Article ▸ # Comparison of MKH-Haase Associated Phoria Charts with Other Common Clinical Tests

Mosaad Alhassan, BSc, MSc, University of Waterloo, Waterloo, Ontario, Canada
Jeffery K. Hovis, OD, PhD, University of Waterloo, Waterloo, Ontario, Canada
B. Ralph Chou, OD, MSc, University of Waterloo, Waterloo, Ontario, Canada

ABSTRACT

Background: The Pola Test measures associated phoria at distance and near using a variety of different targets. This testing method and interpretation is referred to as the MKH-Haase method. The aim of this study is to compare the associated phoria values measured using the MKH-Haase chart results with other associated phoria tests.

Methods: Horizontal and vertical associated phorias were measured at distance and near for 30 symptomatic and 30 asymptomatic participants. The tests used in this study were the Cross, Pointer, Double Pointer, and Rectangle Tests of MKH-Haase charts at distance and near. The other tests were the Mallett Test and AO Slide at distance and the Mallett Unit, AO Card, Saladin Card, Wesson Card, and Sheedy Disparometer at near.

Results: Horizontal associated phoria tests without central fusion lock were significantly different from those with central fusion lock at distance and near. The mean Disparometer associated phoria was more esophoric than all of the other tests. Although there was a significant difference between various horizontal associated phoria tests at distance and near, most of the mean values differed by only 0.50^{Δ} for the asymptomatic group. The differences between tests were larger for the symptomatic group. The largest difference occurred between the Disparometer and the Wesson Card, where the mean values differed by 2.00^{Δ}. Vertical associated phoria tests did not show any significant differences. The limits of agreement between the horizontal associated phoria tests that were not significantly different were usually within $\pm 1.00^{\Delta}$ for the asymptomatic group. The limits of agreement between tests for the symptomatic group could be as large as $\pm 2.50^{\Delta}$.

Conclusions: The larger differences found between tests for the symptomatic subjects suggest that prescribing prism based on just one associated phoria test may not be the best practice.

Keywords: associated phoria, fixation disparity, MKH-Haase Binocular Vision Charts, Pola Test, symptomatic binocular vision

Introduction

Fixation disparity is a small ocular misalignment that occurs during normal binocular vision. When the two eyes are fixating on an object of regard, the visual axis of one or both eyes deviates a small degree away from the target.[1] Single binocular vision is still maintained even though the two images do not stimulate corresponding retinal points because the two images fall within Panum's fusional area.[1-3] Fixation disparity can be measured by partially dissociating the two eyes, which involves presenting two nonius lines dichoptically along with other binocular visible targets. The nonius lines' locations are changed until they are perceived to be in the same visual direction.[1-3]

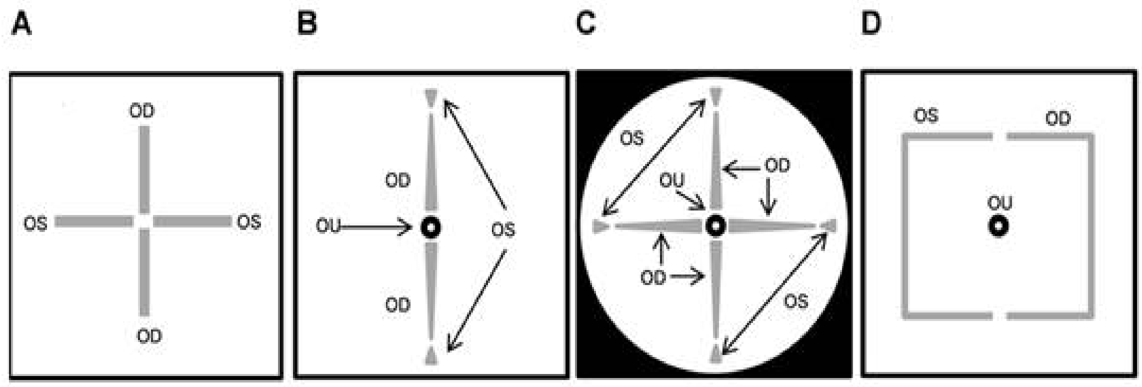


Figure 1. *The MKH-Haase distance associated phoria charts: (A) Cross Test; (B) Pointer Test; (C) Double Pointer Test; (D) Rectangle Test. The gray color indicates that the stimulus is polarized for dichoptic presentation.*

