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Abstract

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A Comparison of the
Different Anisometric Testing Procedures
as done at Pacific University

A Sixth Year Thesis
Presented to the Faculty
of the College of Optometry
Pacific University

In Partial Fulfillment
of the Requirements for the Degree
Doctor of Optometry

by

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INTRODUCTION

In any standard clinical battery of tests one makes several anisometropic measurements. These measurements often show different magnitudes of anisometropia. The purpose of this thesis is to determine which of the anisometropic findings are more valid, the variability of the findings, and how well a particular anisometropic test compares to the "true anisometropia". To do this we first measured the anisometropia using the following procedures:

1. 21 monocular
2. 14A complex
3. 20/40 equalization
4. 20/25 recovery
5. Red-green bichrome with plus and minus presets
6. 7 cross-cylinder complex

An average of the different anisometropic findings was taken and this we labeled the "true anisometropia". The difference between this "true anisometropia" and each individual anisometropic finding was calculated to determine which aniso test compared closest to the true anisometropia.

The subject population for this thesis, consisting of 100, was drawn from the optometric student body of Pacific University. The ages of subjects ranged from 19 to 50 with the predominance of subjects in the early 20's.

The procedures were carried out in the optometric clinic at Pacific University with the use of a Bausch and

Lomb phoropter with $\pm.50$ cross cylinders and an American Optical projector and slide series. The near point testing was done under standard room illumination combined with a standard near point lamp. The far procedures, with the exception of the red-green bichrome test, were done in standard room illumination without the standard near point lamp. The bichrome test was done in the dark.

The procedures were chosen from the standard anisometric tests generally in use at Pacific University. A detailed description is given under the general heading of procedures.

PROCEDURES

The following is a description of the procedures used and the sequence in which they were administered.

Preliminary Astigmatic Correction

The subject was blurred up monocularly with plus until no letters of the 20/20 line were visible on the reduced Snellen at 16 inches, plus was then reduced until the 20/20 line was clear. The lens value was recorded for each eye. Next, a vertical-horizontal cross grid was introduced monocularly and the subject was asked whether the vertical or horizontal lines were blacker. If the vertical lines were blacker the axis was turned to 180 degrees and if the horizontal lines were called blacker the axis was turned to 90 degrees. Minus cylinder was then added until reversal, keeping the sphere equivalent. Next, a 45-135 cross-grid was used and the axis was rocked until both axes of the cross-grid were equally black. The cylinder power was again checked with the vertical-horizontal cross grid adding cylinder or decreasing cylinder until both the vertical-horizontal were equally black. The cylinder power and axis was then recorded and maintained throughout the battery of tests.

21 Monocular

This procedure was done monocularly, adding plus spheres in plus .25 diopter steps over one eye with the

other eye occluded. The target used was the 20/20 line on the reduced Snellen chart at 16 inches. Plus spheres were added .75 diopters above the point at which the subject was unable to call any of the 20/20 letters. Next, the plus was reduced in .25 diopter steps until the point at which the subject was able to call all the letters in the 20/20 line. This was recorded as the 21 monocular finding. This procedure was done first on the right and then on the left eye.

14A Complex

The 14A complex was done in a slightly different manner than is generally done in clinic. The target used was the normal nearpoint cross-grid set at 16 inches; one with the lines orientated at 90-180 and another with the lines orientated at 45-135. The subject was initially preset from the plus side as the 21 monocular had just been done. Initially, the vertical-horizontal grid was used with the red axis of the cross cylinder at 90 degrees. Plus was alternately reduced to reversal before each eye, the midpoint of each measurement was taken as the finding. Then a minus preset was used (-.75 diopter below previous reversal) again with the red axis at 90 degrees. Plus was added until reversal, again the midpoint finding being recorded. This procedure was repeated except with red axis at 180 degrees from both a plus preset and a minus

preset.

