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# Comparison of a unique anaglyphic vertical fixation disparity test to the Sheedy disparometer

## Abstract

The clinical gold standard for deriving vertical prism prescriptions is the patient's vertical associated phoria (The relieving prism to bring a vertical fixation disparity to zero). It is generally accepted that the most accurate device used to measure fixation disparity at nearpoint is the Sheedy disparometer. However, the Sheedy disparometer is relatively large, expensive and not currently manufactured. These factors may make measurements of vertical associated phorias less appealing and accessible to practitioners. This study evaluated the vertical associated phoria measurements of twenty non-asthenopic subjects with measurable vertical phorias. Vertical associated phoria measurements were made using the Sheedy disparometer and a unique inexpensive anaglyphic vertical fixation disparity test composed of a card with a specifically designed red and green image and a pair of standard anaglyphic glasses for the patient to wear. Both tests at 40 em and were administered in an equally randomized order. The results indicate that vertical associated phoria measurements with the anaglyphic test are statistically equivalent to the Sheedy disparometer (mean difference = 0.00; p= value >0.9999). Based on this study, this inexpensive anaglyphic card can be used to confidently derive an accurate vertical associated phoria value for vertical prism prescriptions. Other clinical considerations are discussed.

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**COMPARISON OF A UNIQUE ANAGLYPHIC VERTICAL FIXATION  
DISPARITY TEST TO THE SHEEDY DISPAROMETER**

BY

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RANDY KELLY  
MATT HOPPE

A thesis submitted to the faculty of the  
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Adviser:

SCOTT C. COOPER, O.D., M.Ed.

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DISPARITY TEST TO THE SHEEDY DISPAROMETER**

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PAUL STASIK

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## **BIOGRAPHY PAGE OF THE AUTHORS**

### **Paul Stasik**

Paul received his Bachelor of Science in Aeronautical Science from Embry-Riddle Aeronautical University. Additionally he received flight ratings which include commercial multi-engine instrument pilot and flight engineer turbojet. Paul is also a veteran of the United States Navy. Upon graduation from Pacific University College of Optometry in May of 2003, he plans to practice primary care optometry in the Portland area. Paul is a member of the American Optometric Student Association.

### **Randy Kelly**

Randy attended North Dakota State University for his undergraduate studies, he obtained a Bachelor of Visual Science from Pacific University in May of 2000. He will graduate from Pacific University College of Optometry in May of 2003. Upon graduation, he hopes to practice in a primary care setting. Randy is a member of the American Optometric Student Association and a member of Beta Sigma Kappa Optometric Honor Fraternity.

## **Matt Hoppe**

Matt attended the University of North Dakota for his undergraduate studies; he obtained his Bachelor of Visual Science from Pacific University in May of 2000. He will graduate from Pacific University College of Optometry in May 2003. Upon graduation he hopes to return to Minnesota and practice full scope optometry with an emphasis in primary care. Matt is a member of the American Optometric Association and was active in student council as the class entertainment representative for his class.

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## Abstract

The clinical gold standard for deriving vertical prism prescriptions is the patient's vertical associated phoria (The relieving prism to bring a vertical fixation disparity to zero).<sup>1,2,5,9,12,15</sup> It is generally accepted that the most accurate device used to measure fixation disparity at nearpoint is the Sheedy disparometer. However, the Sheedy disparometer is relatively large, expensive and not currently manufactured. These factors may make measurements of vertical associated phorias less appealing and accessible to practitioners.

This study evaluated the vertical associated phoria measurements of twenty non-asthenopic subjects with measurable vertical phorias. Vertical associated phoria measurements were made using the Sheedy disparometer and a unique inexpensive anaglyphic vertical fixation disparity test composed of a card with a specifically designed red and green image and a pair of standard anaglyphic glasses for the patient to wear. Both tests at 40 cm and were administered in an equally randomized order. The results indicate that vertical associated phoria measurements with the anaglyphic test are statistically equivalent to the Sheedy disparometer (mean difference = 0.00; p= value >0.9999). Based on this study, this inexpensive anaglyphic card can be used to confidently derive an accurate vertical associated phoria value for vertical prism prescriptions. Other clinical considerations are discussed.