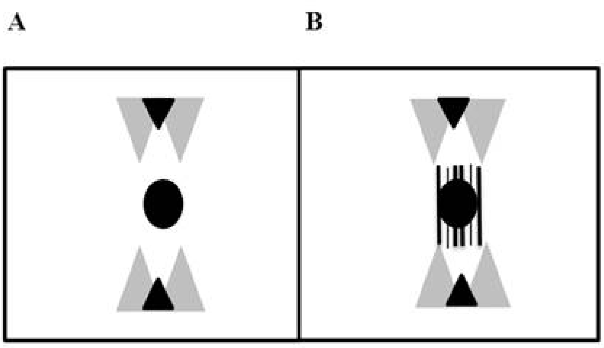


Figure 2. *Pictures of the MKH-Haase Fixation Disparity using Stereo Targets: (A) Stereo Triangle Test; (B) Stereo Balance Test. The gray colour indicates that the stimulus is polarized for dichoptic presentation.*

Prisms or lenses can also be used to eliminate the fixation disparity. The smallest amount of prism needed to reduce fixation disparity to zero is called the associated phoria. This value is often used to determine how much prism to prescribe.[4-6]

Several clinical tests are available for measuring associated phorias. Developed by H.J. Haase, the Pola Test is one test, but many practitioners may be unfamiliar with it. It is used primarily in continental European countries to prescribe prism for symptomatic binocular vision patients.[7-11] Figure 1 shows the MKH-Haase distance associated phoria charts. The near charts are scaled versions of the distance charts. One target does not have a central fusion lock, whereas the rest of the targets do have a central fusion lock.

Testing and prescribing prism is based on Haase's theory of symptomatic binocular vision classification. The testing starts with measuring the associated phoria using the Cross Test (Figure 1A). If there is no associated phoria, then no prismatic correction is required, and the symptoms are not likely caused by inadequate fusional vergences. If an associated phoria is measured, then prismatic correction is determined by refining the prismatic power using the Pointer Test, and then the Double Pointer Test, respectively (Figures 1B & 1C). The Rectangle Test is used to refine just the vertical associated phoria (Figure 1D).

The final prismatic power is determined by viewing the Stereo Triangle Test and the Stereo Balance Test, shown in Figure 2.[12] For the Stereo Triangle Test (Figure 2A), the examiner shows the patient the crossed disparity, followed by the uncrossed disparity. The time taken by the patient to identify the correct depth position of the triangles relative to the circle is monitored. If the patient can determine quickly and successfully the correct depth of the triangles with both presentations, the fixation disparity is fully compensated. If there is a delay in perceiving one of the directions in depth, then the prism needs to be modified (usually increased) so that the time required for perceiving each disparity is equal.

The Stereo Balance Test (Figure 2B) measures ocular dominance in terms of the perceived visual direction when the two eyes are looking at both a crossed and uncrossed stereoscopic image. If the fused top and bottom triangles are pointing exactly at the centre of the scale marks, there is no ocular dominance, and the finding is called isovalence. However, if the fused triangles are deviated from the centre

Table 1. Horizontal and Vertical Associated Phoria Tests at Distance

Test Direction	Associated Phoria Tests	
	Without Central Fusion Lock	**With Central Fusion Lock**
Horizontal	Cross Test	Pointer Test, Double Pointer Test, Mallett Test, American Optical Vectographic Slide
Vertical	Cross Test	Double Pointer Test, Rectangle Test, Mallett Test, American Optical Vectographic Slide

Table 2. Horizontal and Vertical Associated Phoria Tests at Neara

Test Direction	Associated Phoria Tests	
	Wit.. o I hout Central Fusion Lock	**With Central Fusion Lock**
Horizontal	Sheedy Disparometer, Wesson Card, Cross Test	Pointer Test, Double Pointer Test, Mallett Test, American Optical Vectographic Slide
Vertical	Sheedy Disparometer, Wesson Card, Cross Test	Double Pointer Test, Rectangle Test, Mallett Test, American Optical Vectographic Slide

of the scale, there is an ocular dominance, and the result is referred to as anisovalence. To reduce the anisovalence, the prismatic power is modified until isovalence is obtained for both crossed and uncrossed disparity.[12]

There is limited information available on which other common associated phoria tests are compared with the MKH-Haase associated phoria charts in the Pola Test. Comparison of these charts with more common associated phoria tests would help in establishing the validity of the MKH-Haase tests, but in more general terms, the comparison would help to facilitate communication between practitioners who may use different tests to measure the associated phoria. Additional data comparing other associated phoria tests would also be helpful because results from previous studies have been mixed.[4,13-17] Some studies show good agreement between tests, whereas other studies report that the mean difference between associated phoria tests could be as large as 5^{Δ}. The purposes of this

Table 3. Questionnaire Used to Classify Subjects into Symptomatic and Asymptomatic

	Symptom Questions	Yes	No
1	Do you suffer from tired eyes when you read or when you do close work?		
2	Do you feel a headache within the first hour of reading, working on computer, or watching TV?		
3	Do you have blurry vision after the first hour of reading, working on a computer, or watching TV?		
4	Have you ever had double vision after reading, working on a computer, or watching TV?		
5	Have your eyes ever felt dry after reading, working on a computer, or watching TV?		
6	Do you have a difficulty with reading or working on a computer?		