Next the same procedure was done with the cross-grid at 45-135 with the red axis of the cross cylinder first at 45 degrees, then 135 degrees.

20/40 Equalization

This procedure was done at far. A single line of 20/40 Snellen letters was projected at 20 feet and plus was reduced binocularly, with one eye occluded. When the subject was first able to call 2/3 of the letters in the 20/40 line, 3 prism diopters base up over the right eye and 3 prism diopters base down over the left eye was introduced with rotary prisms on the phoropter. The occluded eye was then uncovered, presenting a dissociated 20/40 line to the subject. The subject was then asked to compare the two rows of letters. Plus spheres were added over the eye which saw the letters clearest until the two rows were as equally blurred as possible. This finding was recorded as the 20/40 equalization finding.

20/25 Recovery

Beginning with a plus preset at far from 20/40 fog, monocular occlusion was used adding minus until a clear 20/25 row of letters could be seen. The lens value for a clear monocular 20/25 was then recorded.

Red-green bichrome

A plus preset was used at first with alternating occlusion until first green was called. The midpoint between the last red and first green was recorded. Next $-.50$ below the reversal was added for a minus preset and again alternate occlusion was used until the first red call. The midpoint between the last green and first red was recorded. The illumination was complete darkness.

7 Cross-cylinder

The 7cc was done at far with the following cross cylinder settings: minus or red axis at 90 degrees, 180 degrees, 45 degrees, and 135 degrees. The target used was the diamond on the American Optical projector. The vertical and horizontal lines were isolated when the red axis of the cross cylinder was set at 90 degrees and 180 degrees. The 45 degree and 135 degree lines were isolated when the red axis of the cross cylinder coincided with these two settings. Each of the above settings was done from a plus and minus preset. A plus $.75$ diopters was added to the 7 red-green finding and this was alternately reduced until a reversal was found. Then a minus $.75$ diopters was added below this reversal and plus lenses were added alternately until a second reversal was determined. The recorded finding for each of these was a mid-point between the original dark set of lines and the darkest lines after reversal for each eye.

Because of the nature of the 14A, 7CC, and 7RG, which depend on a reversal response it was necessary to use the mid-point of the finding for each eye. This mid-point was determined to be the dioptric value between the last initial response and the first reversal response. For example, on the 14A complex the last vertical response with a plus 1.00 D. in the phoropter was that the up and down lines were darker. The first reversal response of the horizontal lines being darker occurred with a plus .75 in the phoropter. The recorded finding would be plus .87 diopters. Also, if the patient response went from vertical darker, then to equal, to horizontal darker, the finding recorded was the "equal" response.

DISCUSSION

The 21 monocular was done as described in the procedure section. The anisometropia was computed by subtracting the dioptric value of the left eye from the dioptric value of the right eye. This method of subtraction was used throughout the computations to maintain a constant sign convention. A minus would indicate that the left eye is more plus than the right eye. The opposite would be true for a plus sign. The 14A complex was divided up into four parts, consisting of two plus presets and two minus presets. The anisometric findings which were obtained from the 14A plus preset at 90 degrees and the anisometric findings obtained in the 14A plus preset at 180 degrees were averaged. This was also done for the 14A minus preset at 90 degrees and 180 degrees, 14A plus preset at 45 and 135 degrees, and 14A minus preset at 45 and 135 degrees.

The 20/40 and 20/25 anisometropia were computed by subtracting the dioptric value of the left eye from the dioptric value of the right eye.

The 7rg procedure was done in two parts consisting of a plus preset and a minus preset. Again the anisometropia was directly determined by the difference between the right and left eyes for each preset.

The final anisometric finding was taken from the 7cc

complex. This was computed in the same way as the 14A complex. That is, the anisometric finding of the 7cc plus preset at 90 degrees was averaged with the 7cc plus preset at 180 degrees, the minus 7cc at 90 degrees with the minus 7cc at 180 degrees, the plus 7cc at 45 degrees with the plus 7cc at 135 degrees, and finally the 7cc minus preset at 45 degrees with the minus 7cc at 135 degrees.

