

Pacific University

CommonKnowledge

---

College of Optometry

Theses, Dissertations and Capstone Projects

---

3-16-1987

## A clinical comparison of three astigmatic tests

Leonard O. Graft  
*Pacific University*

Jennifer C. Weaver  
*Pacific University*

### Recommended Citation

Graft, Leonard O. and Weaver, Jennifer C., "A clinical comparison of three astigmatic tests" (1987). *College of Optometry*. 776.

<https://commons.pacificu.edu/opt/776>

This Thesis is brought to you for free and open access by the Theses, Dissertations and Capstone Projects at CommonKnowledge. It has been accepted for inclusion in College of Optometry by an authorized administrator of CommonKnowledge. For more information, please contact [CommonKnowledge@pacificu.edu](mailto:CommonKnowledge@pacificu.edu).

---

## A clinical comparison of three astigmatic tests

### Abstract

Astigmatism is a refractive condition in which the optical system of the eye cannot form a point image of a point object. This is a consequence of varying curvatures of the cornea and or the lens of the eye and is present in a large majority of the detection of astigmatism.

This study takes a look at three subjective tests for astigmatism. Two of these, the Jackson cross cylinder and the Pratt near cylinder, are well established tests used at Pacific University clinics. The third test was designed by Dr. William Preston. Dr. Preston's technique utilizes a near point card with a sunburst target which presents a series of radially arranged lines every 15 degrees. The card also presents three lines of Snellen acuity letter, 20/40, 20/30, and 20/20, which are used in fogging and cylinder axis refinement.

This study concluded that there was no statistical difference between the magnitude and direction of the astigmatic refractive error found by the Preston technique and the Jackson cross cylinder. In addition, the study found that there was a statistically significant difference between the magnitude and the direction of the astigmatic refractive error found by the Preston technique and the Pratt near cylinder. Although these results were statistically significant, the clinical difference between the tests was minimal.

### Degree Type

Thesis

### Degree Name

Master of Science in Vision Science

### Committee Chair

William E. Preston

### Subject Categories

Optometry

## Copyright and terms of use

If you have downloaded this document directly from the web or from CommonKnowledge, see the "Rights" section on the previous page for the terms of use.

**If you have received this document through an interlibrary loan/document delivery service, the following terms of use apply:**

Copyright in this work is held by the author(s). You may download or print any portion of this document for personal use only, or for any use that is allowed by fair use (Title 17, §107 U.S.C.). Except for personal or fair use, you or your borrowing library may not reproduce, remix, republish, post, transmit, or distribute this document, or any portion thereof, without the permission of the copyright owner. [Note: If this document is licensed under a Creative Commons license (see "Rights" on the previous page) which allows broader usage rights, your use is governed by the terms of that license.]

Inquiries regarding further use of these materials should be addressed to: CommonKnowledge Rights, Pacific University Library, 2043 College Way, Forest Grove, OR 97116, (503) 352-7209. Email inquiries may be directed to: [copyright@pacificu.edu](mailto:copyright@pacificu.edu)

PACIFIC UNIVERSITY LIBRARY  
FOREST GROVE, OREGON

**A CLINICAL COMPARISON OF THREE  
ASTIGMATIC TESTS**

**AUTHORS**

**Leonard O. Graf, B.S.  
Jennifer C. Weaver, B.S.**

**ADVISORS**

**William Preston, O.D.  
Nada Richardson, O.D.**

**March 16, 1987**

**This thesis is submitted in partial fulfillment of the  
requirements for the Doctor of Optometry degree.  
Pacific University College of Optometry.**

**SIGNATURE PAGE**

**AUTHORS:**

Leonard O. Graf, B.S. Leonard O. Graf

Jennifer C. Weaver, B.S. Jennifer C. Weaver

**ADVISORS:**

William Preston, O.D. William Preston

Nada Richardson, O.D. Nada Richardson, O.D.

## **AUTHORS**

**Leonard O. Graf**

**Mesa College, A.A.S.**

**Grand Junction, Colorado**

**Pacific University, B.S., O.D.**

**Forest Grove, Oregon**

**Plan: Private Practice; Denver, Colorado**

**Jennifer C. Weaver**

**University of Puget Sound**

**Tacoma, Washington**

**New England College**

**Arundel, England**

**University of Washington**

**Seattle, Washington**

**Pacific University, B.S.**

**Forest Grove, Oregon**

**Plan: Private Practice; Seattle Washington**

## ABSTRACT

Astigmatism is a refractive condition in which the optical system of the eye can not form a point image of a point object. This is a consequence of varying curvatures of the cornea and or the lens of the eye and is present in a large majority of the population. Therefore, many clinical tests have been designed for the detection of astigmatism.

This study takes a look at three subjective tests for astigmatism. Two of these, the Jackson cross cylinder and the Pratt near cylinder, are well established tests used at Pacific University clinics. The third test was designed by Dr. William Preston. Dr. Preston's technique utilizes a near point card with a sunburst target which presents a series of radially arranged lines every 15 degrees. The card also presents three lines of Snellen acuity letters, 20/40, 20/30, and 20/20, which are used in fogging and cylinder axis refinement.

This study concluded that there was no statistical difference between the magnitude and direction of the astigmatic refractive error found by the Preston technique and the Jackson cross cylinder. In addition, the study found that there was a statistically significant difference between the magnitude and the direction of the astigmatic refractive error found by the Preston technique and the Pratt near cylinder. Although these results were statistically significant, the clinical difference between the tests was minimal.

## **ACKNOWLEDGEMENTS**

The authors wish to thank their advisors, Dr. Preston and Dr. Richardson, for their guidance around all the pitfalls that await any research project. In addition, we would like to thank Dr. Robert Yolton for giving us his time and invaluable expertise with our statistical analysis.