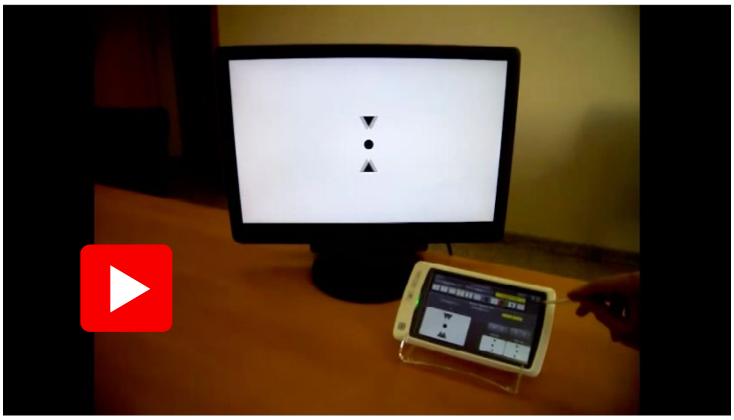
study is to compare the associated phorias measured with several common clinical tests including the MKH-Haase charts.

Methods

A commercially available Pola Test (i. Polatest version 1.2 by Carl Zeiss Vision GmbH, Aalen, Germany) was used in this study. All six targets shown in Figures 1 and 2 were used for both distance and near testing. The other distance associated phoria tests were the Mallett Test (Imperial Optical Co., Mississauga, ON) and the American Optical Vectographic Slide (Stereo Optical Co., Inc., Chicago, IL). The viewing distance for these targets was 6 m. The near tests were the Mallett Unit (Imperial Optical Co., Mississauga, ON), the Near Point American Optical Vectographic Card (Optometric Research Institute Inc., Memphis, TN), the Saladin Near Point Balance Card, ver.1 (Michigan College of Optometry, Ferris State University), the Sheedy Disparometer (Vision Analysis, Columbus, OH), and the Wesson Card 5th edition, 2003 (Bernell, Mishawaka, IN). The viewing distance for the near targets was 40 cm. Tables 1 and 2 summarize the tests' major characteristics.

Subjects

Subjects were recruited through University of Waterloo bulletin boards, email lists, posters, and advertisements in the University newspaper. All subjects were naïve about the clinical procedures and instruments. Their



MKH Haase test sequence on POLA VistaVision (Used with permission of VistaVision DMD Medtech)

ages ranged from 18 to 35 years with a mean value of 26 years. The subjects were divided into an asymptomatic or symptomatic group based on the questionnaire shown in Table 3. They were assigned to the symptomatic group if they answered yes to 3 or more questions. This questionnaire has not been validated but was used to ensure that the visual history was consistent across all subjects. Additional inclusion criteria for both groups were: corrected visual acuity in each eye of at least 6/6, absence of ocular diseases based on case history, lack of strabismus at both 6 m and 40 cm using the cover test, and stereopsis of 60 sec arc or better using the Randot Wirt Circles test. Thirty subjects in each group participated in this project. The study was approved by the University of Waterloo's Office of Research Ethics. Written informed consent was obtained prior to participation, and each subject was free to withdraw from the experiment at any time.

Testing Procedure

All tests were administered by the first author. History, including the questionnaire, was taken first. A visual assessment was performed next in order to determine whether they met the inclusion criteria. We also examined the repeatability of the tests; so as to reduce any fatigue bias that could occur by including the initial assessment in the first session and not the second session, individuals who met the inclusion criteria were asked to return after a minimum of 2 hours.[18] The data presented in this paper are from the first session. Most subjects returned within 2 hours to 3 days of the initial assessment.

