THE IVEX STUDY

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Senior Project

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Abstract:
In this study we have investigated the merits of a binocular refraction. This study used the IVEX refraction system to compare monocular and binocular refractions. The IVEX allowed us to have almost identical conditions for both refractions. Each subject was refracted in a standard examination room by monocular and binocular techniques as a control then examined again with the IVEX system. In this project we looked at changes in cylinder power, cylinder axis, and the balance between the eyes. The experiment showed that statistically the two techniques were the same but there were some differences that may be significant clinically.

Purpose of Study: To use the IVEX Instrument by B & L and the A.O. Vectograph to compare the binocular subjective refraction results with those as determined by established techniques of monocular refraction and blur balance equalization.

Introduction:
Binocular refraction has come in and out of vogue over the years. Many papers were written in the forties and again in the sixties, showing the advantages of the binocular refraction. Even with the documented evidence most practioners do not incorporate a binocular refraction into their routine. In the past, much emphasis has been on which technique was most accurate. It has been reported that all techniques are statistically equal,(2) but there is a difference between a standard subjective refraction and a binocular refraction. In this study we will look at the difference in cylinder axis and power under binocular and monocular refraction conditions and whether any difference exists in equalization (balance) results under binocular verses biocular viewing conditions. We will look at the balance by comparing dissociated blur balance and IVEX binocular balance to a vectograph balance. Let us first review the binocular refraction and some of its advantages.

Proponents of the binocular refraction state that the eyes are in a much more natural state when viewing binocularly. The binocular refraction has been shown to give a more accurate spherical component. Morgan and Stoddard stated that the accomodative response is at a minimum when patients are refracted under binocular conditions. (9) Morgan found that 20% of his patients showed a difference of 0.25 D or more when tested under binocular conditions versus monocular conditions. (6) The most common use of a binocular refraction is as a balancing technique. The monocular fogging method works well for patients with normal visual acuity in both eyes but binocular techniques are better for amblyopes and anisometropes. (2) Finally, does a binocular refraction give a more accurate assessment of the cylinder axis and power.

If we look at this question physiologically it seems that it would make a significant difference. The main cause of a difference between monocular and binocular conditions is the presence of a cyclophorias. When one eye is occluded the eyes will excyclorotate to their position of rest. This rotation would obviously change the lines of sight therefore changing the axis of the patients astigmatism. When the patient is then returned to binocularity his eyes will encyclorotate to take up fusion, therefore changing the axis back to its natural viewing position. There is not accurate documentation about the amount of people who have cyclophoria because we rarely check for it. Morgan found in his study that over two percent of his patients had a ten degree change or more in cylinder axis with binocular viewing conditions. (6) Miles found that the astigmatism axis changed an average of eight degrees.(5) We have attempted to look at the changes in cylinder axis and power under binocular conditions as compared to standard subjective refraction under the same conditions.

The Subjects:
There were forty three subjects who participated in this study. All subjects were previous patients of the Ferris State University Optometry Clinic. The participants had all been screened to ensure they had normal binocular vision and were correctable to 20/20. No contact lens wearers were allowed to particpate. Any patients with known ocular pathology were also dismissed. The patients ranged from twelve to forty years in age. They had varying amounts of cylinder from 0-3.5 DC and some with more than 1D of anisometropia.

Tests:
Binocular refractions were performed on all patients with two different methods. The American Optical (A.O.) Vectograph was incorporated into the standard examination room. The A.O. Vectograph is based on polaroids. The chart is split in two with the right and left sides polarized 90 degrees apart from each other. When the subject is wearing polaroid lenses the right eye will see one side of the chart and the left eye will see the other. The A.O. Vectograph was used as a control. It has been shown that its results are statistically the same as the Turville infinity balance. The Turville has been proven to be statistically the same as the haploscope by Gentsch and Goodwin. (3)

The other binocular refraction method was the Intergrated Vision Examination System (IVEX) by Bausch and Lomb. The IVEX is a computerized refraction system which can be used for retinoscopy, monocular subjective and binocular vision techniques. The IVEX has a complex optical system which can emulate all working distances. We used the system for both a monocular subjective refraction and a binocular refraction at infinity. The binocular refraction system in the IVEX also uses polaroids to dissociate the eyes. The letters on the chart are polarized 90 degrees away from the polarization of the background and border.