## Introduction

Fixation disparity is a measure of the residual misalignment of the visual axes during bifoveal fixation. The measurement of fixation disparity and the vertical associated phoria (VAP) are essential tools available to optimally and accurately manage patients with vertical fusion deviations. It is imperative that before prescribing vertical prism the practitioner needs to determine etiology, measurement variability, comitancy, prism adaptation, and VAP.<sup>1</sup> According to Scheiman and Wick, the VAP has become the standard method for the prescribing of vertical prism over the past 30 years.<sup>10</sup>

In theory, any small misalignment between the visual axes would result in diplopia.<sup>11</sup> However, due to Panum's fusional areas, similar images that fall on small corresponding regions of each visual field will be perceived as single. Without it each eye would have to be precisely aimed in order to maintain single binocular vision. This area, therefore, allows a little "slop" in our vergence system.<sup>6,7,13</sup> Fixation disparity is also considered to be a meaningful cue to regulate and stabilize vergence during sustained viewing.<sup>1,6</sup> For instance, when a patient with an exo fixation disparity focuses on a near object their eyes tend posture slightly behind the object of regard. The small disparity then stimulates a continual positive convergence response which helps in maintaining the object of regard as single. Similarly, with an eso fixation disparity the eyes tend to posture slightly in front of an object, in this case a

negative fusional response is elicited which helps maintain single binocular vision. This concept applies to vertical Vergence adjustments as well.

Any small misalignment in the visual axes can manifest as visual complaints, especially in the vertical meridian.<sup>1,6</sup> Depending upon the nature and degree of a vertical fixation disparity, the clinician can provide great relief through the use of prism and/or vision therapy techniques. Eskridge and Rustein determined in a clinical evaluation of VFD that prism should only be prescribed to those who don't adapt, otherwise there is no benefit. They discovered the majority of patients that prism adapt are asymptomatic, or better treated with methods such as vision therapy.<sup>5</sup> Prism adaptation can be predicted by generation of a vertical FD curve or tested via trial wear of the VAP. Although techniques for testing prism adaptation vary slightly in detail, the process follows these general steps; have the patient wear the prism to be prescribed in a trial frame for 10 to 30 minutes.<sup>1</sup> If a patient adapts readily to the VAP (returns to the original value), the relief from applying prism cannot be expected to sustain. If a patient does not adapt (or only adapts slightly), a prism Rx can be applied with more confidence of sustained benefit over time. Therefore, the measurement of VAP is an almost indispensable tool in the process of choosing to provide a vision therapy regimen and/or prescribing prism.<sup>6</sup>

Most clinical methods employed to measure fixation disparity utilize polarized filters to isolate the image to each eye. Commonly used devices

include the Sheedy Disparometer, the Saladin Nearpoint Card and Wesson card which can quantify the value of the FD. Other devices which allow detection (not measurement) of FD and measurement of VAP include vectographic projection slides.<sup>1,2,13,15</sup> Therefore, this type of target will not allow generation of fixation disparity curves, which is clinically more troublesome when dealing with horizontal vergence problems.

Once a vertical fixation disparity is found, the clinician can subsequently measure the VAP through careful application of relieving prism until the FD becomes zero. The amount of prism that allows the fixation disparity to reduce to zero is the value of the vertical associated phoria (VAP). The patient indicates the VAP is found when vernier alignment of two horizontal lines is achieved.<sup>13</sup>

Vertical and horizontal vergence skills can be analyzed by plotting a FD curve. These curves can help determine the amount of prism to prescribe and whether or not it is likely the patient will adapt. Unlike horizontal curves, vertical curves usually only show a narrow “flat” region in the otherwise almost linear slope. This indicates patients are much less likely to adapt to vertical disparities, which means a small vertical disparity could possibly result in asthenopia. However, it has been shown that the “flat”, prism-tolerant region can be expanded and flattened with vision therapy in patients with normal prism adaptation.<sup>8</sup> Thus it is of the utmost importance in a general vision examination to either routinely utilize vertical FD testing as a screening tool, or

apply vertical FD testing whenever a vertical deviation is discovered by a routinely applied test (such as Maddox rod) or suspected based on case history.

Although the application of vertical fixation disparity detection and VAP measurement to generation of a vertical prism prescription is well documented to be the ideal clinical approach, the majority of practitioners do not utilize vertical fixation disparity information in their exam sequence.<sup>7</sup> This is likely due to the price of the testing devices, lack of knowledge that some of the devices exist, or perceptions of how long FD testing will take. This has lead the authors to develop an anaglyphic target on a standard size nearpoint card which can be used to detect vertical fixation disparity and allow measurement of VAP.

# The Anaglyphic Target Nearpoint Card



If patients can perform the test using standardized instructions and the VAP results are equivalent to those derived from a currently accepted clinical method, practitioners would have a low-cost, easily stored and held device for gathering these essential measurements.

This study is designed to compare vertical AP measurements from the experimental anaglyphic card to those measured with the Sheedy Disparometer.

## Methods

Twenty subjects (ages 18 to 55) with vertical dissociated phorias were identified for the study. The presence of a vertical dissociated phoria was confirmed by either standard von Graefe testing in phoropter or cover test. Inclusion criteria for each subject were the following: near visual acuity of 20/20 or better in each eye when measured under standard clinical protocols, no ocular disease or media opacities, no strabismus, and asymptomatic near vision.