This paper is dedicated to Rick and Gina for their support and understanding over the year that it took us to put this paper together. Thanks to all of you for helping to make this a successful and rewarding experience.

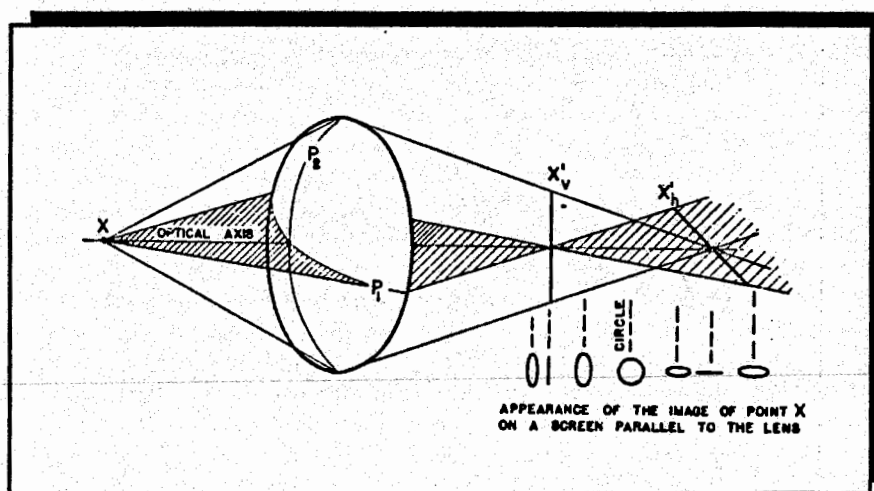


# A CLINICAL COMPARISON OF THREE ASTIGMATIC TESTS

## INTRODUCTION

Astigmatism is a condition in which there is a variation in power of the eyes refractive components from one meridian to the other. The major, or principle, meridians are generally 90 degrees apart. This type of optical system is incapable of forming a point image of a point object. The image of an extended object, which is made up of an infinite number of discrete points, is spread out into two line foci. The vertical meridian of the eye produces a horizontal line focus and the horizontal meridian forms a vertical line focus. The three dimensional area between the two principle foci forms a conoid. The distance between the two foci is the Interval of Sturm. A cross-section of light taken through the dioptric midpoint of the Interval would be circular and is termed the circle of least confusion. (Figure-1)

**FIGURE-1. ASTIGMATIC IMAGE OF A POINT SOURCE**



(from Melvin Rubin M.D., OPTICS FOR CLINICIANS, pp 89, 1974.)

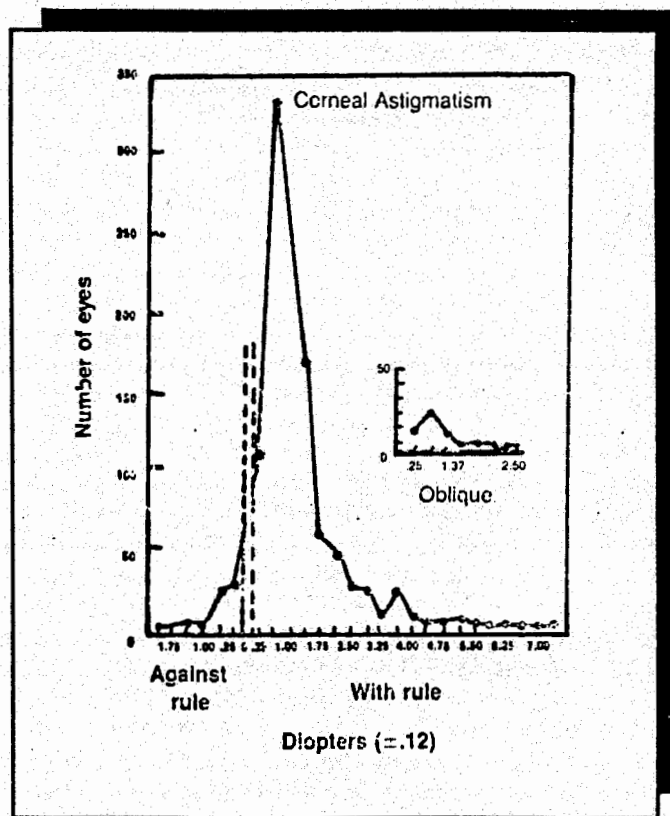
The components which contribute to the eye's total or refractive astigmatism are the cornea and the lens. The major source of clinically significant amounts of astigmatism is held to be the anterior surface of the cornea which usually exhibits direct, with the rule, astigmatism. Some astigmatism has been ascribed to the posterior corneal surface. However, this is generally a small amount of inverse, against the rule, astigmatism and serves to modify the ultimate effect of the anterior surface only to a slight degree.<sup>3</sup>

The major contribution of the lens to refractive astigmatism is generally held to be the result of lens tilt rather than varying curvature. Sheard noted that a tilt of the lens around its horizontal axis of 10 degrees would produce 0.50D of against the rule astigmatism.<sup>12</sup> Carter, in a study on lenticular astigmatism, found 2-3% of the cases revealed with the rule; 87% showed against the rule; and 10.7% revealed oblique astigmatism.<sup>4</sup>

Marton pointed out other potential sources of internal or residual astigmatism: traction of the extraocular muscles forcing the sclera into a toroidal shape without altering the cornea, foveal eccentricity relative to the visual axis, changes in the vitreous gel and resultant changes in refractive index, and fundus irregularities i.e., retinal tilt.<sup>9</sup> It should be noted that these are only theoretical postulates. There is no way to clinically measure internal astigmatism.

Very few distribution curves for astigmatism have been published in the literature. Lyle published a distribution curve for corneal astigmatism in 1961. The data consisted of 1208 eyes of patients of various ages seen in his optometric practice. Its general form is very similar to the distribution curve for spherical ametropia, having its peak at 0.75D of with the rule astigmatism.<sup>7</sup> See Figure-2 on the following page.