Distance associated phorias were measured before near. The test sequences at distance and near were determined by random block design. However, the MKH-Haase charts were presented in the recommended sequence of: Cross Test, Pointer Test, Double Pointer Test, Rectangle Test, Stereo Triangle Test, and Stereo Balance Test.[12]

The MKH-Haase protocol requires two measurements for each chart. For the first measurement, View 1, the Polaroid axes were at 45º for the right eye and 135º for the left eye. For the second, View 2, the axes were flipped 90 degrees. View 1 was always presented first. Which part of the target was viewed by each eye with the two configurations depended on the chart. Figure 1 shows the View 1 presentations. View 1 was the crossed disparity for the Stereo Triangle and Balance Tests, and View 2 was the uncrossed disparity. At distance, the views could be switched by either flipping the axes of each polarized lens in the trial frame or by reversing the polarization of the targets on the MKH-Haase distance charts. This latter option was unavailable for the near charts.

To measure the horizontal associated phoria, the subject reported whether the vertical line was aligned with the central fixation lock or bisected the break in the horizontal line of the Cross Test. If not, prisms (supplied with the Pola Test) were inserted in steps of 0.25^{Δ} in order to align the targets. If alignment occurred for multiple prisms, then the minimum value was selected as the associated phoria. If there was no alignment before the reversal, then the prism that produced the reversal was recorded as the associated phoria. The prisms were removed, and the procedure was repeated for View 2. Vertical associated phorias were measured next if the target was present on the chart using the same procedure.

This procedure varied from the recommended MKH-Haase method of starting with the prism from the previous chart in place and altering the value if necessary. We started with no prism for each chart in order to determine the value for each chart with minimal bias from the previous measurement and to be consistent with the measurement of the associated phorias using the other test charts.

After completing the associated phoria on the MKH-Haase charts, the Stereo Triangle Test and Stereo Balance Test were presented. There was no prism in the trial frame for the initial presentation of both tests. For the Stereo Triangle Test, there were two different disparity magnitudes presented as crossed and uncrossed disparities at distance. The values were 11.5′ and 6.9′. Only the 11.5′ value (crossed and uncrossed) was presented at near. We estimated the time that subjects required to identify the correct depth position of the two triangles to determine whether there was an obvious stereo delay in one presentation over the other.

Ocular prevalence or dominance was measured using the Stereo Balance Test. The disparities were the same values as the ones presented in the Triangle Test. To determine the isovalence vs. anisovalence responses, the subject was asked whether the upper and lower triangles were pointing exactly toward the middle of the circle or off to one side. If there was an anisovalence response, then prism was to be introduced in 0.25^{Δ} steps until the triangles were in line with the circle. However, when this procedure was attempted on the first 10 subjects who had an anisovalence, the direction of the fused target did not change with the prism. In fact, several of these individuals reported double vision before any alignment occurred with the higher amounts of prism. Because of this problem, we decided to record only the initial direction of any anisovalence response for each view.

Associated phorias were measured on the other tests with axes of the Polaroid lenses at 45° for the right eye and 135° for the left eye. Associated phorias were measured by the Saladin Card, the Sheedy Disparometer, and the Wesson Card using the trial frame without generating the fixation disparity curve.

Data Analysis

We first compared the View 1 and View 2 results of the MKH-Haase associated phoria charts. The mean difference, using the paired t-test, for both groups was never larger than 0.05^{Δ} for any test, and the differences were not significant ($p>0.05$). Because there were no significant differences, the values for the two presentations were averaged for further analysis. This is different from the MKH-Haase procedure. The recommended procedure is to measure the associated phoria for View 1 and then present View 2 with any prism in place. The power would be modified as needed.

The comparison of MKH-Haase and other associated phoria test results was analyzed using a Mixed Model Repeated Measures ANOVA (MRANOVA), with the various tests as the repeated measures and the two groups as the between-subject factor. The least significant difference was conducted to examine all pairwise comparisons. IBM SPSS ver. 22 was used for this data analysis. The criterion of $p\leq0.05$ was used to determine a significant effect. The second method was the 95% limits of agreement, according to the Bland-Altman method of agreement.[19,20] The 95% limits of agreement were calculated for associated phoria tests when the differences between them were not significant. The 95% limits of agreement were 1.96 times the standard deviation of the mean difference between tests. Sigma Plot (ver. 11, Systat 2008, Chicago, IL) was used for these data analyses.