The Procedure:
All examinations were performed in room 622 and 624 of Pennock Hall, Ferris State University. The lighting was held constant at fourteen ft. cd. except during bichrome tests when the lights were completely off. A standard refraction and vectograph procedures were performed in 622 and the IVEX trials were performed in 624. It was randomly decided which procedure would be done first on each patient. All examinations were performed by one of two examiners using the procedures and criterion which follows:

Standard Refraction

1. Neutralize habitual prescription
2. Habitual Monocular Visual Acuities
3. Place habitual rx in phorophtor
4. Monocular subjective - occlude left eye
   a. Set maximum plus to maximum visual acuity (MPMA) with bichrome. Blur to +0.50D bring patient down to -0.25 past the last red response
   b. Check cylinder axis and power with Jackson cross cylinder (JCC)
      *Isolated 20/30 line was used
      *Axis check, power check, axis check
      *If no cylinder power present a power check was made at every 45 degrees
   c. Repeat with left eye
5. Dissociated blur balance

a. Blur both eyes +0.50D
b. Isolate 20/30 line
c. Patient asked which line is clearer
d. +0.25 added to clearer eye
e. If this reversed the clearer eye the patient was asked which choice the lines are closest to being the same

6. Binocular MPMA set with bichrome -0.25D past last red response

Vectograph

1. Begin with habitual rx
2. Polaroid lenses are placed in the A.O. Ultramatic phoropter and the A.O. Vectograph slide is placed in the projector
3. Check subjective refraction
   a. Blur right eye +0.75D Return to MPMA
      Never more than -0.75D past just readable 20/20
   b. Check cylinder axis, power, axis
   c. Repeat with left eye.
4. Add +0.25 to one eye and ask patient if change is noted.

IVEX Monocular Refraction

1. Habitual rx
2. Monocular visual acuity
3. MPMA with bichrome -0.25D past last red response
4. Check cylinder axis, power, axis with JCC
   a. Bracket Axis
   b. Isolated 20/40 line
   c. If no cylinder present a power check was made every 45 degrees
   d. Repeat for left eye
5. Dissociated blur balance
   a. Isolated 20/30
   b. Blur patients +0.50D
   c. Patient asked which line is clearer
   d. Add +0.25D to clearer eye if patient reports reversal in clearest eye then patient was asked which choice the lines were closer to being the same
6. Binocular MPMA set with bichrome last red response

IVEX Binocular Refraction

1. Habitual rx
2. Add +0.75D to right eye and return to MPMA
   No more than -0.75D past just readable 20/20
3. Check axis, power, axis with JCC
   a. Use whole chart
   b. Advised patient to attend to the 20/40 line
   c. Use MPMA as endpoint after JCC determination
4. Repeat on left eye
5. Final check of balance endpoint
   a. Add +0.25D to one eye and ask patient if a change is noted.
   b. Repeat with other eye

Results:

In order to compare balancing techniques we recorded the difference in spherical equivalents for each subject. A mean was calculated for each technique. (Figure 1) A correlation coefficient was figured showing the extreme similarities in these values. A t-test was also run showing that statistically there is no significant difference between all balancing techniques used.

The results show that the IVEX binocular refraction balance is statistically the same as the vectograph and by interpolation the vectograph is the same as the haploscope. We used the standard refraction and vectograph to act as a control to check the validity of the IVEX system. The difference between the refractions was statistically insignificant so the remainder of our discussion will be about the IVEX system only.

The IVEX monocular subjective refraction was compared to the binocular refraction technique by looking at changes in sphere, cylinder, and axis. A mean was calulated for each value and they were found to be statistically the same. A correlation coefficient was figured for each sphere, cylinder, and spherical equivalent to see whether a difference existed between monocular and binocular refractions. The results were coefficient of 0.9921 and 0.9953 for the sphere, 0.9660 and 0.9481 for the cylinder and 0.9961 and 0.9976 for the axis. The values prove that the IVEX monocular and binocular refractions are statistically the same. These results are summarized in Figure 2. Scatter plots were also made which display the close correlation of the monocular and binocular refractions. These plots are shown in Figures 3-9.