**FIGURE-2. DISTRIBUTION OF CORNEAL ASTIGMATISM**



(from W.M. Lyle, AOA Journal, Vol. 48, pp 467-468, 1971.)

Banon and Walsh, in a study done in 1945, found astigmatism in 1666 of 2000 patients: 33% had with the rule, 20% against the rule, and 30% in an oblique position. Symmetry between the eyes was fairly common. Unilateral astigmatism was found in some 30% of the cases.<sup>2</sup> Table-1, on the following page, summarizes the distribution of astigmatism by magnitude as given by Cava.<sup>6</sup>

**TABLE-1. DISTRIBUTION BY MAGNITUDE**

<u>AMOUNT</u>	<u>PERCENT</u>
0.00-0.50D	22.94
0.50-1.00D	42.44
1.00-1.50D	16.18
1.50-2.00D	9.21
2.00-3.00D	6.39
3.00 and up	2.84

These results compare closely to Lyle's findings. ( see Figure-2 )

Visual acuity in the uncorrected astigmat is dependent on the magnitude and the type of astigmatism present. Strictly speaking, the individual does not have a sharp retinal image at any distance. If one or both of the focal lines are behind the retina (simple or compound hyperopic astigmatism) visual acuity can be improved to some degree by accommodating so that the circle of least confusion coincides with the fovea. In mixed astigmatism visual acuity is relatively good because the circle of least confusion is close to or may even coincide with the fovea. However, if one or both of the focal lines are in front of the fovea (simple or compound myopic astigmatism) any attempts at accommodation will move the circle of least confusion even farther from the fovea and thus make the retinal image more blurred.<sup>7</sup>

Many investigators have found discrepancies in the magnitude of astigmatism when measured at different task distances. In general, there is an increase in with the rule astigmatism at the near point. Hofstetter, Bannon, and Walsh, have advanced several theories regarding this phenomenon. The chief cause appears to be the variation of in the effective power of the lens when accommodation is activated for a near

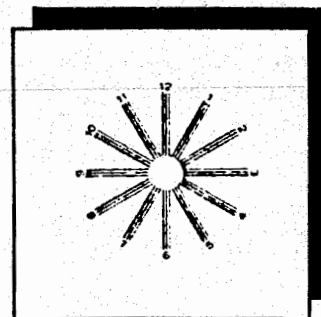
point task. Secondly, vision at near may be directed obliquely through the correcting lens. In addition, accommodation may bring the circle of least confusion in coincidence with the fovea. Other factors include, exacerbation of lenticular astigmatism due to lens tilt, stenopaic effect of narrowing lids and miosis during a near point task, and variation of the angle of incidence from a near point task which permits the eye to select a different bundle of rays to focus.<sup>2,8</sup>

Scobee also reported as many as 75% of his cases revealed a shift in the axis of the correcting cylinder at the near point which he ascribed to lenticular changes.<sup>11</sup> Bannon and Walsh demonstrated that the shift in the axis was due primarily to torsional effects as a result of convergence.<sup>2</sup> The torsional effect causes the upper pole of the vertical axis to rotate outwards during binocular fixation (excyclorotation). Collins and Oberhelman also described the tendency for the eyes to excyclorotate four to six degrees during binocular fixation.<sup>5</sup>

Today astigmatism is undoubtedly the most widely prevalent refractive anomaly presented for correction.<sup>3</sup> It is important for clinicians to have a wide variety of astigmatic tests at their disposal for the accurate determination of the magnitude and axis of an astigmatic refractive error. These tests are all based on the type of chart and special instrumentation required to do the test.

The most common astigmatic chart used at Pacific University clinics is the clock dial. ( Figure-3 )

**FIGURE-3. CLOCK DIAL CHART**

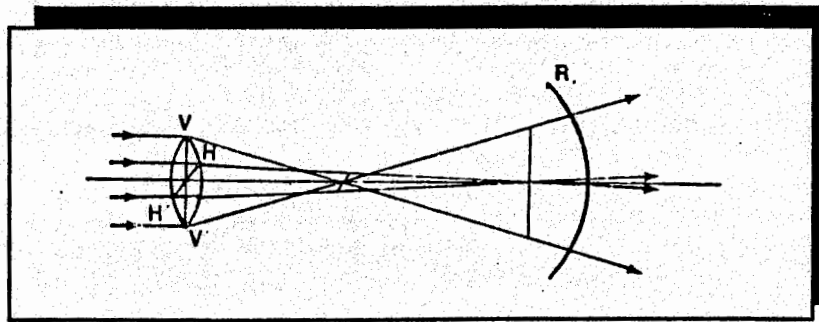


(from T.P. Grosvenor, PRIMARY CARE OPTOMETRY; pp 164, 1982.)



The chart was introduced by John Green in 1868. It consists of 12 radiations at angular intervals of 30 degrees. Each radiation usually consists of three separate lines spaced by an acuity demand of 20/25 or 20/30.<sup>3</sup> Before the chart is used each eye is fogged monocularly with plus lenses. This will insure that the entire Interval of Sturm is placed in front of the retina (see Figure-4 ). Generally a 20/30 or 20/40 fog at six meters is required to meet this criterion.

**FIGURE-4. ASTIGMATIC FOG**



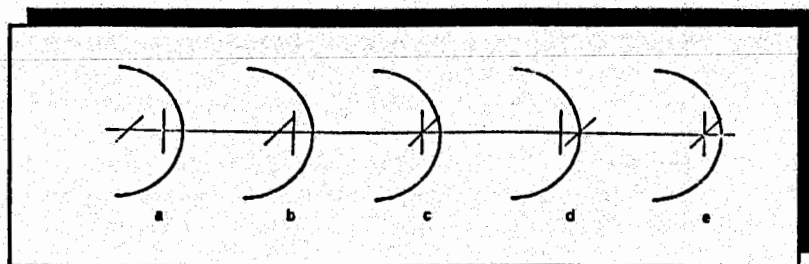
(from T.P. Grosvenor, PRIMARY CARE OPTOMETRY; pp 164, 1982.)