It was not possible to record any delay in identifying the depth of the triangle in the Stereo Triangle Test because subjects responded very quickly and correctly for all disparities at both

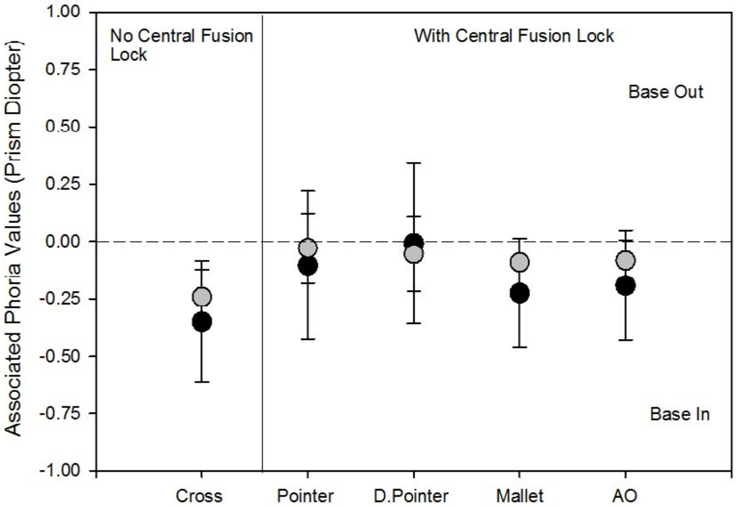


Figure 3. *Comparisons of horizontal associated phoria tests at distance. Black Circles: Symptomatic Group; Grey Circles: Asymptomatic Group. Error bars represent the standard error of the mean. Cross: MKH Cross Test; Pointer: MKH Pointer Test; D.Pointer: MKH Double Pointer Test; Mallett: Mallett Test; AO: AO Slide.*

viewing distances. For this reason, the test has been excluded from further analysis.

For the Stereo Balance Test, we counted the number of subjects who gave an isovalence response (no dominance) and those who gave an anisovalence response along with their corresponding eye dominance (i.e., right eye or left eye prevalence) for each viewing condition without any prism. A subject would be considered to have isovalence at distance if s/he reported isovalence for all four disparities at distance. Similarly, right or left eye dominance was recorded if the same dominance was present for all 4 disparities. If a subject had varied responses across the four viewing conditions, then that person was classified as having a "Mixed Anisovalence." The same scoring criteria were followed for two disparities at near. We examined the frequency of the valence responses across viewing conditions using the chi-square test (X^2). The probability used to determine statistical significance was $p<0.05$.

Results

Comparison of horizontal associated phoria tests at distance

Figure 3 shows the mean associated phoria for the symptomatic and asymptomatic groups. MRANOVA revealed a significant test effect (p=0.014) but no significant difference between subject groups (p=0.81) or significant subject-by-test interaction (p=0.83). Direct comparisons showed that the Cross Test was significantly more exophoric than all other tests except the Mallett Test. However, the differences between means of tests were no greater than 0.25^{Δ}. Comparisons between other tests were not statistically significant. The higher exophoric values found for the Cross Test raise the question as to whether this target should be included in the MKH-Haase charts.

Table 4. 95% Limits of Agreement (in Prism Diopter) for Different Horizontal Associated Phoria Tests at Distance. (The 95% limits of agreements were rounded to the closest 1/8$^{\Delta}$ step for all of tests.)

Test	Double Pointer Test	Mallett Unit	AO Slide
Pointer Test	-0.75 to 0.50* -0.375 to 0.375^	-1.50 to 1.875* -0.75 to 1.00^	-1.50 to 1.875* -0.875 to 1.00^
Double Pointer Test		-0.625 to 1.25* -1.00 to 1.00^	-0.625 to 1.25* -1.00 to 1.00^
Mallett Test			-0.50 to 0.50* -0.25 to 0.25^

(*)Symptomatic Group, (^) Asymptomatic Group

Table 4 shows show the 95% limits of agreement (in prism diopters) between different horizontal associated phoria tests at distance when the differences between them were not significant. The highest agreement (the lowest range) was between the Mallett Test & the AO Slide for both groups. The MKH-Haase pointer charts also had relatively good agreement, but lower agreements with the Mallet Test and AO Slide for both groups. This latter result occurred primarily due to two subjects in each group who showed large differences (i.e., 1.50^{Δ} between these tests).

Comparison of horizontal associated phoria tests at near

Figure 4 shows the mean associated phorias for the symptomatic and asymptomatic groups. For both groups, the means of the tests with the central fusion locks tended to be exophoric, whereas the results for the tests without the central fusion locks were

