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The correlation of the gross opthalmometer anisometropia with the best far point acuity lens (O.E.P. #7A) anisometropia

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Abstract

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THE CORRELATION OF THE GROSS OPTHALMOMETER ANISOMETROPIA WITH THE BEST FAR POINT ACUITY LENS (O.E.P. #7A) ANISOMETROPIA

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by

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INTRODUCTION

ABSTRACT

Throughout the optometric examination, the examiner strives to obtain consistent findings, i.e., of the cylinder power, cylinder axis and also of the anisometropia of the subjective acuity lenses and objective findings.

The experimentors wish to show that the correlation between the far point subjective spherical equivalent anisometropia and the anisometropia of the average of the two principal meridians of the corneal power as determined by ophthalmometry is not high enough to be a check of internal consistency of the optometric analysis.

STATEMENT OF PROBLEM

There are certain tests that allow the clinician to check his findings, one against the other. Several varifications for anisometropia are Static Retinoscopy, Dynamic Retinoscopy, Red-Green, 20/40 Equalization, Dissociate Cross-Cylinder and Positive and Negative Relative Accommodation (monocularly). Just as the ophthalmometer findings are an attempt to correlate the dioptric difference in curvature of the two principal meridians of the anterior surface of the cornea with the total astigmatism of the eye ascertained by subjective measurements, it is our intention to validate that the anisometropia of the spherical equivalent of #2 does not have a significant correlation with that of the anisometropia of the spherical equivalent of #7A.

EXPERIMENTAL CONTROLS

The following limitations were incorporated to achieve maximum reliability of findings and it was agreed upon to exclude the following conditions:

1) Any evidence of Ocular Pathology.
2) Cases manifesting Strabismus.
3) Cases manifesting Amblyopia.
4) Habitual contact lens wearers.
5) Ages below 20 years and above 35 years.
6) Cases manifesting refractive error greater than plus and minus 4.00 diopters.

METHOD

This experiment employed the testing of 102 subjects. Each subject was examined to determine their best far-point subjective acuity lens (#7A) and ophthalmometer (#2) readings. Fifty-two of the subjects were males and fifty of the subjects were females.

The procedure for best far-point subjective acuity lens (#7A) was as follows:

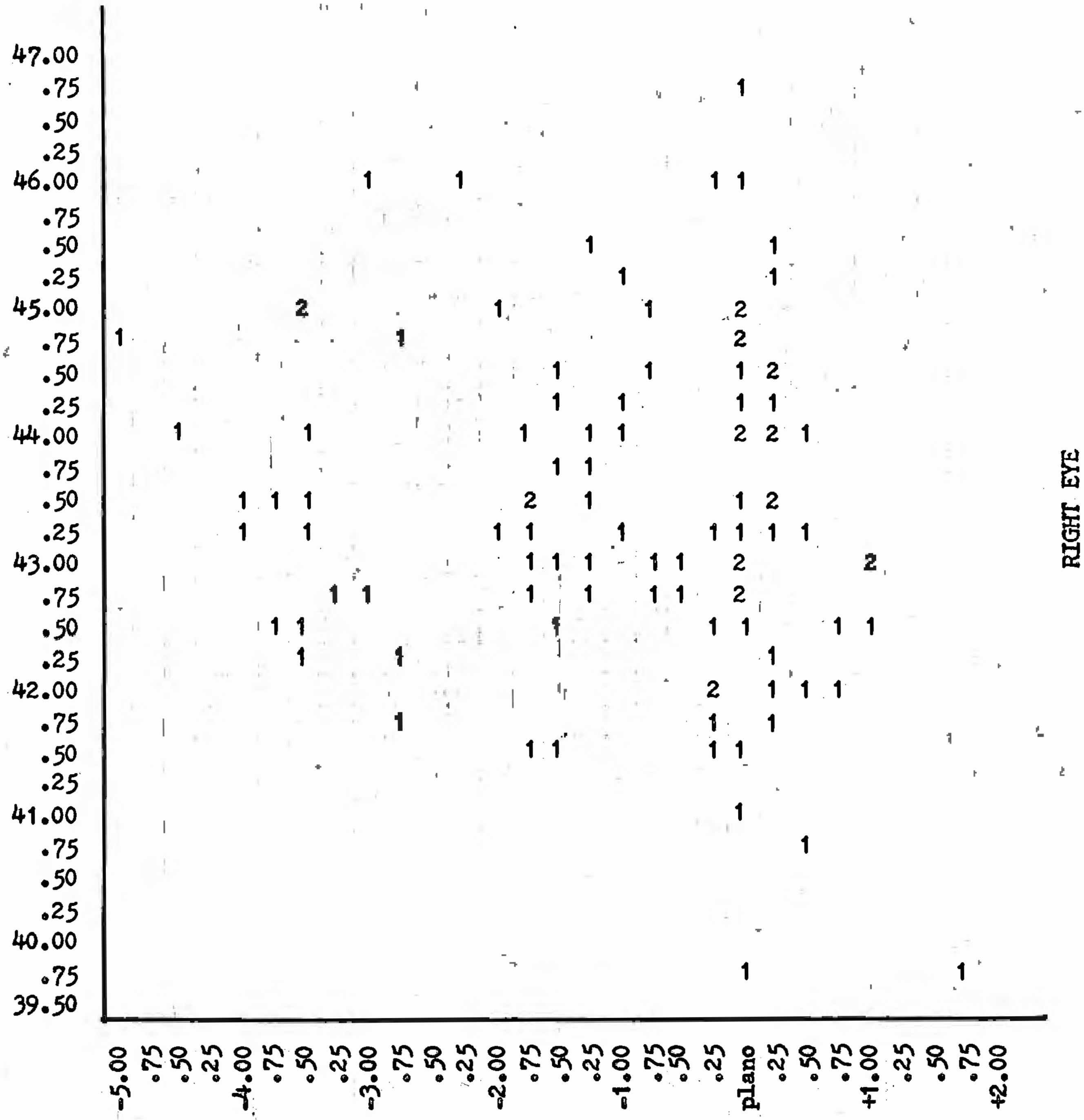
Enough plus was placed in the phoropter before both eyes so that the subject was unable to read with either eye the letters smaller than 20/50 at 20 feet. Plus was decreased until the subject could just distinguish the 20/30 line. The astigmatic clock dial was brought into view and the subject asked to determine monocularly which, if any, of the lines appeared the blackest and most distinct. If the subject reported any set of lines appearing blackest and most distinct, minus cylinders were added with the axis opposite to the blackest line until all the lines appeared equally black. The same procedure was repeated for the left eye. Illumination of the examining room was then reduced to 2 ft. cdles and a Red-Green 20/40 line of letters projected. The subject was requested to report which set of letters appeared to be blackest and most distinct, either in the Red of the Green. Plus was reduced until both sets of letters appeared equal. Illumination was then increased to standard level, and a 20/40 set of letters projected. The Jackson Cross Cylinder was introduced before the right eye and left eye alternately for a refinement of axis and power of cylinder. The subject was blurred in plus so that the 20/40 letters were just readable. At this time the Risley prisms were adjusted before each eye, 3 prism diopters base-up O.D. and 3 prism diopters base-down O.S., so as to determine a 20/40 equality. A 20/20 Snellen line was projected and plus was reduced until the subject could read this line. A 20/20 equalization was determined. A 20/15 Snellen line was projected and plus lenses reduced until best visual acuity was obtained.

