 1.50-2.00 percentage points with any of the lenses on and in each meridian evaluated. Appendix B holds the table detailing the averages of the magnification for each meridian.

In the final table, Appendix C—Averages for Each Meridian, the average of the standard deviation and averages for each magnification meridian was obtained. With this data, it was confirmed that the horizontal meridian showed the most variable results,

followed by the diagonal, and the vertical was most consistent. A practitioner testing his patients should consider this when evaluating data to prescribe lenses for a patient.

From all the data collected and evaluated, our opinion is that the Aniseikonia Inspector is reliable and yields repeatable data when tested on subjects both without aniseikonia and with induced aniseikonia. Based on the experiences we have had with the Aniseikonia Inspector, a clinician should run the program no less than six times to produce reliable results on a patient. During these six tests, the patient is able to establish the learning curve and reliable data can be collected from that point. More trials will likely yield a better average that is closer to the actual aniseikonia present but would be time consuming to both the clinician and the patient.

Discussion

Based on the above results, the Aniseikonia Inspector program yielded reliable data and was found to be user friendly for practitioners and patients. Practitioners can administer the test with ease without taking up valuable office space, and it is a relatively inexpensive piece of software. Training a technician or optician to administer the test would allow for better time management, freeing up valuable chair time. The Aniseikonia Inspector includes a program which takes the patient's data into account and designs aniseikonic lenses. Although it offers options for lenses which minimize the aniseikonia the most, some of the lens parameters may not be practically changeable. The optician may take the measurements and choose the appropriate lens parameters for the patient's aniseikonic lenses. It is important to establish communication between the practitioner and optician to evaluate which lenses provide the most benefit for the patient

and still are cosmetically appealing. Overall, patients will find this program easy to use as well. Instructions are straightforward and the complete sequence of testing is relatively short. This is helpful because of the slight learning curve involved with taking the test.

When patients report to the clinic complaining of symptoms possibly connected to aniseikonia, the Aniseikonia Inspector can be used as a screening test. Patients are sensitive to different percentages of aniseikonia. Table 2 lists the clinical values of aniseikonia that produces symptoms of aniseikonia as initially described in the introduction.

Table 2: *General Clinical Values of Aniekonia that Produce Symptoms Described in Table 1* [7]

Percentage Aniseikonia	**Symptom Severity**
0.00-0.75%	No Symptoms
1.00-3.00%	Symptoms in Sensitive Individuals
3.25-5.00%	Symptoms and Binocular Impairment
5.25-over%	Binocular Vision Generally Absent

As described above, most patients do not begin to notice symptoms caused by their aniseikonia until it is greater than two percent. The study performed induced one and three percent magnification and yielded favorable results demonstrating sensitivity of the software to the small amount of aniseikonia. The study could be broadened by using a greater range of size lenses to determine the sensitivity to the higher percentages of aniseikonia.

Future studies should investigate the Aniseikonia Inspector using an expanded range of ametropia, magnification, and subjects. In order to maintain control of the variables involved in this study, this study was limited to those with minimal to no prescription, used one and three percent magnification lenses, and only involved six

subjects. The Aniseikonia Inspector offers the option to correct for fixation disparity. Recommendations for future studies would include measuring fixation disparity with formal testing prior to administering the Aniseikonia Inspector, correcting fixation disparity for each subject during each trial, and performing the complete testing sequence during the same day versus multiple days.

Conclusion

The Aniseikonia Inspector is valid (see study by Christina Kennedy) and reliable based on the data collected and evaluated from this study. This software program is an efficient, cost effective, and worthwhile addition to clinical management of patients presenting with symptoms relating to aniseikonia. Aniseikonic symptoms are vague and difficult to illicit from a patient's history. Today, aniseikonia is not only caused by anisometropia but can also be induced from procedures such as cataract extraction with intraocular lens implantation and refractive surgery. Whether screening, diagnosing, or treating aniseikonia, the Anisekionia Inspector proves to be a valuable addition in the aresenal of tools for this ever growing and increasingly demanding population.