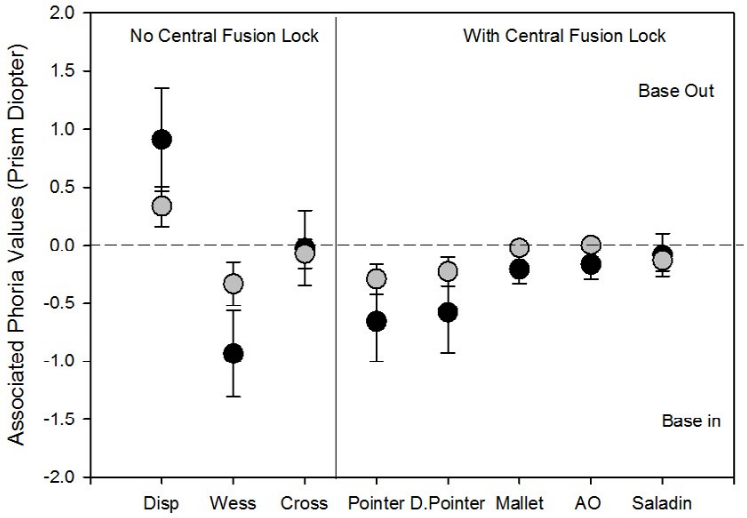


Figure 4. *Comparisons of horizontal associated phoria tests at near. Black Circles: Symptomatic Group; Grey Circles: Asymptomatic Group. Error bars represent the standard error of the mean. Disp: Sheedy Disparometer; Wess: Wesson Card; Cross: MKH Cross Test; Pointer: MKH Pointer Test; D.Pointer: MKH Double Pointer Test; Mallett: Mallett Unit; AO: AO Card; Saladin: Saladin Card.*

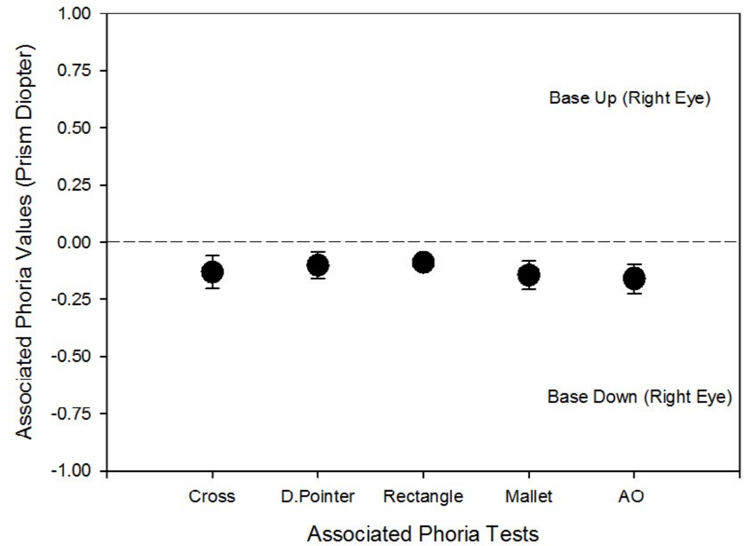


Figure 5. *Comparisons of vertical associated phoria tests at distance for the symptomatic group. Error bars represent the standard error of the mean. Cross: MKH Cross Test; Pointer: MKH Pointer Test; D.Pointer: MKH Double Pointer Test; Mallett: Mallett Test; AO: AO Slide.*

Table 5. 95% Limits of Agreement (in Prism Diopters) for Different Horizontal Associated Phoria Tests at Near. (The 95% limits of agreements were rounded to the closest 1/8$^{\Delta}$ step for all of tests.)

Test	Mallett Unit	AO Card	Saladin Card
Double Pointer	-3.00 to 2.25* -1.25. to 0.75^	-3.00 to 2.25* -1.25. to 0.75^	-3.00 to 2.50* -1.25. to 1.00^
Mallett Unit		-0.50 to 0.50* -0.25 to 0.25^	-0.75 to 0.50* -0.25 to 0.50^
AO Card			-0.75 to 0.50* -0.25 to 0.50^

(*)Symptomatic Group, (^) Asymptomatic Group

Table 6. MKH-Haase Stereo Balance Tests' Results at Distance

Groups	Isovalence	Right Eye Valence	Left Eye Valence	Mixed Valence
Symptomatic (N=34)	15 (44.11%)	5 (14.7%)	1 (2.9%)	13 (38.2%)
Asymptomatic (N=40)	20 (50%)	4 (10%)	2 (5%)	8 (23.5%)

Mixed Prevalence means there was no consistency between the stereo balance tests results

varied. MRANOVA revealed a significant test effect (p<0.001) and significant interaction between groups (p=0.014) but no significant difference between subject groups (p=0.62). The significant interaction was primarily due to the larger mean values for the symptomatic group on the Disparometer, Wesson Card, and Pola Pointer Test relative to the asymptomatic group. Because there was a significant interaction between tests and groups, Repeated Measures of ANOVA was performed for each group separately. There was a significant test effect (p<0.001) for each group. For both groups, eye posture with the Sheedy Disparometer was significantly more esophoric than all other tests, and the Wesson Card was significantly more exophoric than all tests except the Pointer and Double Pointer Tests. The Cross Test was significantly more esophoric than the Pointer Test in the symptomatic group. The Pointer Test was significantly more exophoric than the AO Card and the Mallett Unit for the asymptomatic group. None of the other comparisons were significantly different. Similar to the distance results, the difference between the Cross Test and other MKH-Haase charts raises the question as to whether this target is a necessary part of the Pola Test sequence.