The aniso determined from each of the tests was averaged together and this value was taken to be the true anisometropia for the subject. The true aniso was subtracted from the aniso of each anisometric test to determine how far each test deviated from this "true" finding.

A sign convention was used to relate whether the anisometropia found on a particular test was more or less than the true aniso found. Therefore, since the true aniso was subtracted from each finding for a particular subject a plus sign indicated that the true aniso was less plus or more minus, than the aniso for that finding. A minus sign indicated that the true aniso was greater plus or less minus, than the aniso for that finding.

This value for each of the 13 tests was recorded for each subject. For example, the 21 monocular for each individual composed one set of data. Once the 13 sets of data were compiled the mean, standard deviation, variance and t-test were computed with the aid of the P.U. computer.

RESULTS

Graph I is an illustration of the relative standard deviation of the thirteen anisometric tests. With the exception of the #21 monocular test, the other twelve procedures were within .05 standard deviation of each other, ranging from .158 D. to .209 D. The #21 monocular had a standard deviation of .282 D. which was .072 D. standard deviation from the -7RG, which was the next closest test. Although the #21 monocular standard deviation showed the greatest value, .28 D. is still not too large.

Graph II shows the relative values of the variance of the thirteen anisometric tests. These values are directly related to the standard deviation in that the standard deviation is the square root of the variance. Therefore, the graph shows the same relative positions of the thirteen tests.

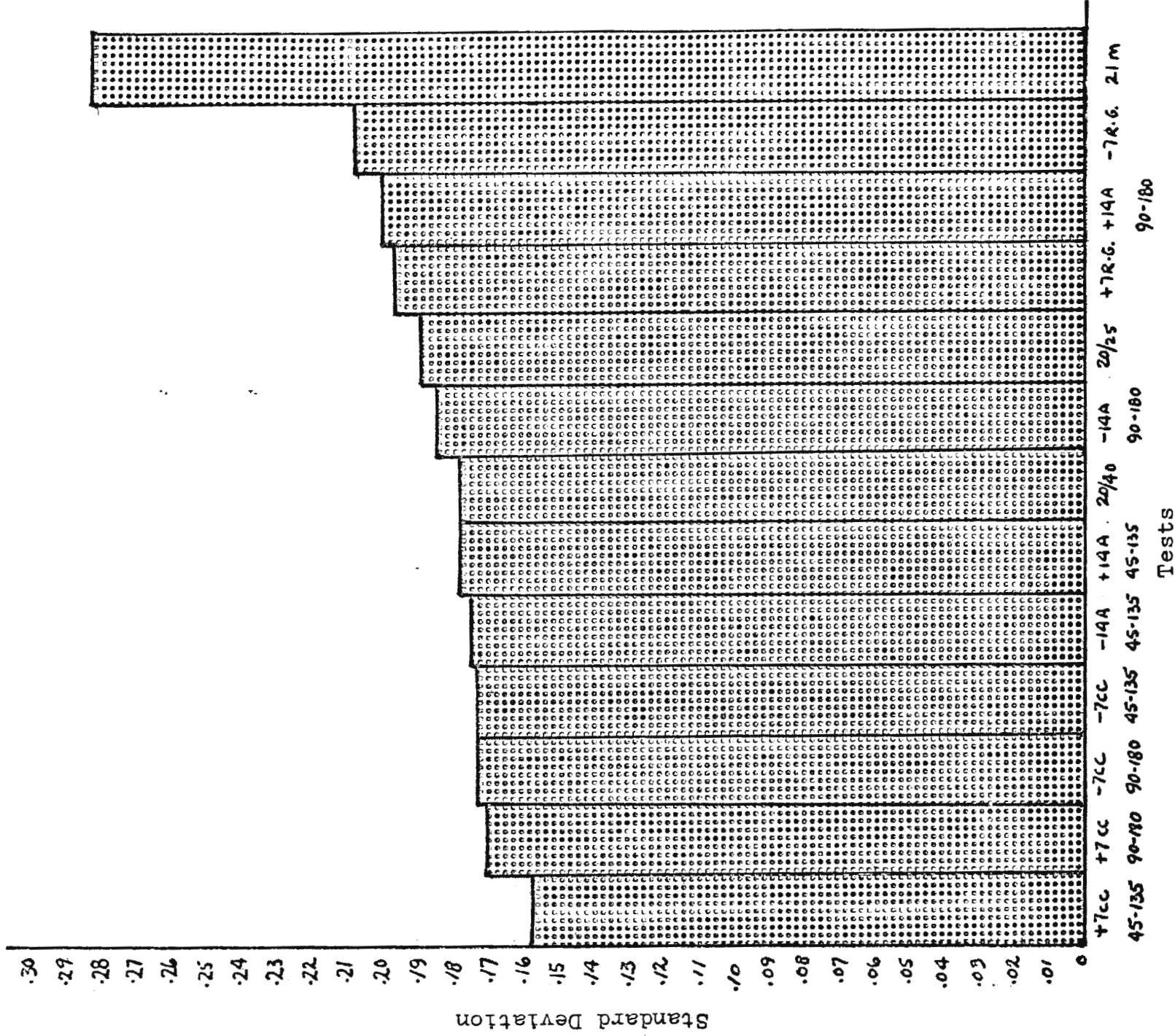
Graph III illustrates the relative t-test values of the thirteen tests. For our study we chose a significance level of .05. The t-test value for this significance level and with a population of 100 was 1.64. Therefore, any t-test value greater than 1.64 is considered to be a significant deviation. As can be seen on the graph, only three tests fall into this category-the 21 monocular, -14A @90°-180°, and -7CC @ 90°-180°. A plus sign on the t-test