The procedure for ophthalmometry (#2) was as follows: The keratometer was calibrated to 42.50 diopters by using a 5/8" bright steel ball and readings from each subject were taken and recorded in the sequence O.D., O.S., three times each and then averaged.

For each subject, the spherical equivalent of each eye was calculated, both for ophthalmometry and the best visual acuity formula. The anisometropia was then calculated from the spherical equivalent of the ophthalmometry and best visual acuity formula.

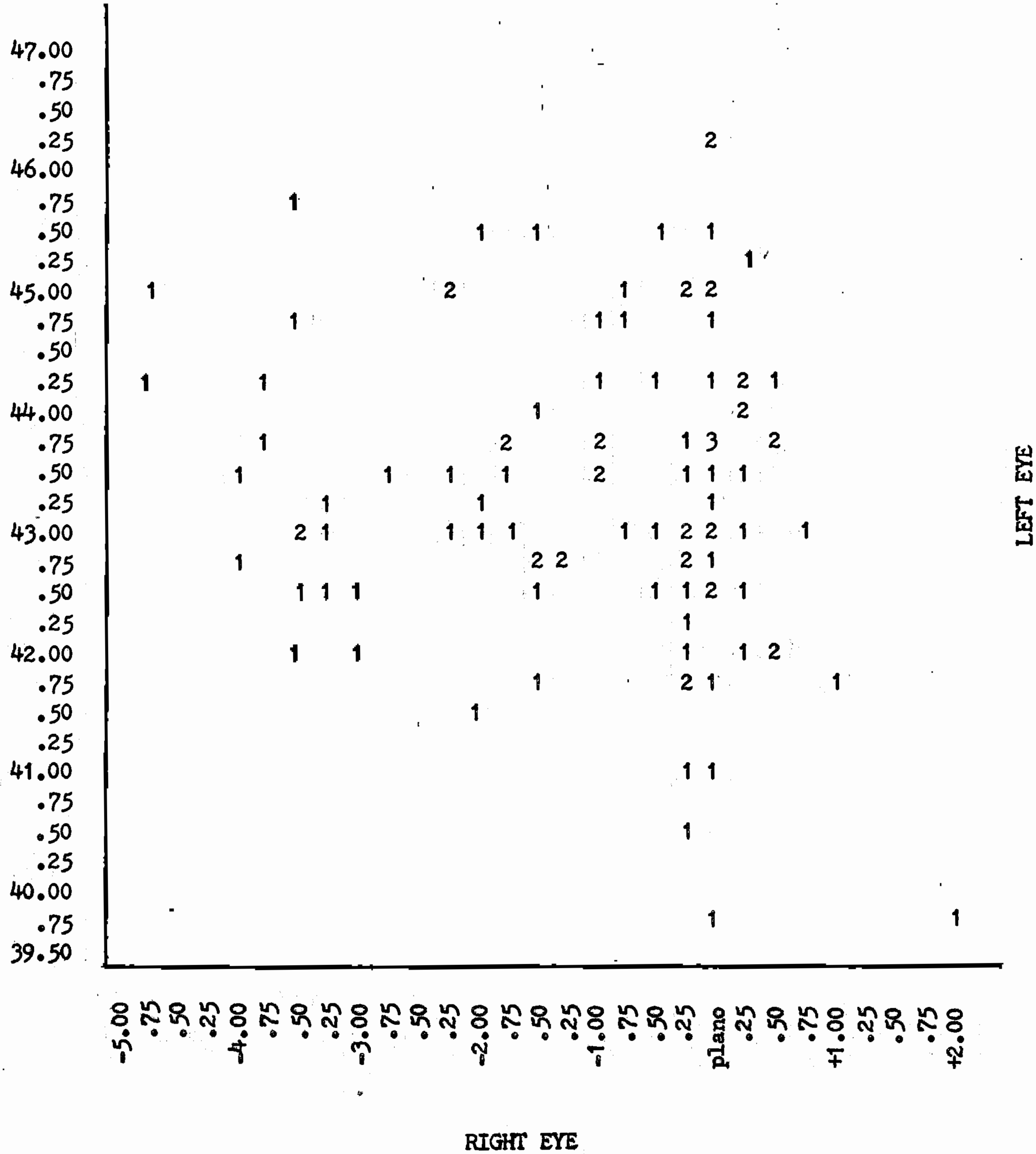
GRAPH 1

CORRELATION OF OS #7A AND OS #2



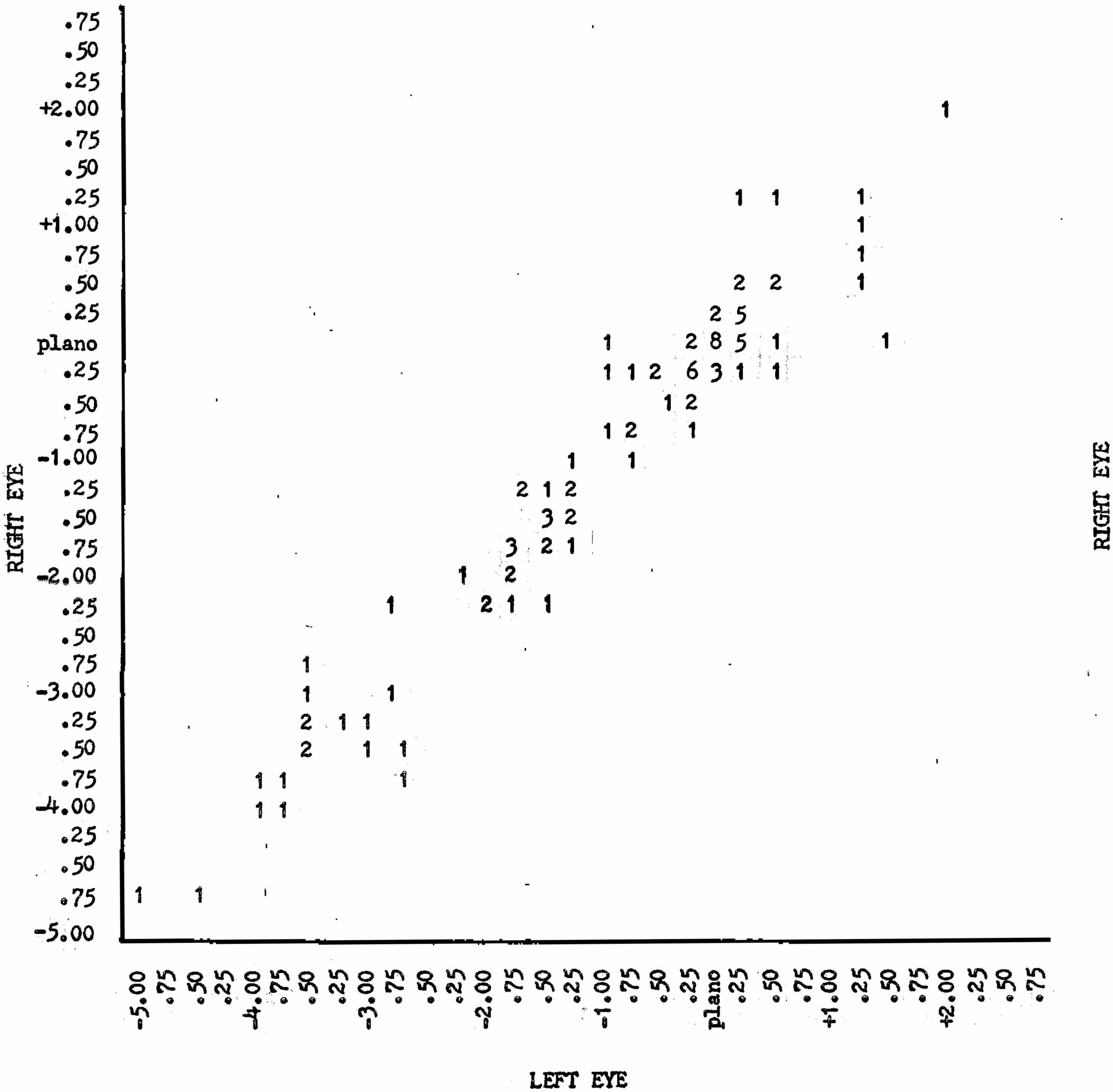
GRAPH 2

CORRELATION OF OD #7A AND OD #2



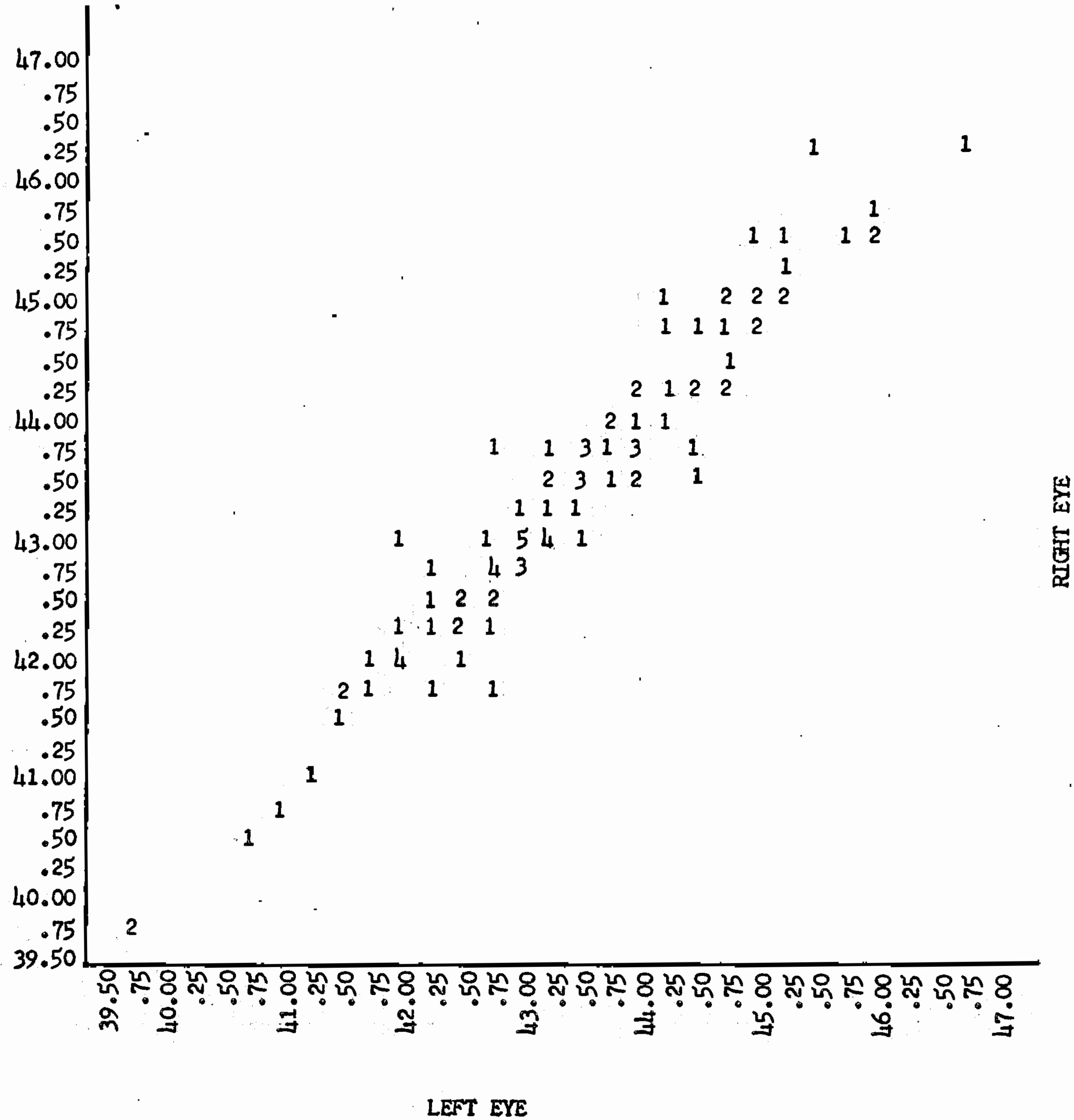
GRAPH 3

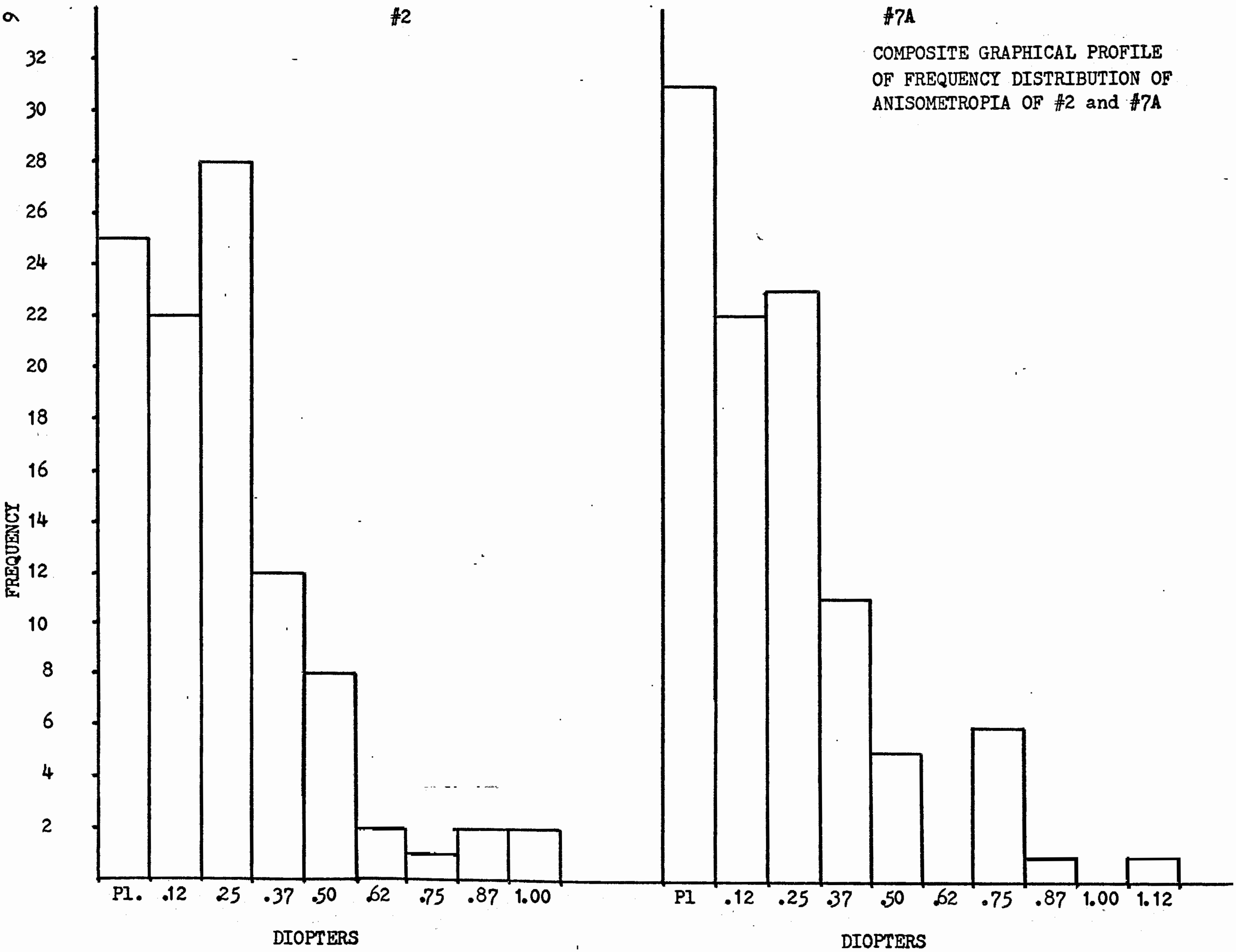
CORRELATION OF OD AND OS OF #7A



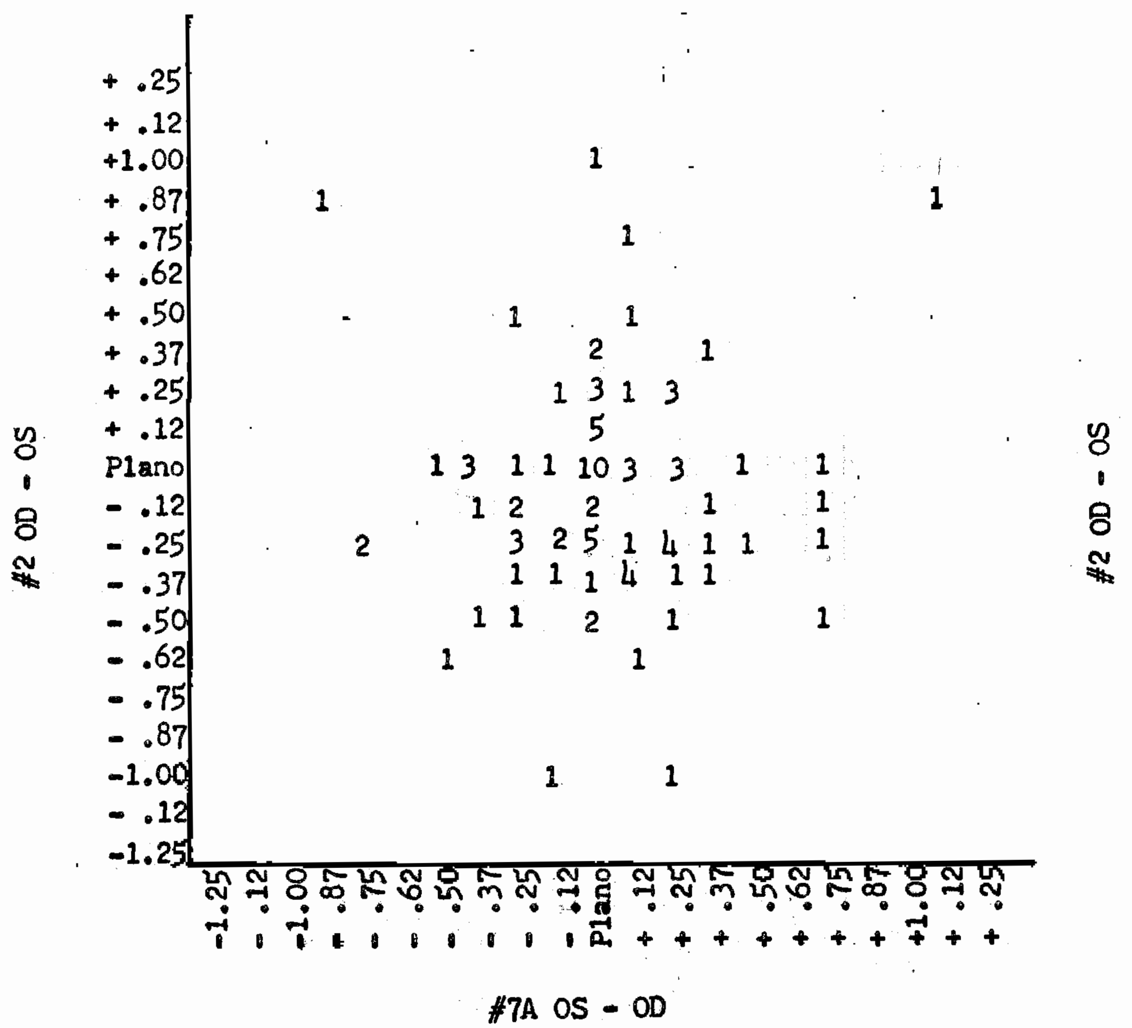
GRAPH 4

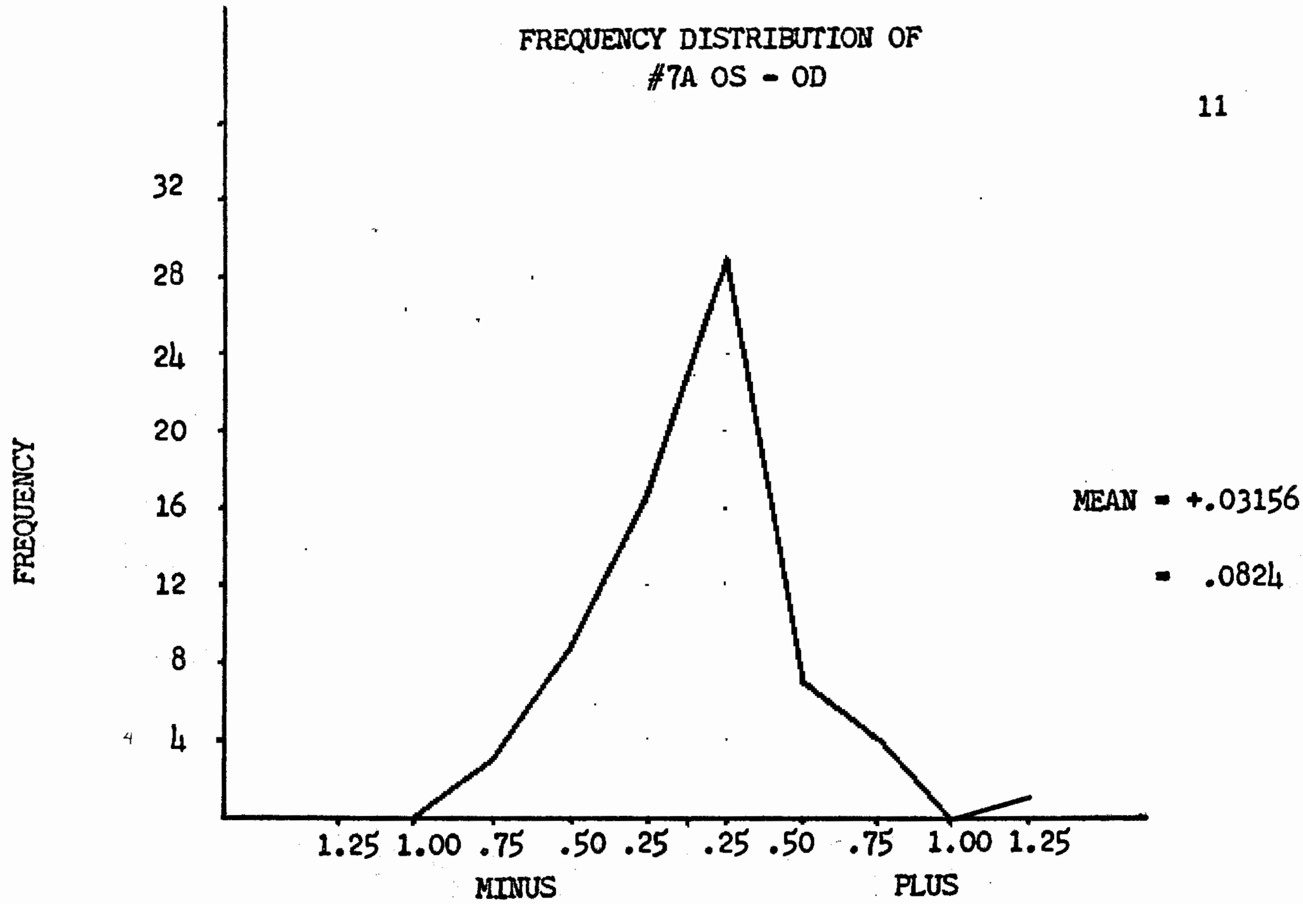
CORRELATION OF OD AND OS OF #2

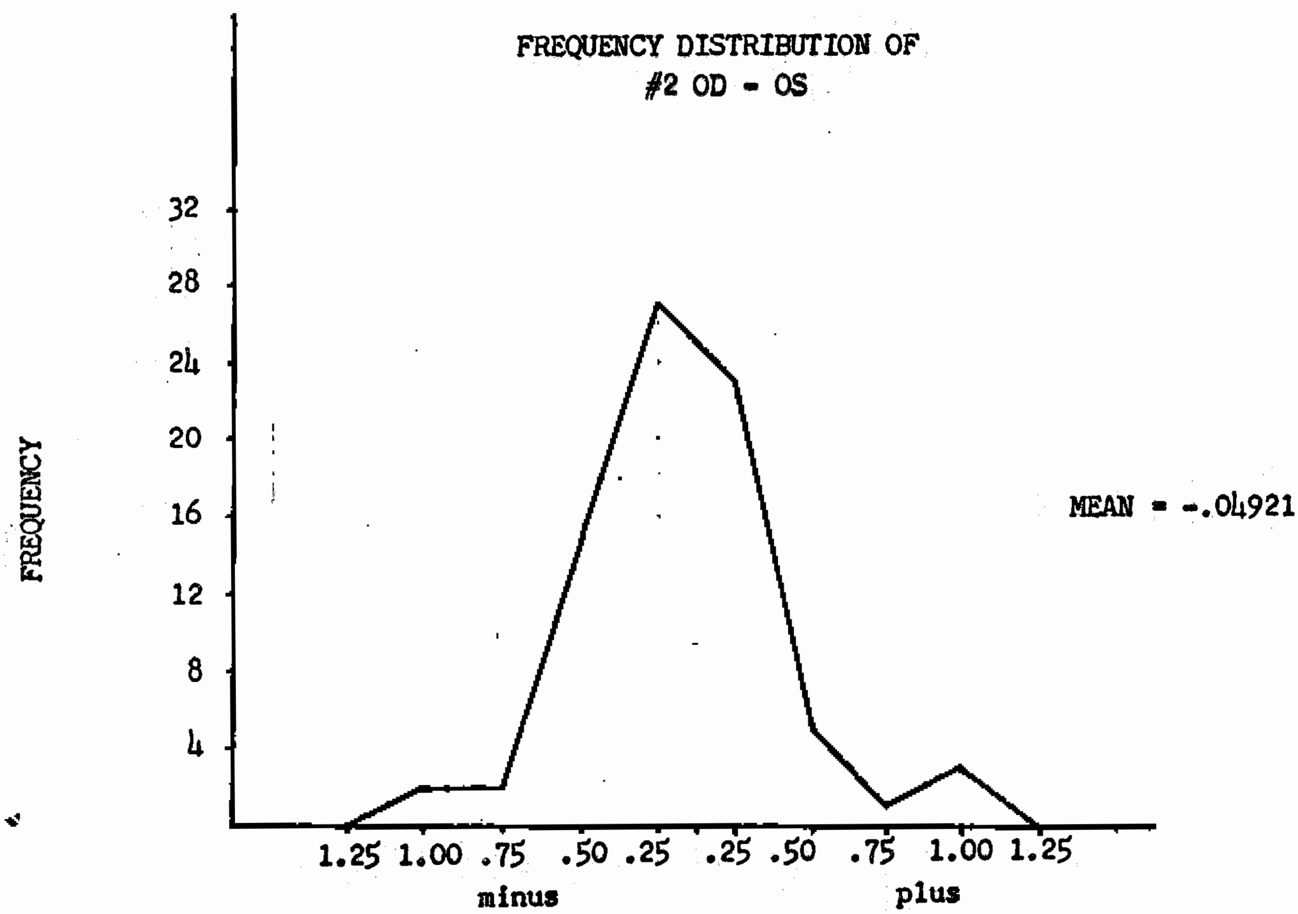