Table 5 shows the 95% limits of agreement (in prism diopters) between different horizontal associated phoria tests at near when the differences between them were not significant. There was high agreement between the Mallet Unit, the AO Card, and the Saladin Card for both groups. However, the Double Pointer Test had lower agreement with these 3 tests. This was due to a large difference (i.e., 2.00$^{\Delta}$ to 4.00$^{\Delta}$ in associated phoria values between Double Pointer Test

Table 7. MKH-Haase Stereo Balance tests' Results at Near

Groups	Isovalence	Right Eye Valence	Left Eye Valence	Mixed Valence
Symptomatic (N=34)	15 (44.11%)	10 (29.4%)	1 (2.9%)	10 (29.4%)
Asymptomatic (N=40)	32 (80%)	4 (10%)	0	4 (10%)

Mixed Prevalence means there was no consistency between the stereo balance tests results

and the other 3 tests for a few subjects in both groups).

Comparison of vertical associated phoria tests at distance and near

MRANOVA of vertical associated phoria tests at both distance and near did not show any significant differences among different tests (p=0.46). In addition, the analysis did not reveal any significant difference between subject groups or significant subject-by-test interaction. Figure 5 shows the distance test data for the symptomatic group where the variation between the means was the largest. At near, the mean range between tests was very small (from 0.008 BU$^{\Delta}$ to 0.008 BD$^{\Delta}$). The 95% limits of agreement between all vertical tests at both distances were always within ±0.25$^{\Delta}$.

The MKH-Haase Stereo Balance Test results

Table 6 summarizes the results of the Stereo Balance Test at distance. The table showed that less than half of the participants from the symptomatic group and exactly half of the participants from the asymptomatic group gave an isovalence response for all disparities. Few participants from either group had consistent eye dominance; however, participants who had right eye valence were more common than individuals with left eye prevalence in both groups. The number of participants who had mixed prevalence was marginally higher in the symptomatic group. The differences in the number of participants within each category (with pooling of the left and right eye prevalence into one group) of ocular valence tests were not significant between groups (X^2=2.34, DF=2, and p=0.5).

Table 7 shows that the eye prevalence at near showed a different pattern. Less than half of the participants from the symptomatic group had an isovalence for all disparities, whereas this was the most frequent finding in the asymptomatic participants. The right eye valence was again higher than the left eye with both groups. Mixed valence was more common in the symptomatic group. The frequencies of the subjects within each category (with pooling of the left and right eye prevalence into one group) were significantly different between groups (X^2=11.8, DF=2, and p=0.003).

Discussion

To our knowledge, no comparison between the MKH-Haase charts of the Pola Test and other associated phoria tests has been reported in the English language literature. There were small but significant differences between the distance horizontal associated phoria tests for both groups. The Cross Test was significantly more exophoric than the other tests. Nevertheless, the mean difference was no greater than 0.25$^{\Delta}$ in any of the comparisons, so it is unlikely that this difference would be clinically important. Targets with central fusion locks had very similar values.

The central fusion lock is most likely explanation for the more esophoric and near orthophoric values for these tests relative to the Cross Test. Previous research showing that the fixation disparity at distance is lower in magnitude in the presence of central fusion locks is consistent with this finding.[21,22] However, the change in the magnitude of X-intercepts (associated phoria) with the foveal fusion lock was not consistent across all subjects.[23-25] This variation in the phoria values across subjects with and without central fusion lock was probably due to different types of fixation disparity curves.[23,24]

Our result showing that the distance Mallett Test and AO Vectographic Slide results were similar was consistent with Brownlee and Goss, who reported that the associated phoria values were statistically identical for these two tests.[4] The MKH-Haase charts were more variable, especially for the symptomatic group. The higher variability within the tests suggests that the tests may be more sensitive for measuring associated phoria than the Mallett Test and the AO Slide.