The experimental anaglyphic card has a round central target that is 9mm in diameter. The outer circumference of the target is a black ring that is 0.75mm thick. The left half of the target within the black ring is green and the right half is red. When one eye is closed, the other eye should see black on the opposite side of the circle target and vice versa; they have to cancel for an accurate measurement of associated phoria and fixation disparity. Standard near point lighting was used when the red and green were properly tuned through trial and error for optimal cancellation with standard anaglyphic glasses. Two horizontal lines are used to measure the VAP. Each line is 3mm long and 0.50mm thick. There is 0.50mm of space between the outer edge of the line and the outer black ring and 1mm of space between the lines (0.50mm of space within each color zone). These specifications were chosen to approximate the features of the disparometer.

The subjects were familiarized with vertical fixation disparity testing procedures for both the Sheedy Disparometer and the experimental Anaglyphic card. The subject was informed, "This is a device to measure how your two eyes aim together. Do you see these two horizontal lines? I am going to have you wear these glasses and tell me when the lines are perfectly level with each other, when the right line is above the left line, or when the right line is below the left line." To sensitize the patient to a change in disparity, 2 prism diopters base up and down were applied by holding up loose prism over the subject's right eye with both targets before testing started.

Both tests were administered in a randomized order. All testing was out of phoropter at 40cm with standard near point overhead lighting. The anaglyphic glasses were worn with the red filter on the subject's right eye and the green filter on the subject's left eye for the anaglyphic card. The cards were held straight and steady by the examiner at the measured 40cmduring testing. This helped standardize protocols for testing vertical alignment as well as maintain consistent cancellation when using the polarized target of the Sheedy Disparometer.

The subject was instructed to gaze out towards a hanging standard Snellen chart at 6 meters with their habitual prescription for 10 seconds, and then look at the near test. The subject was instructed to try to keep the letters clear to the right and left of the lines while noticing the horizontal lines and any disparity.<sup>4,14</sup> Next, the subject had to respond whether the line on the right-



hand side was 'equal', 'above', or 'below' within 10 seconds or the process was repeated. If a disparity between the two lines was reported, the test was repeated with compensating prism over the right eye in increasing  $0.5\Delta$  increments until no fixation disparity was reported. Care was taken to assure that the prism was held with the base exactly up or down with no rotation which would reduce the effective vertical prism power applied. Each time the test conditions were modified, the subject was instructed to look at the 6-meter chart and then look back to the test. Three VAP measurements were taken with each device. These values were averaged for each subject, and these averages were used for statistical comparison.