#2
#7A
COMPOSITE GRAPHICAL PROFILE
OF FREQUENCY DISTRIBUTION OF
ANISOMETROPIA OF #2 and #7A
FREQUENCY
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
Pl. .12 .25 .37 .50 .62 .75 .87 1.00
DIOPTERS
Pl .12 .25 .37 .50 .62 .75 .87 1.00 1.12
DIOPTERS

SCATTERGRAM OF #2 OD - OS AND #7A OS - OD




FREQUENCY DISTRIBUTION OF
#7A OS - OD
FREQUENCY
32
28
24
20
16
12
8
4
1.25 1.00 .75 .50 .25 .25 .50 .75 1.00 1.25
MINUS
PLUS
MEAN = +.03156
= .0824


FREQUENCY DISTRIBUTION OF
#2 OD - OS
FREQUENCY
32
28
24
20
16
12
8
4
1.25 1.00 .75 .50 .25 .25 .50 .75 1.00 1.25
minus
plus
MEAN = -.04921

STATISTICAL ANALYSIS

It is our desire to analyze the data obtained from this experiment to statistically determine the significance and correlation of its results. The method of analysis was chi square and the "t" test. We are testing the data of this experiment with the hypotheses of:

1) There is a low correlation of the spherical equivalent between O.S. #2 and O.S. #7A.
2) There is a low correlation of the spherical equivalent between O.D. #2 and O.D. #7A.
3) There is a high correlation of the spherical equivalent between O.D. and O.S. of #7A.
4) There is a high correlation of the spherical equivalent between O.D. and O.S. on #2.
5) There will not be a significant correlation of anisometropia of the spherical equivalent of #2 with that of the anisometropia of the spherical equivalent of #7A, with anisometropia up to 1.00 diopter.