Although there was a statistically significant interaction between subject groups across the various near horizontal associated phoria tests, the interaction was primarily due to the magnitude of the difference between tests. The symptomatic group had larger mean differences between tests relative to the asymptomatic group. Regardless of the subject category, the Sheedy Disparometer mean value was more esophoric than all other tests, and the Wesson Card mean value was more exophoric than the other test values. As a result, the mean difference between the Disparometer and the Wesson Card was approximately 2.0^{Δ}.

The large difference between the Sheedy Disparometer and the Wesson Card with each other and with the other tests is likely due to the target design. First, neither the Sheedy Disparometer nor the Wesson Card has a central fusion lock. However, the lack of a central fusion lock cannot account for the differences because the mean associated phorias are in opposite directions. The results from the MKH-Haase Cross Test and Double Pointer Test suggest that the absence of the central fusion lock at near would likely produce a change towards the esophoric direction relative to a target with a central fusion lock; however, the peripheral fusional locks are also different between the MKH-Haase charts, and so this could be another factor contributing to the difference in these results. One factor that could explain the esophoric findings for the Disparometer is that the nonius lines of the Disparometer are located behind the plane of fixation. If the subject had no fixation disparity, the nonius lines that were in physical alignment but located behind the fixation plane would appear as an esophoric fixation disparity. This could be the possible reason for the higher base-out associated phoria values with this test.[22]

Most studies have reported that the associated phoria values measured with the Sheedy Disparometer were more esophoric than a number of other tests.[4,13-15,17] The exception was Pickwell et al.,[16] who reported that Disparometer associated phoria values were significantly more exo than the Mallett Test by approximately 5.0^{Δ} for naïve subjects and statistically identical for experienced subjects. Our finding that the Saladin Card associated phoria values were more esophoric than the Wesson Card for both groups confirms Ngan et al's[17] findings for the two charts.

Comparisons of vertical associated phoria of MKH-Haase charts and the other clinical tests did not show any significant differences at both distance and near. This result was expected since the natural status of the vertical vergence system is less variable, and the majority of the subjects had a vertical associated phoria no greater than 0.25^{Δ}. The mean values of vertical associated phoria tests varied from zero prism diopters to 0.125^{Δ}.

In principle, the underlying theory for testing fixation disparity using stereo targets according to Haase may appear reasonable; however, our results suggest that the actual tests, the Stereo Triangle and Stereo Balance Tests, may be problematic. The first problem was that no one had a noticeable stereo delay, or the delay was so small that it could not be measured reliably in the clinical setting. One of the problems with this test is that recording the time for the stereo impression with a stopwatch is impossible for the examiner because s/he needs two hands to manipulate the Polaroids. It might be possible to have the subject operate a response box or stop watch, but our initial impression was that it would take longer to start and stop the timer than to actually perceive the depth information correctly. The issue for the Stereo Balance Test was that we could not correct any dominance revealed on the test with prism on the initial set of test subjects. Part of this problem could be related to the angle between the line of sight and the distant display screen. Although we did not investigate the effect systematically, we did notice that the eye dominance could be changed by tilting the distance monitor slightly about the horizontal axis. This effect was not as obvious using the near display, and that may be the reason for the higher frequencies of isovalence responses at near for the asymptomatic group. The other problem was the consistency of the Balance Test results. One might anticipate a low isovalence response in symptomatic patients, but the fact that their response often changed for the same type of disparity suggests that prescribing prism based on these results could be problematic if it was possible to do so.

The difficulty found administering and interpreting the Stereo Balance Test was also noted by others. Kommerell showed that ocular valence was not significantly different when measured with and without the MKH-Haase prismatic correction. Similar to our experience, they also reported that the ocular valence did not change when the vergence system was forced by prisms.[26]

Conclusions

Our results showed that the vertical associated phorias measured at both distance and near, as well as distance horizontal associated phoria measured with the various tests, were similar. Although the values measured with the Cross Test at distance were significantly more exophoric, this difference was small and unlikely to be clinically important. The associated phoria values measured at near varied more across tests, with the Sheedy Disparometer and the Wesson Card producing the two extreme ranges of values. These results raise the obvious question as to which test gives the "correct" prismatic prescription. This question was beyond the scope of this study, but our results do indicate that prescribing prismatic corrections based on just the associated phoria values may not be the best practice.

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Correspondence regarding this article should be emailed to Mosaad Alhassan, BSc, MSc, at malhassa@uwaterloo.ca. *All statements are the authors' personal opinions and may not reflect the opinions of the representative organizations, ACBO or OEPF, Optometry & Visual Performance, or any institution or organization with which the authors may be affiliated. Permission to use reprints of this article must be obtained from the editor.* *Online access is available at www.acbo.org.au, www.oepf.org, and www.ovpjournal.org.*

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