REFERENCES

1. Kulp MT, Raasch TW. Patients with Anisometropia and Aniseikonia. In: Benjamin, WJ, Borish IM, editors, Borish's Clinical Refraction. 1st ed. W.B. Saunders Company; 1998. p. 1134, 1142-3

2. Bannon RE, Triller W. Aniseikonia-a Clinical Report Covering a Ten Year Period. Am J Optom 1944:21: 171-82

3. Weale RA. On the Age-related Prevalence of Anisometropia. Ophthalmic Res. 2002;34: 389-392

4. Byrne J. Technology, Good Care Help Laser Centers Thrive. Primary Care of Optom. 2005 Jan;10:1

5. Kramer PW, Lubkin V, Pavlica M, Covin R. Symptomatic Aniseikonia in Unilateral and Bilateral Pseudophakia. A Projection Space Eikonometer Study. Binocular Vision Strabismus Q 1999;14:183-190

6. LubkinV, Shippman S, Bennet G. Aniseikonia Quantification: Error Rate of Rule of Thumb Estimation. Binocular Vision Strabismus Q 1999;14: 191-196

7. Michaels D. Visual Optics and Refraction: A Clinical Approach. St. Louis (MO): Mosby; 1985.

APPENDIX A

MAIN DATA TABLE

Main Data Table

		3% OS		1% OS		ZERO		1% OD		3%OD	
		X	σ	X	σ	X	σ	X	σ	X	σ
Vertical											
	1	2.333	2.066	2.000	0.894	-0.667	0.651	-1.500	1.225	-1.330	0.000
	2	2.000	1.095	-1.667	0.816	-1.083	1.730	-4.167	1.169	-5.167	0.753
	3	2.000	1.789	-0.167	1.169	-0.167	1.801	-2.833	1.472	-3.833	0.753
	4	2.500	1.378	1.833	0.983	1.250	3.494	-1.833	1.329	-0.666	1.505
	5	1.000	2.966	-0.833	3.601	-0.750	1.055	-2.660	2.338	-2.500	1.643
	6	1.833	1.722	1.500	0.837	-0.750	1.288	-1.830	1.941	-2.500	1.871
Horizontal											
	1	2.333	2.503	2.167	0.753	0.500	1.314	-0.167	0.753	-0.333	1.033
	2	1.000	2.757	-1.000	2.530	0.875	2.560	0.000	2.191	-3.167	2.858
	3	3.833	1.722	0.500	0.837	2.292	3.003	-1.330	1.862	1.667	1.505
	4	3.333	2.503	2.500	3.017	1.083	4.166	-1.000	4.336	1.833	2.229
	5	4.000	2.000	3.000	3.742	0.000	2.296	-2.330	2.251	-0.833	2.229
	6	5.667	1.506	3.000	1.414	-0.250	2.633	0.166	1.169	0.167	1.169
Diagonal											
	1	3.267	1.143	3.733	1.143	1.867	1.243	0.933	1.696	0.467	1.446
	2	1.200	3.743	1.633	1.861	0.500	3.531	-2.560	1.377	1.633	1.637
	3	2.567	1.054	-1.167	1.376	0.467	1.824	-3.517	1.952	-3.283	1.478
	4	0.933	2.753	-0.700	2.123	-0.125	2.652	-3.300	3.656	-1.650	3.929
	5	2.833	3.581	1.867	2.108	-0.233	1.965	-1.630	1.637	-0.700	2.300
	6	2.333	0.723	0.467	2.286	-0.583	1.836	-0.700	0.767	-1.667	0.572

Key: X= average; σ=standard deviation

APPENDIX B

AVERAGES OF THE MAGNIFICATION FOR EACH MERIDIAN

Averages of the Magnification for Each Meridian

	3% OS		1% OS		ZERO		1% OD		3% OD	
	X	σ	X	σ	X	σ	X	σ	X	σ
Vertical	1.944	1.836	0.444	1.383	-0.361	1.670	-2.471	1.579	-2.666	1.087
Horizontal	3.361	2.165	1.695	2.049	0.750	2.662	-0.777	2.094	-0.111	1.837
Diagonal	2.189	2.166	0.972	1.816	0.315	2.175	-1.796	1.847	-0.867	1.894

Key: X= average; σ=standard deviation

APPENDIX C

AVERAGES FOR EACH MERIDIAN

Averages for Each Meridian

	Vertical	Horizontal	Diagonal
X	-0.622	1.323	0.163
σ	1.156	2.022	1.677

Key: X= average; σ=standard deviation