STATISTICAL COMPUTATIONS

Chart 1

Total Polulation (102) Indicating Amount of Anisometropia.
#7A

#2		pl - .125	.13 - .25	.26 - .37	.38+
	pl - .125	24	9	6	6
	.13 - .25	12	9	0	2
	.26 - .37	7	4	2	2
	.38+	10	4	1	4

Chart II

Total Male Population (52) Indicating Amount of Anisometropia.
#7A

#2		pl - .125	.13 - .25	.26 - .37	.38+
	pl - .125	15	3	3	4
	.13 - .25	8	3	0	1
	.26 - .37	4	1	2	1
	.38+	4	2	0	1

Chart 3

Total Female Population (50) Indicating Amount of Anisometropia.
#7A

#2		pl - .125	.13 - .25	.26 - .37	.38+
	pl - .125	9	6	3	2
	.13 - .25	4	6	0	1
	.26 - .37	3	3	0	1
	.38+	6	2	1	3

STATISTICAL COMPUTATIONS

Graph 1 Correlation of O.S. #7A and O.S. #2.

#7A

$\Sigma f = 102$
$\Sigma x = -182$
$\Sigma fx = -422$
$\Sigma (fx)^2 = 5{,}071$

#2

$\Sigma f = 102$
$\Sigma y = 15$
$\Sigma fy = 176$
$\Sigma (fy)^2 = 3{,}172$

$$\Sigma xy = -1{,}088$$

$$N\Sigma xy = f(\Sigma xy) - (\Sigma fx)(\Sigma fy)$$
$$= (102)(-1088) - (-422)(176)$$
$$= -36{,}702$$
$$N\Sigma x^2 = f(\Sigma(fx^2)) - (\Sigma fx)^2$$
$$= 102(5071) - (422)^2$$
$$= 339{,}158$$
$$N\Sigma y^2 = f(\Sigma(fy)^2) - (\Sigma fy)^2$$
$$= 102(3172) - (176)^2$$
$$= 292{,}568$$

$$r = \frac{N\Sigma xy}{\sqrt{(N\Sigma x^2)(N\Sigma y^2)}} = .116$$

Calculations of Variance and Standard Deviation for Graph 1.

$$\Sigma x^2 = \Sigma X^2 - \frac{(\Sigma X)^2}{N}$$
$$= 10.0215 - .322$$
$$= 9.6995$$
$$s^2 = \frac{\Sigma x^2}{N-1}$$
$$= .096024$$
$$s = .31$$

Graph 2 Correlation of O.D. #7A and O.D. #2.

#7A

$\Sigma f = 102$
$\Sigma x = 174$
$\Sigma fx = -422$
$\Sigma (fx)^2 = 5,090$

#2

$\Sigma f = 102$
$\Sigma y = 14$
$\Sigma fy = 148$
$\Sigma (fy)^2 = 2,910$

$$\Sigma xy = -877.$$

$N\Sigma xy = f(\Sigma xy) - (\Sigma fx) - (\Sigma fy)$

$= 102(-877) - (-422)\ (148)$

$= \_26,998$

$N\Sigma x^2 = f(\Sigma (fx)^2) - (\Sigma fx)^2$

$= 102(5090) - (422)^2$

$= 341,096$

$N\Sigma y^2 = f(\Sigma (fy)^2) - (\Sigma fy)^2$

$= 102(2910) - (148)^2$

$= 274,916$

$$r = \frac{N\Sigma xy}{\sqrt{(N\Sigma x^2)(N\Sigma y^2)}} = -.088$$

Calculations of Variance and Standard Deviation for Graph 2.

$\Sigma x^2 = \Sigma X^2 - \frac{(\Sigma X)^2}{N}$

$= 11.5547 - .502$

$= 11.0502$

$s^2 = \frac{\Sigma x^2}{N-1}$

$= -.1094$

$s = .39$

Graph 3 Correlation of O.D. and O.S. #7A.

#7A

$\Sigma f = 102$

$\Sigma x = 174$

$\Sigma fx = 460$

$\Sigma(fx)^2 = 5,024$

#2

$\Sigma f = 102$

$\Sigma y = 174$

$\Sigma fy = 418$

$\Sigma(fy)^2 = 5,160$

$$\Sigma xy = 4874$$

$$N\Sigma xy = f(\Sigma xy) - (\Sigma fx)(\Sigma fy)$$

$$= 102(4874) - (460)(418)$$

$$= 304,868$$

$$N\Sigma x^2 = f(\Sigma (fx)^2) - (\Sigma fx)^2$$

$$= 102(5024) - (460)^2$$

$$= 300,848$$

$$N\Sigma y^2 = f(\Sigma (fy)^2) - (\Sigma fy)^2$$

$$= 102(5160) - (418)^2$$

$$= 351,596$$

$$r = \frac{N\Sigma xy}{\sqrt{(N\Sigma x^2)(N\Sigma y^2)}} = .93738$$

Graph 4 Correlation of O.D. and O.S. #2.