To determine the axis of the correcting cylinder the patient is asked to report which of the spokes are clearest or most distinct. The axis of the correcting cylinder is then determined by the rule of thirty. The smaller of the two numbers reported by the patient as darkest is multiplied by 30. For example, if the patient reports the 12 to 6 line as darkest the examiner would place the axis of the correcting cylinder at 180 degrees ( $6 \times 30 = 180$ ).

The power of the correcting cylinder is determined by calling the patients attention to the two principle meridians. In our example, the 12 to 6 line would be compared to the 3 to 9 line. The examiner then adds minus cylinder 0.25D at a time. After each addition of the cylinder the patient is asked to report which of the two meridians is clearer or more

distinct. The addition of the minus cylinder, axis 180 degrees, will move the horizontal focal line and the circle of least confusion toward the retina without changing the position of the vertical focal line. When the proper amount of minus cylinder has been added Sturms conoid will collapse and the patient will report equality of the lines. The addition of another 0.25D of minus cylinder should cause a reversal of the patients response ( 3 to 9 line is now darkest ). The final image will still be out of focus by the amount of the fogging lens. ( Figure-5)

**FIGURE-5. CORRECTING WITH-THE-RULE ASTIGMATISM  
UNDER FOG**



Original fog level (a); Minus cylinder increased (b); Point of equality (c); Reversal (d); Return to equality (e).

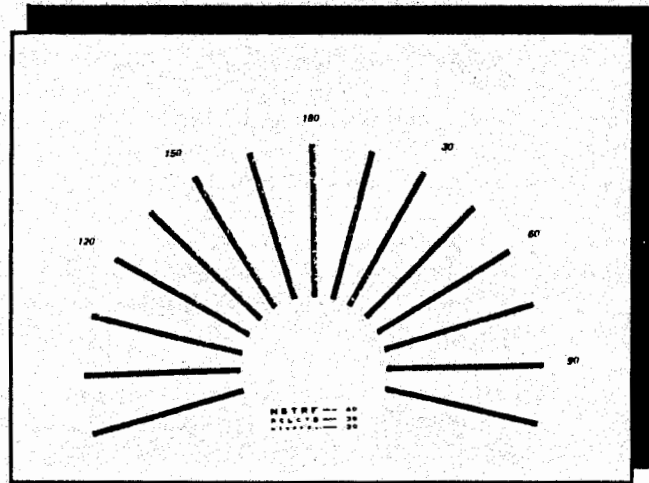
(from T.P. Grosvenor, PRIMARY CARE OPTOMETRY, pp 165; 1982.)

### THE PRESTON TEST

In the fall of 1985, William Preston O.D., Chief of Staff, at Pacific University College of Optometry, designed a new target for the far point subjective assessment of astigmatism. The target was developed to produce a cylinder test performed under fog that was easy to administer and facilitated patient comprehension. The target is on a near point card and consists of a sunburst arrangement of radial lines which are spaced 15

degrees apart. The card also has three lines of Snellen acuity letters, 20/40, 20/30, and 20/20, which are utilized for fogging and the determination of the axis of the correcting cylinder. The Snellen letters may also be used for maximum plus and minus to blur at 40 centimeters. (Figure-6 )

**FIGURE-6. THE PRESTON TARGET**



(Target reduced by 40 percent.)

The target is placed at 40 centimeters and aligned on the monocular visual axis. This positioning serves several purposes. First, the near target distance allows the patient or the examiner to easily point, touch, or identify specific components of the target. This is of great value in patient communication and comprehension. Secondly, placement on the monocular visual axis prevents the torsional effects of convergence which may result in an axis shift of the correcting cylinder.

The test begins with the examiner performing a monocular fog at 40 centimeters with standard near point illumination. The patient is asked to report the lowest line of Snellen letters that can be identified. Sufficient plus lens power is then added to blur that line. The illumination is then dimmed by turning the near point light away from the target, this reduces



glare from the target. The patient's attention is then directed to the sunburst and asked to report which, if any, of the lines are sharper or more distinct. The examiner then places the axis of the correcting cylinder at the indicated position. The target is conveniently labeled with the axis position for the line reported as darkest by the patient. For example, if the patient reports the up and down line as darkest the axis is set at 180 degrees. If a group of lines is reported as darkest the axis is set at the midpoint of the group. The examiner then adds minus cylinder, 0.25 D at a time, until the patient reports that all the lines appear about equal in darkness.