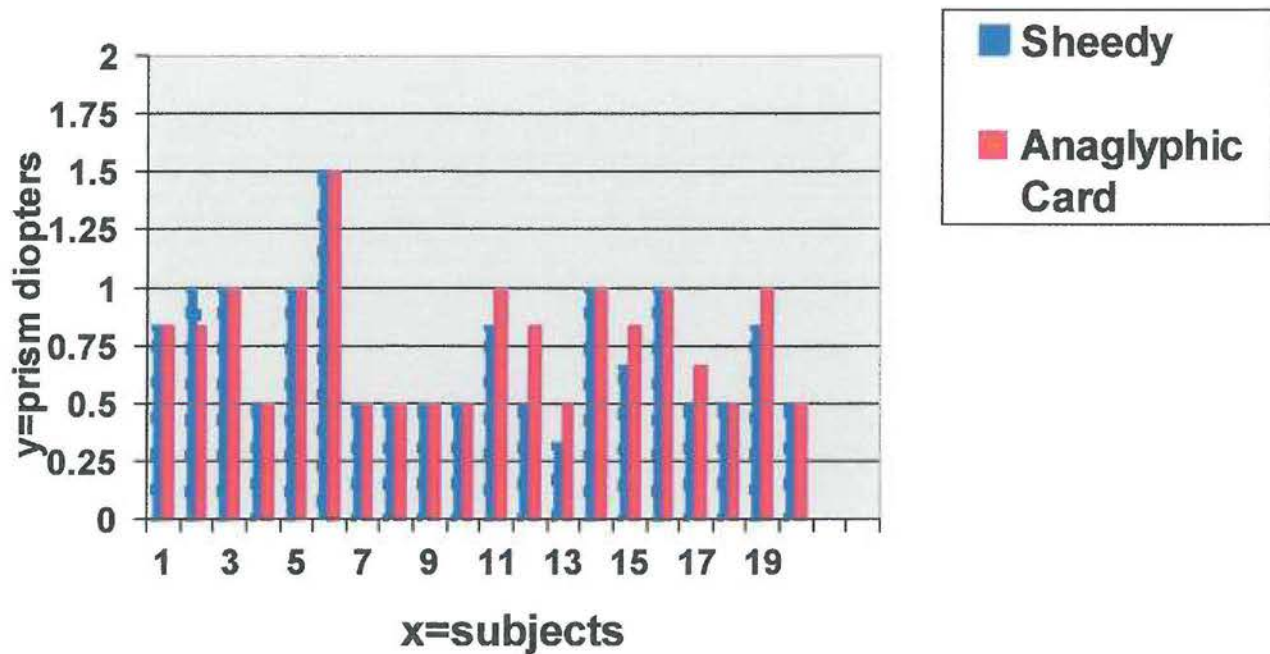
## Results

The averages for each subject are presented in table "**Measured VAP**". Simply scanning the results for each subject shows that the average VAP prism value is easily within clinical acceptability. The largest difference between the two testing conditions for an individual subject was 0.33 prism diopters (occurred in two of twenty subjects). By practical clinical consideration, this maximum difference is not ideal, but is reasonable when approaching a vertical prism prescription.

The collected data was analyzed using a paired t-test. The mean value measured with the Sheedy disparometer was found to be  $0.03 \pm 0.81$ , whereas the mean value obtained with the anaglyphic card was  $0.03 \pm 0.85$ . The mean difference of the two test conditions was  $0.00 \pm 0.13$ . The analysis

of this data provided  $p > 0.9999$ . It was determined that the two test conditions did not prove statistically different. Thus, according to our data the anaglyphic card gives a statistically equivalent measurement to the Sheedy Disparometer.

## Measured VAP



Vertical Associate Phoria Results

Subject	Sheedy Disparometer (Avg. $\Delta$ )	Anaglyphic Card (Avg. $\Delta$ )	Difference of Measurements ( $\Delta$ )
1	-0.83	-0.83	0
2	1	0.83	-0.17
3	-1	-1	0
4	0.5	0.5	0
5	-1	-1	0
6	1.5	1.5	0
7	0.5	0.5	0
8	0.5	0.5	0
9	-0.5	-0.5	0

10	0.5	0.5	0
11	-0.83	-1	-0.17
12	0.5	0.83	0.33
13	0.33	0.5	0.17
14	-1	-1	0
15	-0.83	-0.83	0
16	1	1	0
17	-0.5	-0.83	-0.33
18	0.5	0.5	0
19	0.83	1	0.17
20	-0.5	-0.5	0
<b>Mean</b>	<b>0.03</b>	<b>0.03</b>	<b>0.00</b>
<b>Standard Deviation</b>	<b>0.81</b>	<b>0.85</b>	<b>0.13</b>

\*Negative values indicate "Left Hyper", Positive values indicate "Right Hyper"

## Discussion

Results from this study indicate the experimental anaglyphic card and the Sheedy vertical fixation disparity test provide clinically and statistically equivalent VAP results. This illustrates that the experimental card can confidently be utilized in clinical care where FD detection and/or VAP measurement is indicated.

The most efficient practitioners perform a problem-focused exam when time is of the essence. Based on plentiful evidence in optometric literature and clinical experience, the authors feel VAP this is the most clinically useful piece of data to predict an optimal vertical prism prescription or, through consideration of prism adaptation, lead to a viable vision therapy program. Additionally, applying the VAP when prescribing vertical prism might actually be cost effective with fewer prescription redos than might occur with less precise prism estimation methods.

As the experimental card is an inexpensive, easily stored, easily held item that is quick and easy for the patient and doctor to use, the anaglyphic card should allow practitioners in essentially any practice setting to gather VAP measurements without undue expense or chair-time. This, in turn, will allow the practitioner to make optimal decisions about the care of patients with vertical vergence deviations.

Challenges of the study included designing a red/green card which would provide VAP results equivalent to the current clinical gold standard, the polarized Sheedy disparometer. Details of the card design can be found in the methods section.

An anticipated challenge that did not present itself during this study was that of suppression. The anaglyphic glasses could cause suppression to occur more easily than the polarized glasses. The higher the contrast, the least likely suppression will occur.<sup>6</sup> The anaglyphic glasses reduce contrast slightly more than polarized glasses when testing. Additionally, the dioptric difference between the red and green sides (varies by exact filter colors, but is approximately 0.37 diopters from red to green), and the different colors themselves could create enough rivalry to encourage a patient with unstable sensory fusion to suppress during the test. Suppression would have caused one line to become absent or fade in and out during testing. No subjects reported any symptoms of suppression. In order to break suppression, the

subject would have been instructed to blink or wave a finger in front of their eyes.

The study did not include full vertical fixation disparity curve generation. Future studies could include designing cards with known arc minute of line misalignment to allow the patient to identify the fixation disparity value with each prism application. Results from vertical FD curves could be compared using anaglyphic and polarized methods. If adequate accommodative controls were incorporated, the results of horizontal FD testing could also be compared using anaglyphic and polarized targets. However, the dioptric difference between the red and green filters might introduce more accommodation inaccuracy or fluctuation, potentially making horizontal FD testing difficult for the patient and less reliable for the practitioner.

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