The evaluation of two new computer-based tests for measurement of aniseikonia: discussion

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ABSTRACT

Purpose: To discuss the clinical relevance of the article with the same name by authors: R.J. Fullard, R.P. Rutstein, and D.A. Corliss. Method: The results of the authors are compared to clinical relevant aniseikonia values. Also, the (in)accuracy of the analysis is questioned. Results: The authors used an aniseikonia test range (-3.5% to 3.5%) that for the most part will not give symptoms. The measurement results show deviations from the expected aniseikonia values in the order of 0.3%, which is not clinically significant. The repeatability values found (~0.5%) are small enough for clinically useful aniseikonia management. More accurate results could have been obtained if the accuracy of the size lenses would have been taken into account. Conclusions: When considering the clinical relevance of the findings in the article, it becomes clear that the Aniseikonia Inspector is a useful (and only) tool for complete aniseikonia management.

Key Words: aniseikonia, measurement, aniseikonia inspector, size lenses

Introduction

The group of Rutstein et al. (School of Optometry, UAB, Birmingham, Alabama, USA) has published a series of articles in which the Aniseikonia Inspector (Optical Diagnostics, Culemborg, The Netherlands) has been evaluated. The first two articles have been criticized by letters to the editor for their experiment design, analysis of the results, and lack of a discussion on the clinical relevance of the results found. Their third article was recently published, but still contained some of the same ‘flaws’ as the previous articles. Therefore, this letter discusses their latest article, so the reader can better assess the value of that article.

Desired clinical accuracy

Before saying anything about the clinical relevance of the results, it is important to define what kind of accuracy would be considered clinically accurate enough. The goal of aniseikonia management is to reduce the patient’s aniseikonia so the patient becomes asymptomatic. Aniseikonia becomes symptomatic at approximately 3-5%. Therefore, the accuracy of the aniseikonia test should preferably be (much) smaller than 3%. Note that sometimes sensitive patients are said to become symptomatic at values less than 3%, but this is more likely to be an accompanying anisophoria symptom than an aniseikonia symptom.

Absolute versus relative errors

The criterion that the test accuracy needs to be less than 3% is an absolute and not a relative one. To asses the clinical implication of a possible underestimation or overestimation of an aniseikonia test, the authors could therefore better have calculated the absolute under- or overestimation. For example, in the horizontal direction for the Aniseikonia Inspector 1, the authors find a slope of 0.866 and then state in the text that the test underestimates by a relative value of 14%. Table 1 below gives the same data, but now as an absolute underestimation.

Table 1: Transforming relative errors to absolute errors

<table>
<thead>
<tr>
<th>Induced aniseikonia</th>
<th>Underestimation of 14% means:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0%</td>
<td>0.1%</td>
</tr>
<tr>
<td>2.0%</td>
<td>0.3%</td>
</tr>
<tr>
<td>3.5%</td>
<td>0.5%</td>
</tr>
</tbody>
</table>

* This letter was originally sent to the journal Optometry and Vision Science as a letter to the editor. However, the editor decided not to publish the letter because of space limitations in the journal. Also, he did not see the need for a similar discussion as with a previous article. I disagree with that, because without a discussion on the clinical relevance of their results, the reader may have been given the wrong impression on the clinical usefulness of the Aniseikonia Inspector.
The main thing to notice from Table 1 is that all absolute underestimation errors are much smaller than 3%, and therefore this underestimation would not have a major impact on the clinical usefulness of the test. In the discussion, the authors themselves reject as insignificant a possible chromatic error of 0.25%. Therefore they will probably agree that the underestimation they found, which is of the same order of magnitude, cannot be considered clinically significant.

**Test range validity**

It is unfortunate that the authors only tested in a range of -3.5% to 3.5%, since in this range people are for the most part not symptomatic. Neither can one extrapolate their results to larger (more symptomatic) aniseikonia values, because previous research indicates that for larger aniseikonia values the relative underestimation reduces.\(^5,9\)

**Illumination**

The authors’ study makes a distinction between measuring with and without room illumination. The clinical relevance of the differences found is again doubtful. The reader should also know that the test setup section of the Aniseikonia Inspector manual already states that the best results are obtained with dimmed lights. Normal illumination is therefore not with the room lights on.

**Induced aniseikonia accuracy**

Even though the slope differences found do not have a large clinical impact, for a more accurate analysis the inaccuracies of the size lens induced aniseikonia values should also have been included. The authors use a size lens of said 1%, 2%, and 3.5% magnification in front of the left and right eye. However, since the calculated slopes are with an accuracy of 2 or 3 decimal places, this means that the size lenses are assumed to be 1.00%, 2.00%, and 3.50%. To manufacture (or evaluate) lenses with such a precise magnification would require near perfect control on the base curve, center thickness, residual power, and refractive index as a function of the wavelengths used in the test. Also, when the 3.50% size lens is held in front of the right eye, then the induced aniseikonia is \((1/1.035-1)*100\% = -3.38\%\), so clearly different from the value -3.50% used in the analysis. Note again that all these differences are clinically not very important, but can cause significant differences when statistically evaluating if a test underestimates or overestimates.

**Repeatability**

The standard deviation of repeated measurements that the authors find is in the order of 0.5%. When compared to the approximately 3% at which aniseikonia becomes symptomatic, this could be considered clinically useful. Note also that the silent assumption that aniseikonia is stable over time does not seem to be true.\(^10,11\) Reasons could be, for example, fluctuations in adaptation (cortical processing), refraction, or accommodation. So part of the repeatability inaccuracy may also be actual aniseikonia fluctuations.

**Inter-subject differences / outliers**

As with other psychophysical tests, an aniseikonia test will also experience inter-subject differences due to the statistical measurement uncertainty and natural fluctuations. These normal differences seem to be clinically acceptable. However, looking at the raw data, I agree with the authors that there are some subjects who show one or more weird data points, causing relatively large slope differences. It would indeed be interesting to know why these outliers arose. Didn’t the subjects understand the test well enough, did they make accidental errors, were they perhaps unmotivated or tired after many measurements?

**Conclusion**

The authors end their article by recommending the use of the Aniseikonia Inspector 1 for clinical use above the customized aniseikonia test (erroneously called version 2 in the article). I disagree with this conclusion. First of all, the above shows that the customized test also seems to provide useful results for clinical practice. Secondly, the customized test used by the authors was a preliminary, not commercially available, research version, which has been further improved since then. By the time it became part of successive commercially available Aniseikonia Inspector versions, it contained 1) a
full fixation disparity correction, 2) a strong fixation target, 3) an optimized size target shape, 4) field of attention widening stimuli, and 5) a three alternative forced choice procedure instead of a two-alternative forced choice procedure. Thirdly, there are several reasons why the new aniseikonia test was developed in the first place: 1) the new test measures static aniseikonia without interference of anisophoria, 2) the new test measures field-dependent aniseikonia important for retinally-induced aniseikonia, 3) in the new test accidental patient handling errors are less likely, 4) the forced choice method provides a measurement consistency parameter, so the eye care provider can evaluate the patient’s testing capability, and 5) the test is less affected by fluctuating fixation disparities due to the short presentation times.

In conclusion, the Aniseikonia Inspector measures aniseikonia with a clinically relevant accuracy and successive Aniseikonia Inspector versions are preferred above version 1 (both for the aniseikonia testing capabilities as discussed above, as well as the iseikonic lens design capabilities).

References
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