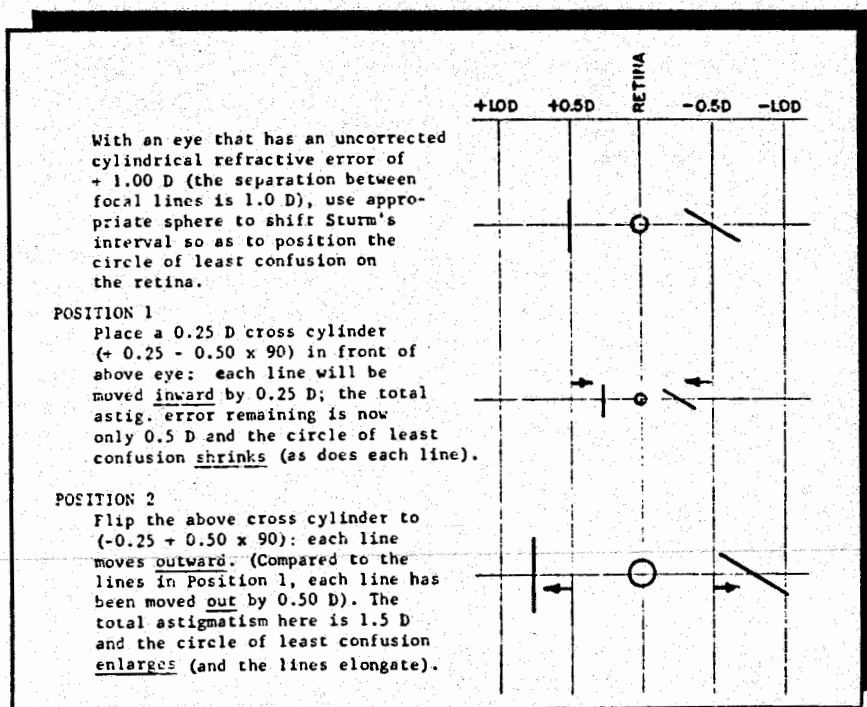
Dr. Preston recommends that the original fog level be checked at this point to assure accommodative control. The standard near point illumination is returned and the patient is directed back to the previously fogged line. If that line can now be read it is fogged once more and the cylinder power is then rechecked.

The next step is to refine the cylinder axis. The near point illumination is returned and the fog is reduced to the best visual acuity. This reduction in plus is usually 1.00 D for presbyopes. The patient is then instructed to look at the second row of letters (20/30). The axis of the correcting cylinder is then rapidly rotated away from its initial position. The patient is expected to report that the 20/20 line is now blurred. For cylinder powers less than 0.75 D, the axis may have to be rotated farther from the initial position for the patient to perceive a just noticeable difference. The axis is then slowly rotated back toward the initial position and the patient is asked to report when the 20/30 letters are clear again. The axis is then rotated in the opposite direction and returned toward the initial position with the same instructions. The midpoint of the recovery arc is the axis of the correcting cylinder. The complete procedure is then repeated on the other eye.

## THE JACKSON CROSS-CYLINDER

The Jackson cross-cylinder is generally used to refine the correcting cylinder which has been determined under fog. This test employs the use of a cross-cylinder which has a minus cylinder ground on one side and a plus cylinder ground on the other. Most phoropters are generally supplied with powers of either  $\pm 0.25D$ ,  $\pm 0.37D$  or  $\pm 0.50D$ . The axes of the cross-cylinder are 90 degrees apart. The plus power meridian is marked with a red dot or line and the minus power meridian is marked with a white dot or line. The cross-cylinder increases or decreases the Interval of Sturm without changing the spherical power. The circle of least confusion will also increase or decrease in size which allows subjective comparison of blur circles of different sizes. ( Figure-7 )

**FIGURE-7. ASTIGMATIC CHANGE CREATED WITH THE JACKSON CROSS CYLINDER**



(from Melvin Rubin M.D., OPTICS FOR CLINICIANS; pp 175, 1974.)

The test is performed at six meters following a subjective test which establishes a monocular best visual acuity. This procedure is necessary to insure that the circle of least confusion is on the retina in the event that there is any uncorrected astigmatism remaining after determining the cylinder under fog. The remainder of the discussion on this test will assume that the examiner is using a minus cylinder phoropter.

In order to refine the power of the correcting cylinder, the examiner directs the patients attention to a single line of letters larger than their best visual acuity. This is done because the cross-cylinder will blur the letters. If the acuity is 20/15 or 20/20, 20/40 letters should be used. The axes of the cross-cylinder placed parallel and perpendicular to the axis of the correcting cylinder. When the plus power of the cross-cylinder coincides with the strongest meridian of the eye the Interval of Sturm enlarges and when the plus power of the cross-cylinder coincides with the weakest meridian of the eye the Interval of Sturm shrinks (refer to Figure-7). If the patient prefers the letters with the plus power parallel to the correcting cylinder's axis, -0.25D cylinder is added. If the patient prefers the letters with the minus power parallel to the correcting cylinder's axis, a 0.25D of minus cylinder is removed. Subjective equality is the endpoint of the test.

It is essential that the spherical equivalent be maintained throughout the testing to insure that the circle of least confusion is on the retina. When 0.50D of cylinder is added or removed the sphere must be adjusted by 0.25D in the appropriate direction.

To refine the cylinder axis, the examiner rotates the cross-cylinder such that the correcting cylinder's axis bisects the two principle meridians of the cross-cylinder. In one position the resultant axis of the cross-cylinder and the correcting cylinder is moved in one direction, when

the cross-cylinder is flipped the resultant axis of the combination is moved an equal amount in the opposite direction. When the patient prefers the cross-cylinder in position one, the axis of the correcting cylinder is rotated toward the white dot or line. If the patient prefers the cross-cylinder in position two, the axis of the correcting cylinder is rotated toward the red dot or line. When the patient reports equality of the images, the axis has been determined. If an arc of equal responses is reported, the axis of the correcting cylinder should be placed at the midpoint of the arc.

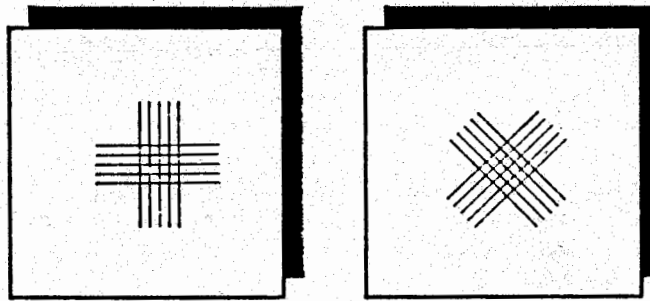
Borish, Allen, and Carter have all identified sources of error in testing with the Jackson cross-cylinder.<sup>1,3,4</sup> These sources include the following:

- A) Failure to start the test with the circle of least confusion on the retina.
- B) Failure to maintain the circle of least confusion on the retina during the testing.
- C) Incorrect speed of flipping.
- D) Failure to allow time for accommodation to hold the circle of least confusion on the retina.
- E) Failure to communicate:
  - 1.) Identification of the wrong position.
  - 2.) Misinterpretation of the instructions.