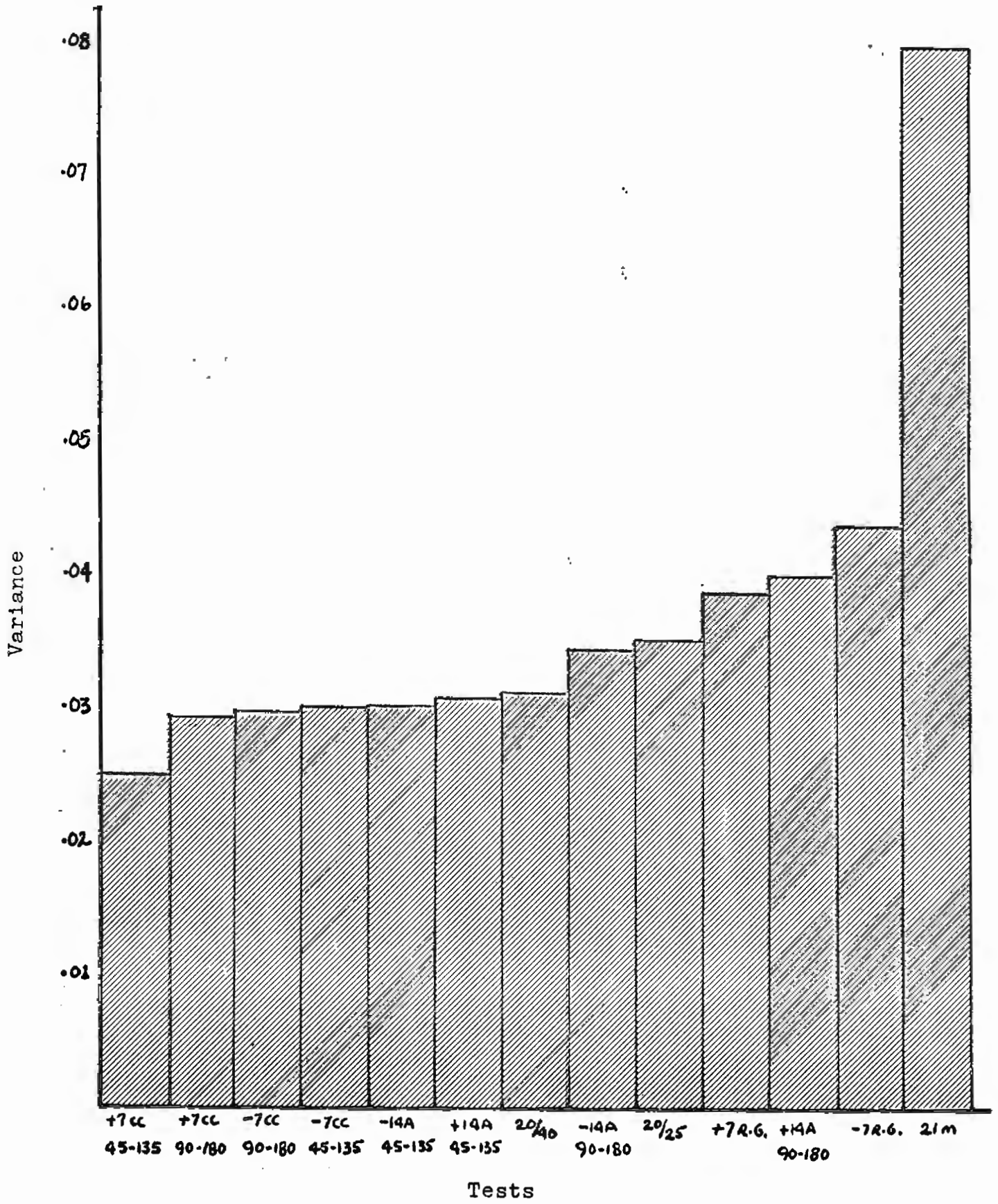
indicates that that aniso test, on the average, showed more plus, or less minus, than the "true aniso". A minus sign indicates that that particular test showed less plus, or more minus, than the "true aniso". Naturally, the closer the t-test value is to zero the closer the mean of a particular aniso test corresponds to the "true aniso".