#7A

$\Sigma f = 102$

$\Sigma x = 15$

$\Sigma fx = 155$

$\Sigma (fx)^2 = 3,263$

#2

$\Sigma f = 102$

$\Sigma y = 14$

$\Sigma fy = -208$

$\Sigma (fy)^2 = 3,130$

$$\Sigma xy = 2143$$

$$N\Sigma xy = f(\Sigma xy) - (\Sigma fx)(\Sigma fy)$$

$$= 102(2143) - (155)(-208)$$

$$= 250,826$$

$$N\Sigma x^2 = f(\Sigma (fx)^2) - (\Sigma fx)^2$$

$$= 102(3263) - (155)^2$$

$$= 289,562$$

$$N\Sigma y^2 = f(\Sigma (fy)^2) - (\Sigma fy)^2$$

$$= 102(3130) - (-208)^2$$

$$= 295,235$$

$$r = \frac{N\Sigma xy}{\sqrt{(N\Sigma x^2)(N\Sigma y^2)}} = .8578$$

STATISTICAL SUMMARY

1) When #7A is $\geq$ +.37 the #2 will be:

Difference of #7A & #2 = +.62

No. of cases = 14

mean = .04 or plano

2) When #7A is $\geq$ -.37 the #2 will be:

Difference of #7A & #2 = -.62

No. of cases = 14

mean = .04 or plano

3) When #2 is $\geq$ +.37 the #7A will be:

Difference of #7A & #2 = +.75

No. of cases = 16

mean = .04 or plano

4) When #2 is $\geq$ -.37 the #7A will be:

Difference of #7A & #2 = -.75

No. of cases = 16

mean = .04 or plano

Distribution of Paired X and Y values for 102 Observations with Three Classes for X and Three for Y.

	X_0	X_1	X_2	Total
Y_2	24	9	12	45
Y_1	12	9	2	23
Y_0	17	8	9	34
Total	53	26	23	102

Calculation of X^2.

Classes	f	F	$(f-F)^2/F$
X_2,Y_0	24	(53/102)(45) = 23.355	.01781
X_2,Y_1	9	(26/102)(45) = 11.430	.51600
X_2,Y_2	12	(23/102)(45) = 10.125	.34722
X_1,Y_0	12	(53/102)(23) = 11.937	.00003
X_1,Y_1	9	(26/102)(23) = 5.842	1.70700
X_1,Y_2	2	(23/102)(23) = 5.175	1.94700
X_0,Y_0	17	(53/102)(34) = 17.646	.02365
X_0,Y_1	8	(26/102)(34) = 8.636	.04683
X_0,Y_2	9	(23/102)(34) = 7.650	.23820
$\sum$	102	102.	4.30774

$$x^2 = \frac{(f-F)^2}{F}$$

$= 4.30774$ for 15^0 freedom

Values of Variables X_1 and X_2 for a Sample of 102 Subjects.

ΣX_1	ΣX_2	ΣD	ΣD_2	$\bar{x}_1$	$\bar{x}_2$
-4.77	+3.10	-7.63	21.179	-.04921	+.03156

$$\Sigma d^2 = \Sigma D^2 - \frac{(\Sigma D)^2}{N}$$

$$= 21.179 - \frac{(7.63)^2}{102}$$

$$= 20.61$$

$$s_d = \sqrt{\frac{d^2}{N-1}}$$

$$= \frac{20.6}{101}$$

$$= .45$$

$$s_{(\bar{x}_1 - \bar{x}_2)} = \frac{s_d}{\sqrt{N}}$$

$$= \frac{.45}{10.4}$$

$$= .043$$

$$t = \frac{\bar{x}_1 - \bar{x}_2}{s_{(\bar{x}_1 - \bar{x}_2)}} = 1.879$$

DISCUSSION

The experimental results revealed that the hypotheses 1 and 2 are significantly upheld. There is a correlation on the O.S. #2 and O.S. #7A, and O.D. #2 and O.D. #7A, such that a plus curvature relative to the norm on #2 corresponds with a minus on #7A, thus revealing an inverse relationship. However, this relationship effects only a portion of the curve. The relationship is probably because of too few cases in the plus (of #7A) and below 42.00 of #2. If we were to eliminate the relationship at plano, the relationship of #2 to #7A exists from -.50 diopter and above 43.00 diopters for both eyes. This is basically the same for both graphs one and two. Although the relationship between O.D. and O.S. on #2 and #7A are highly related linearly (Graph 3 and 4), the differences between #2 and #7A (monocularly) are not related. In addition, the distributions on graph 1 and 2 are not explained by the graphs 3 and 4.

The hypothesis #5 is verified, that is, there is less than no relationship as shown with a $x^2 = 4.30774$ significant at the 15^0 freedom level. The obtained values are so close to the expecteds it would appear something is holding the variables this way. This shows that the differences of #2 and #7A are not free to vary independently. But, there is a relationship of kind and not of amount. An investigation would appear to be called for to determine the kind of differences that produce a relationship. We cannot just take differences; we should take into account direction. The differences are within the #2 variables.

It is likely that the relationship between #2 and #7A as calculated would not be changed significantly by a more even distribution of the samples. The results do not significantly differ, that is, this tells the extent with which the hypothesis is verified. From a statistical point of view there is basically no anisometropia below $\pm.37$ diopters. Even by working with those values equal to or greater than $\pm.37$ diopters this also shows to be not statistically significant. With #7A $\geq \pm.37$ the #2 will be .04 or plano. With #2 $\geq \pm.37$ the #7A will be .04 or plano. The anisometropia of $\pm.37$ to ±1.00 diopters is not associated with the ophthalmometer findings of appreciable magnitude to be of significance. The "t" test indicates no significant correlation, t = 1.87. Therefore also showing no correlation at .025 degrees of freedom.

SUMMARY

It was our intention to validate that the anisometropia of the spherical equivalent of #2 showed no significant correlation with that of the anisometropia of the spherical equivalent of the #7A. This hypothesis was verified. It was calculated that there is less than no relationship as shown with a $x^2 = 4.30774$ at a 15^0 freedom level. Even by eliminating those cases below ±.37 diopter, there is still no significant relationship between #2 and #7A with anisometropia less than ±1.00 diopter, "t" = 1.87 at .025 freedom level.