### THE PRATT NEAR CYLINDER TEST

The last astigmatic test used in this study was devised by C.B. Pratt of Pacific University. The target for the test consists of a cross grid chart with lines at 90 and 180 degrees on one side of the target and lines at 45 and 135 degrees on the other side. See Figure-8 on the following page.

**FIGURE-8. PRATT NEAR CYLINDER TARGET**



As described earlier, the torsional effects due to convergence can cause excyclorotation. Accommodation at near can cause an increase in the cylindrical power of the eye. These effects may be significant enough to require a change in the correcting cylinder power and axis for near. Therefore, the Pratt test is performed before the near cross-cylinder sequence to insure that the patient's responses are based solely on accommodation. The test is performed monocularly with the target placed on the midline at 40 centimeters. Standard near point illumination is used. The control lens is maximum plus to first legible 20/20 at distance with an additional 2.00D of plus, or the recovery lens from the maximum plus to blur at 40 centimeters.

To determine the cylinder power, the side of the card with lines that are most nearly parallel and perpendicular to the previously determined correcting cylinder axis is presented. The patient is instructed to report which set of lines are clearer or more distinct. If the darkest lines are perpendicular to the axis of the correcting cylinder, minus cylinder is added 0.25D at a time until equality or a reversal is reported. If the darkest lines are parallel to the correcting cylinder axis, minus cylinder is removed 0.25D at a time until equality is reported.

The cylinder axis is refined by presenting the opposite side of the card and instructing the patient again to report which set of lines are clearer and more distinct. The axis of the correcting cylinder is then



rotated until the opposite set of lines are darker. This step may need to be repeated to bracket the patients responses. The axis is set at the midpoint of the recovery arc.

## **PROCEDURE/METHODS**

In order to determine if the Preston test was a clinically sound assessment of the far point subjective cylinder and axis it was compared to an established far point test (Jackson cross-cylinder) and a near point cylinder test (Pratt near cylinder test). Twenty first year optometry students were selected at random ( N=80 since each subject was examined by two researchers). All subjects were between the ages of 20-35 years old. There were no restrictions on the magnitude of the refractive error of the subjects, however, a best corrected Snellen acuity of 20/20 far and near was required. Correction of the refractive error was by spectacles or soft contact lenses only. The following data was collected on each subject:

- A) Far and near Snellen acuities were taken through the habitual prescription to determine 20/20 acuity potential.
- B) Baseline refractive testing consisting of an MSBVA and clockdial were performed to establish a control lens.
- C) The Preston, Pratt, and Jackson cross-cylinder tests were then conducted by the standard clinical methods previously described. After each test the control sphere was returned and monocular acuities were taken at far and near.
- D) After each exam sequence the subjects were asked to rank the individual tests in the order which they felt was easiest to respond to. Space was also provided on the exam form for the subjects to write any additional comments on the tests.

## **EXPERIMENTAL DESIGN**

The study consisted of a within and between groups design. Since the subjects acted as their own control, they made up the within groups portion of the design. The result of this section was the determination of the absolute difference in the magnitudes of the cylinder axis and power of a given subject between the tests. This portion of the study also determined the ability of the Preston test to accurately predict the findings of the Jackson cross-cylinder test. The between groups design was composed of the investigators, the outcome of this section was interclinician variability.

The data is parametric with interval scaling. The dependent variables were the cylinder power and axis measured. The independent variables were the various astigmatic tests.

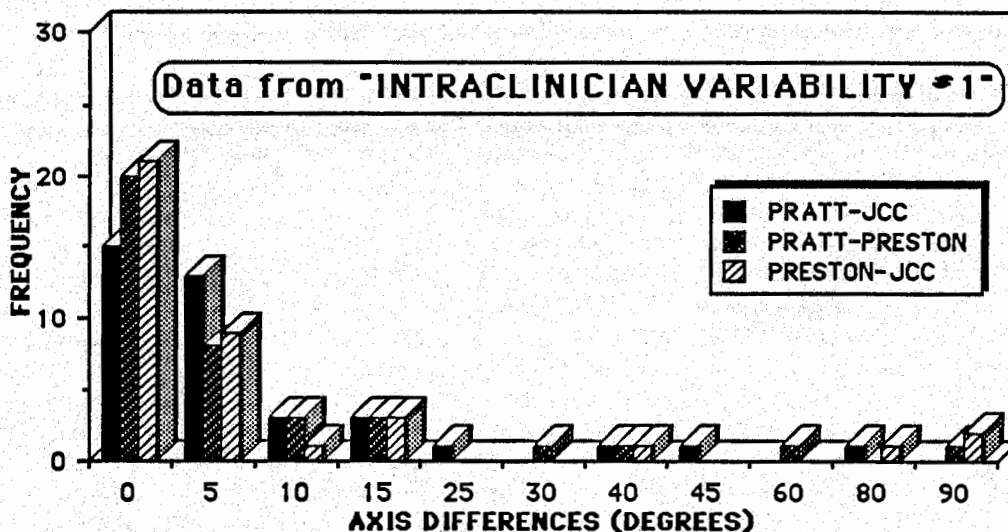
In an attempt to prevent bias, the population selected for the study was unfamiliar with the astigmatic tests. The tests were also presented in a different order by each investigator. Use of standardized instruction sets, illumination, and testing procedures were also employed. The investigators did not have access to the habitual prescription, retinoscopy findings, or keratometry readings.