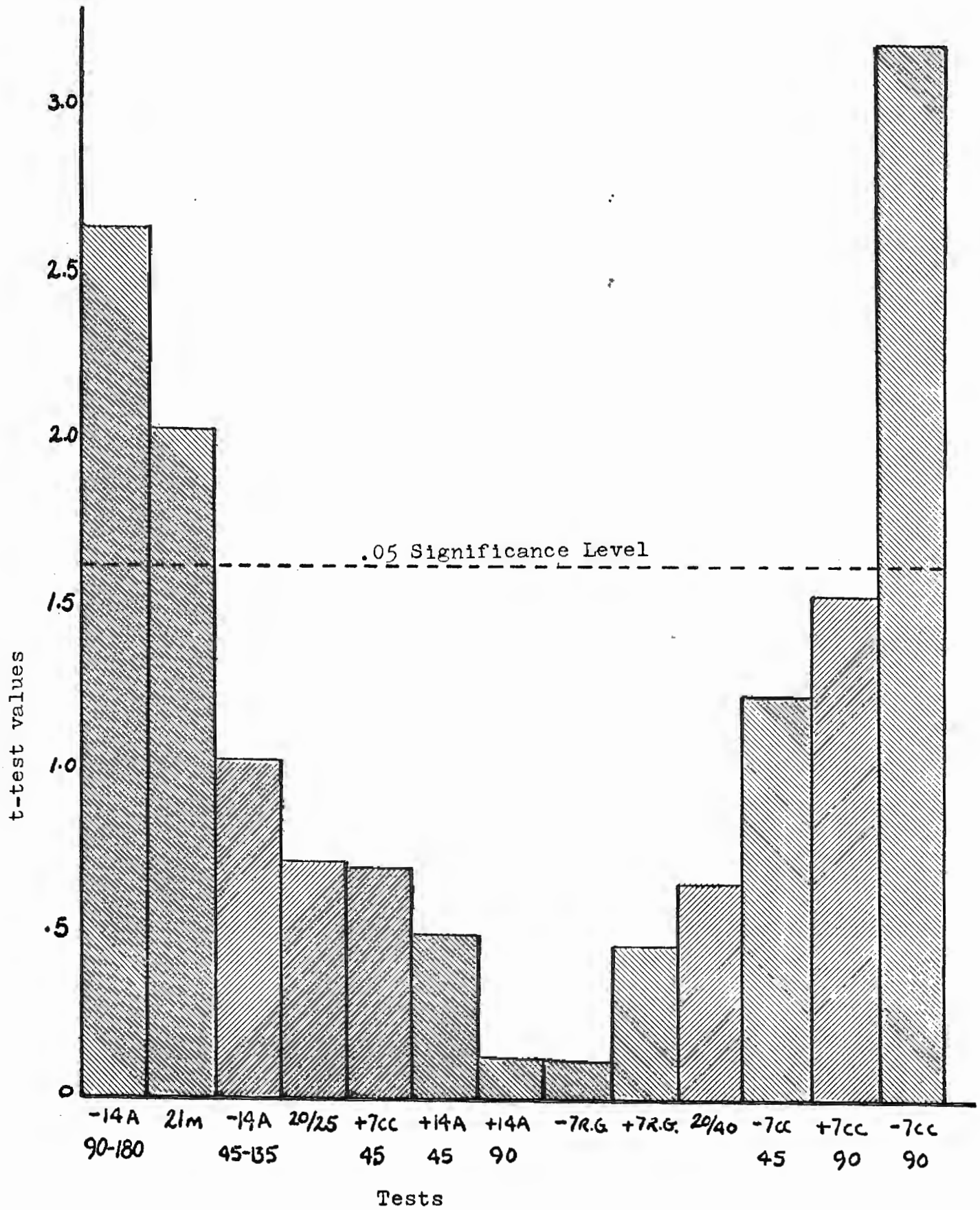
Graph IV shows the distribution of the subjects according to their anisometropia. The bulk of the subjects had less than .50 diopters of anisometropia.