## **RESULTS:**

A study done at Pacific University College of Optometry in 1984 compared the IVEX refraction system to traditional methods of refraction. It was pointed out in this study that the statistical evaluation of differences in cylinder axis found between the two methods was difficult. Numerical comparison of an axis of 5 degrees to an axis of 175 degrees produces a statistical variation of 170 degrees, while the clinical variation is only 10 degrees. Consequently, a frequency histogram was prepared to analyze the axis differences.<sup>10</sup>

The analysis of the cylinder axis results in our study was done in the same manner. Frequency histograms were prepared to compare the axis differences between the tests performed by the same examiner (intraclinician variability). In addition, another histogram was prepared to analyze the axis differences found on the same tests performed by a different examiner (interclinician variability). All histograms indicate that the majority of axis differences fell between 0 and 10 degrees.

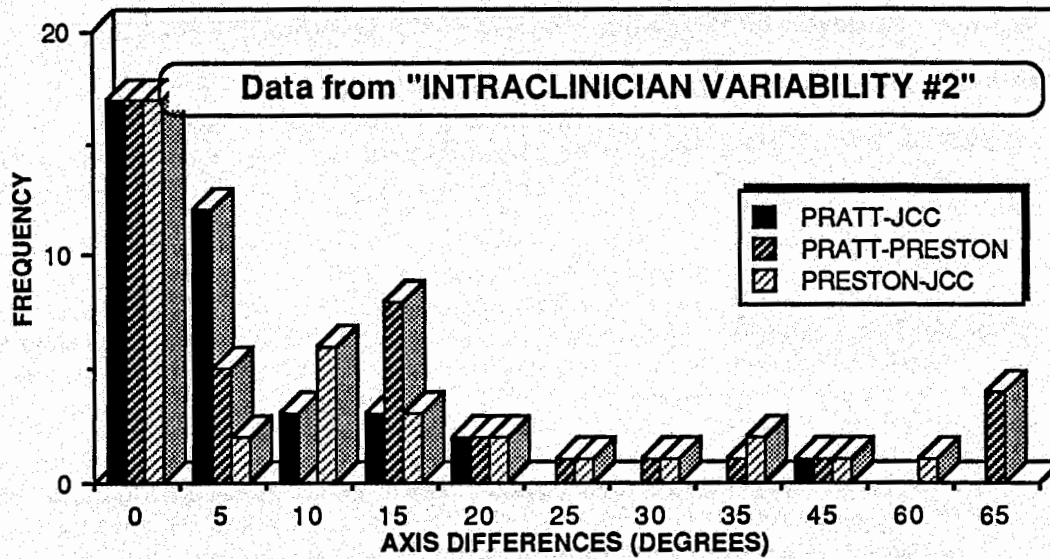
HISTOGRAM #1



In histogram #1, there were nine instances where the Pratt axis varied greater than 10 degrees from the Preston axis; seven instances where the JCC axis varied greater than 10 degrees from the Preston axis; and eight instances where the Pratt axis varied greater than 10 degrees from the JCC axis. There was no case where the axis differences were greater than 30 degrees for a cylinder power of 1.00 diopter or greater.

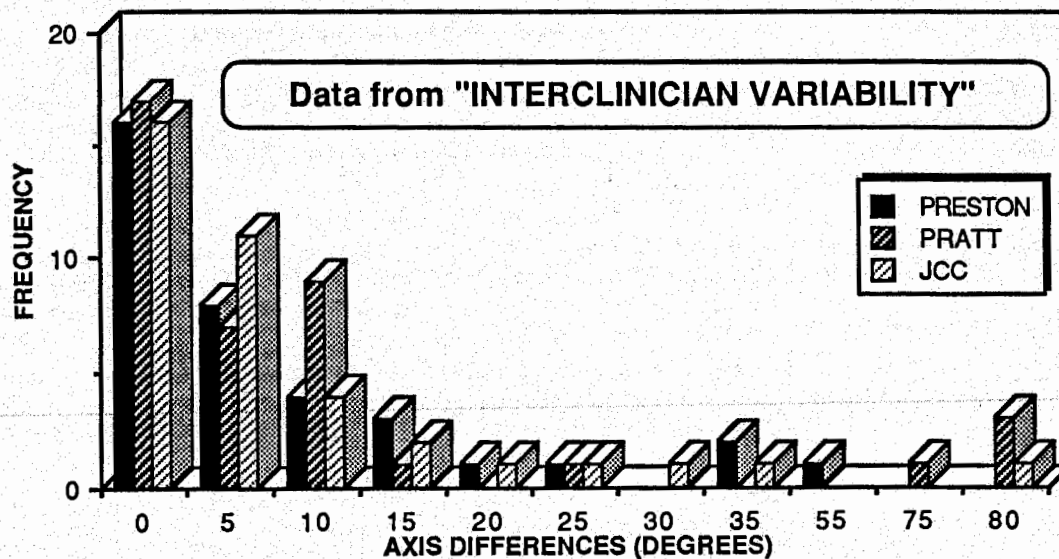


## HISTOGRAM #2



In histogram #2, there were fifteen instances where the Pratt axis varied greater than 10 degrees from the Preston axis; eleven instances where the JCC axis varied greater than 10 degrees from the Preston axis; and six instances where the JCC axis varied greater than 10 degrees from the Pratt axis. There was no case where the axis differences were greater than 15 degrees for cylinder powers of 0.75 diopter or greater.

## HISTOGRAM #3



In histogram #3, there were five instances where the Pratt axis varied greater than 10 degrees between the examiners; nine instances

where the JCC axis varied greater than 10 degrees between the examiners; and eight instances where the Preston axis varied greater than 10 degrees between the examiners. There was no case where the axis differences were greater than 10 degrees for a cylinder power of 1.00 diopter or greater.

An overview of histograms one and two indicates that the largest variations in cylinder axis were found when the Pratt test was compared to the Preston test. In addition, histogram three shows that the largest disparity between a single test performed by a separate examiner was found with the Pratt test. The axis differences were no greater than expected: lower cylinder powers tended to show more axis variation from one test to another and from one examiner to the other.

The analysis of the cylinder power data was done by first reviewing interclinician variability. A linear regression was done on each set of tests performed by the respective examiners. An "r" value of .80 was predetermined as a statistically significant level to pool both the examiners data together. If the "r" values had been less than .80 the study would have been invalidated because; (1) the two examiners were inconsistent, (2) the tests were not measuring what they were designed for, (3) the subject variability was too great. The "r" values calculated are shown in Table-2 below.

**TABLE-2. COEFFICIENTS OF CORRELATION**

PRESTON.....	0.896
JCC.....	0.892
PRATT.....	0.876

Each examiners data was then pooled together to establish a mean value for each of the three tests. See Table-3 on the following page.

**TABLE-3. MEAN DIOPTRIC VALUES**

PRESTON.....	0.531D
JCC.....	0.584D
PRATT.....	0.637D

A repeated measures analysis of variance (ANOVA) was then performed across the groups of tests to determine if there was a significant variation between mean values of the tests. The values for the Scheffe F-test are given in Table-4 below:

**TABLE-4. SCHEFFE F-TEST**

JCC-MEAN vs. PRATT-MEAN.....	1.361
JCC-MEAN vs. PRESTON-MEAN.....	1.361
PRATT-MEAN vs. PRESTON-MEAN.....	5.442

These values were significant to the .02 level. These variations indicate that the Pratt test and the Preston test are not measuring the same magnitudes of cylinder power. The comparison of the JCC mean to the Pratt and Preston mean indicates that these tests are consistently measuring the same magnitudes of cylinder power.

Even though the difference between the Pratt and Preston means are statistically significant, a 0.12D difference is not clinically significant.

In addition, there was no case where the final visual acuities differed by more than a few letters from test to test for a given eye. There was also no overwhelming subject preference for any of the tests given.

## **CONCLUSIONS:**

This study found that the Preston technique can be used in place of the Jackson cross cylinder to determine the far point subjective cylinder and axis. There was no statistically significant or clinically significant difference between the means of these two tests. The clinical difference between the Jackson cross cylinder and the Preston technique was on the order of 0.053D, with the Preston technique yielding slightly less minus cylinder power.

A statistically significant difference was found when the Pratt mean was compared to the Preston mean. However, the difference between the mean values of these two tests was on the order of 0.12D which is clinically insignificant. There was no statistically or clinically significant difference between the mean values of the Pratt and Jackson cross cylinder tests. The clinical difference was on the order of 0.053D, with the Pratt test yielding slightly more minus cylinder power.

It is interesting to note that from a clinical standpoint all three of the tests yielded essentially the same magnitudes of cylinder power for a given subject. The Pratt near cylinder test was selected as part of the study because we felt the need to differentiate the results of the Preston test from a test designed specifically for the same task distance which measures the near point cylinder and axis changes previously described. In retrospect, the selection of the Pratt test was not an auspicious choice since it does not allow binocular viewing of the target.

A more appropriate choice for a near point comparison test would have

been the binocular clock dial on the Mallet Box or a Humphriss modification of the Pratt test in which the nonfixating eye's central vision is suspended by a +0.75D fogging lens. Future research should focus on these points as well as the use of the Humphriss technique with the Preston target.

In summary, the Preston test is easy to perform, it's procedural aspects being quite similar to the conventional clockdial test. While a period of time was necessary to become familiar with the Preston target and instructional set, with practice the technique is time efficient and easily understood by the patient. The target can also be used to collect additional data such as maximum plus (NRA) and minus (PRA) to blur.



## BIBLIOGRAPHY

- 1.) Allen, M.J. "Cylinder Axis and Power Determination in Refraction." Journal of the American Optometric Association., 30:394. 1959.
- 2.) Bannon, R.E. and Walsh, R. "Astigmatism." Archives of the American Academy of Optometry., 22:162;210:263., 1945.
- 3.) Borish, I.M. "Clinical Refraction." The Professional Press Inc., Chicago Illinois, Third Edition, 1970.
- 4.) Carter, D.H. "Sensitivity Variations in the Jackson Crossed Cylinder Axis Test." Optometric Weekly, 575 (28):29.
- 5.) Collins, R. and Oberhelman, B. "Astigmatic Axis Changes Due to Convergence." Doctoral Thesis. Pacific University College of Optometry, Forest Grove, Oregon. May 1975.
- 6.) Duke-Elder, W.S. "Textbook of Ophthalmology." Vol. 4, C.V. Mosby Co., St. Louis, Missouri. 1949.
- 7.) Grosvenor, Theodore P., O.D., Ph.D., "Primary Care Optometry: A Clinical Manual." The Professional Press Inc., Chicago, Illinois, First Edition. 1982.
- 8.) Hofstetter, H.W. "The Correction of Astigmatism for Near Work." Archives of the American Academy of Optometry., 22:121. 1945.
- 9.) Lyle, W.M. American Journal of Optometry. Vol. 48: pp467-468, 1971.
- 10.) Marton, H.B. "Astigmatism." Reprint from Optical Developments. May 1942.
- 11.) Roggenkamp, J.R. et al "The IVEX Refraction System: A Clinical Comparison." Journal of the American Optometric Association., 56/7:532-536. 1985.
- 12.) Rubin, Melvin M.D. "Optics for Clinicians." Triad Publishing Co., Gainesville, Florida. Second Edition, 1974.
- 13.) Scobee, R.G. "Oculorotary Muscles." C.V. Mosby Co. St. Louis, Missouri. 1947.

14.) Sheard, C. "Ophthalmometry and It's Application to Ocular Refraction and Eye Examination." American Journal of Physiological Optics., 1:357, 1920.