Graph V shows a distribution of the standard deviations. As one can see, most of the standard deviations fell within a range of .16 diopter to .18 diopters.

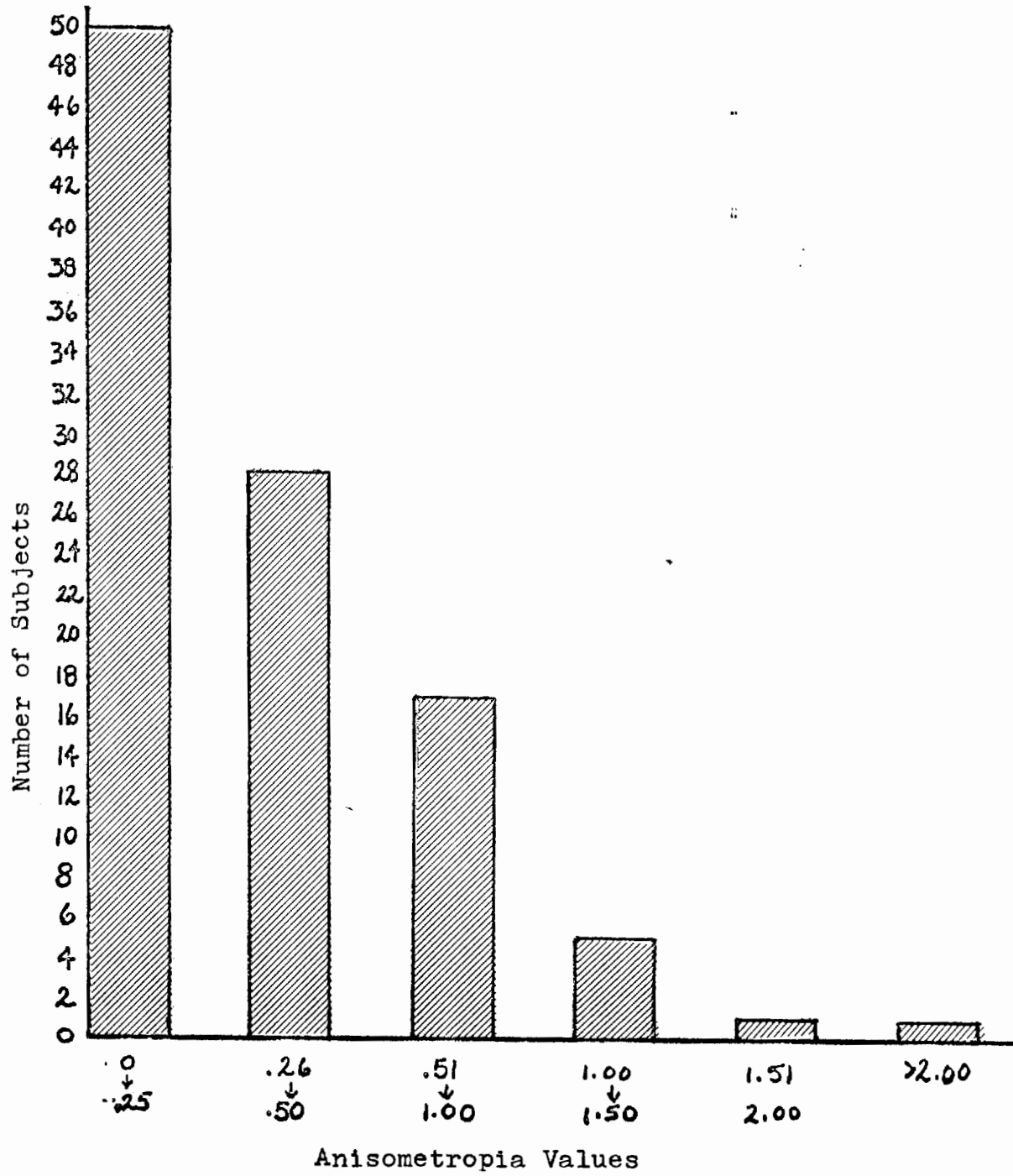
Graph I: Relative Standard Deviation



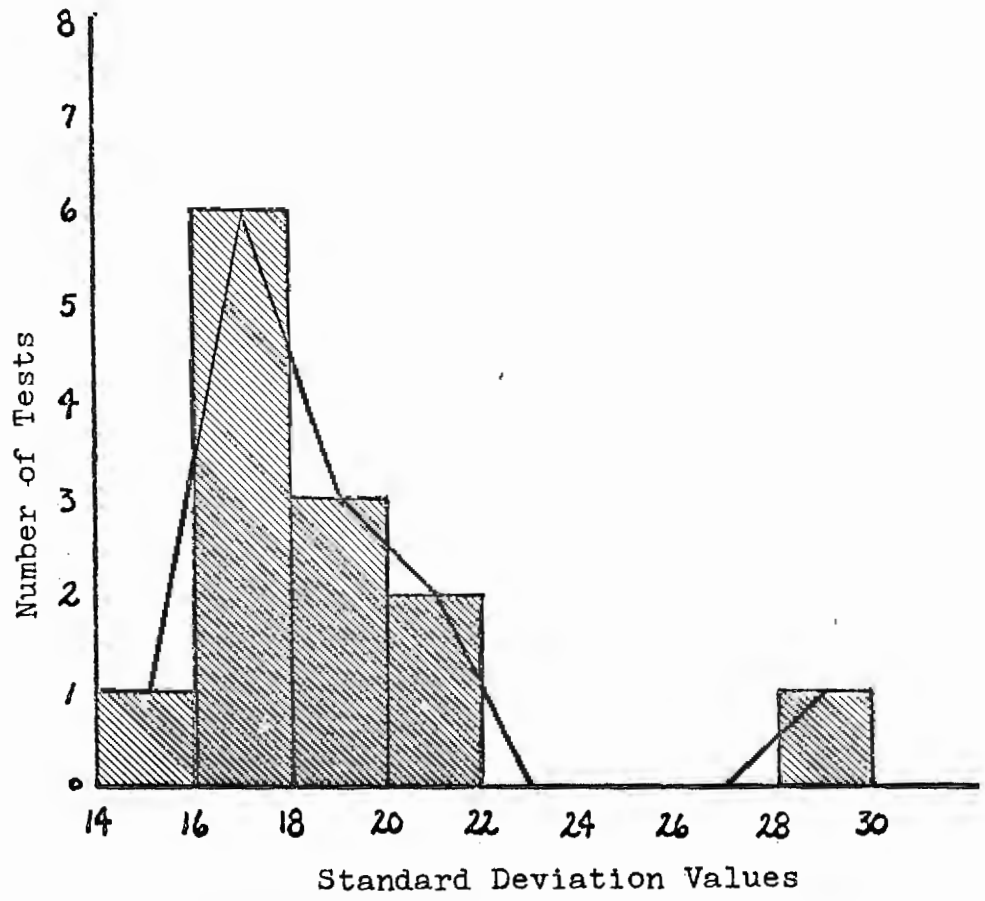




Graph IV: Distribution of Anisometropia



Graph V: Distribution of Standard Deviation Values



CONCLUSION

In picking our subjects we did not set a minimum amount of anisometropia as a criterion. As graph IV showed, the majority of our population had less than .50 diopter of anisometropia. Therefore, we feel that this could have had an influence on our results.

Looking at the tests from a mathematical viewpoint the following conclusions can be made. There are 10 tests, according to the t-test values, that give reliable results in testing for anisometropia. These tests are the 20/25, 7cc at 45-135, 14A at 45-135, 14A at 90-180, -7rg, +7rg, 20/40, -14A at 45-135, -7cc at 45-135, and 7cc at 90-180. Finally, there are three tests that, according to the t-test, are significantly different from the "true anisometropia". They are the 21 monocular, -7cc at 90-180, and the -14A at 90-180.

In looking at the variance in each test, all the tests with the exception of the 21 monocular were essentially equal. The 21 monocular had a variance of .08D which was nearly double that of the next nearest test. This large difference could possibly be attributed to the method in which the test was administered. A subsequent thesis could be done to investigate if this difference is due to technique or is inherent in the test itself. Perhaps an alternate occlusion technique could be compared to the

technique we used.

As has been shown mathematically, some of the tests have been shown to be significantly different from the true anisometropia. However, when one evaluates the data from a clinical standpoint, the results are seen in a different light. When looking at the test which showed the greatest deviation, according to the t-test, from the true anisometropia it is evident that this value is still outside the measureable limits of the clinical instrumentation. The t-test being directly related to the means indicates which tests deviate significantly from the true aniso. In looking at the -7cc at 90-180 which showed the greatest t-test value and therefore the greatest deviation from the true aniso, the average amount by which this test differed from the true aniso was .056D. Therefore the test which showed the greatest significant deviation from a mathematical viewpoint, is seen to deviate by a value that is below the measureable limits of the clinical phoropter.

Our results show that no one test can be considered to give "the" anisometropia of a particular subject. It is suggested that a number of anisometric tests be administered and the results compared. If the results are similar the anisometropia is easily determined, but if one test deviates significantly from the others, that test should be ignored.