We have shown statistically that there is no difference between the IVEX monocular subjective refraction and the IVEX binocular refraction. But as clinicians, we must decide whether or not to accept these statistics as a standard of practice. We should look at any differences in the data and decide if any are clinically significant. On a strict percentage basis six percent of the subjects showed a change in their sphere of greater than 0.25 D. Seven percent of those tested showed a cylinder power change of greater than 0.25D. Fifteen percent had a cylinder axis change of five degrees or more but only three percnet had a change of ten degrees or more. A balance change of greater that 0.25D was found in seven percent of the subjects.

By inspection of the data a few comparisons can be made. All subjects who had more than 0.25D change in cylinder power were in the range of 1.75 DC- 2.25 DC. Those who had greater than a five degree change in axis had less than 0.50 DC except one who had 1.75 DC and eleven degree shift in axis. This amount of change in axis for this low amount of cylinder is insignificant. The only conclusion that can be drawn about those who had a change in sphere power or balance is that many of the ones who changed sphere power also changed their balance.

Conclusion:

The goal of this study was achieved. We attempted to compare a monocular refraction to a binocular refraction under the most controlled conditions. The IVEX has allowed us to have identical working conditions including lighting, target size, background atmosphere and patient positioning. We compared the IVEX to a standard refraction lane first to establish its validity. We have shown that statistically the binocular and monocular techniques are the same. In practice at least 94 percent of the patients would not be affected one way or the other by a binocular refraction, but there are some who may benefit from it. These are not new ideas. Since binocular refraction was invented there has been proof that some people would benefit from it and no one would be harmed by it.

The biggest obstacle keeping binocular refraction from becoming part of the "standard" is convenience. Practitioners will not disrupt their routine to help the six percent which may benefit from the additional testing. Optometry needs a binocular refraction system that can be incorporated into the normal sequence as easily as the IVEX binocular refraction can be used with its monocular subjective refraction.

BALANCE COMPARISON

	Standard	Vectograph	IVEX Standard	IVEX Binocular
1.	0.50	0.50	0.25	0.25
2.	0.25	0.50	0.25	0.25
3.	0.00	0.00	0.25	0.375
4.	0.25	0.25	0.00	0.00
5.	0.50	0.50	0.50	0.50
6.	0.00	0.00	0.00	0.25
7.	0.25	0.25	0.50	0.50
8.	0.25	0.00	0.25	0.25
9.	0.50	0.50	0.50	0.50
10.	2.00	2.00	2.00	1.75
11.	0.50	0.375	0.375	0.625
12.	0.125	0.375	0.00	0.00
13.	0.625	0.375	0.50	0.625
14.	0.00	0.00	0.00	0.00
15.	0.00	0.00	0.00	0.00
16.	2.75	2.50	2.25	2.50
17.	0.125	0.375	0.625	0.375
18.	0.125	0.25	0.50	0.125
19.	0.125	0.25	0.125	0.25
20.	0.25	0.25	0.00	0.00
21.	0.25	0.25	0.25	0.25
22.	0.50	0.125	0.75	0.75
23.	0.375	0.375	0.75	1.00
24.	0.375	0.375	0.375	0.375
25.	0.25	0.25	0.125	0.375
26.	0.50	0.50	0.75	0.50
27.	1.00	0.875	1.00	1.00
28.	1.50	0.75	0.625	0.625
29.	0.00	0.375	0.25	0.25
30.	0.625	0.625	0.625	0.75
31.	0.125	0.125	0.375	0.125
32.	1.00	1.00	0.75	0.50
33.	0.50	0.25	0.75	0.75
34.	0.125	0.375	0.375	0.25
35.	0.25	0.25	0.125	0.00
36.	0.25	0.375	0.00	0.375
37.	1.25	1.00	1.25	1.25
38.	1.125	1.875	2.25	1.375
39.	0.375	0.375	0.375	0.375
40.	0.50	0.50	1.00	0.875
41.	0.25	0.25	0.00	0.25
42.	0.50	0.125	0.375	0.125
43.	0.125	0.125	0.125	0.125

Figure 1

IVEX

	OD			OS			SE
	S	C	X	S	C	X	
Correlation Coefficient	0.9921	0.9660	0.9961	0.9953	0.9481	0.9976	0.9127
Mean Monocular	-1.709	-0.715	101.25	-1.616	-0.756	108.85	0.5029
Mean of Binocular	-1.703	-0.698	100.28	-1.587	-0.820	108.79	0.4855
t Value	50.58	23.917	62.081	65.648	19.093	80.43	14.305
t Probability	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Figure 2

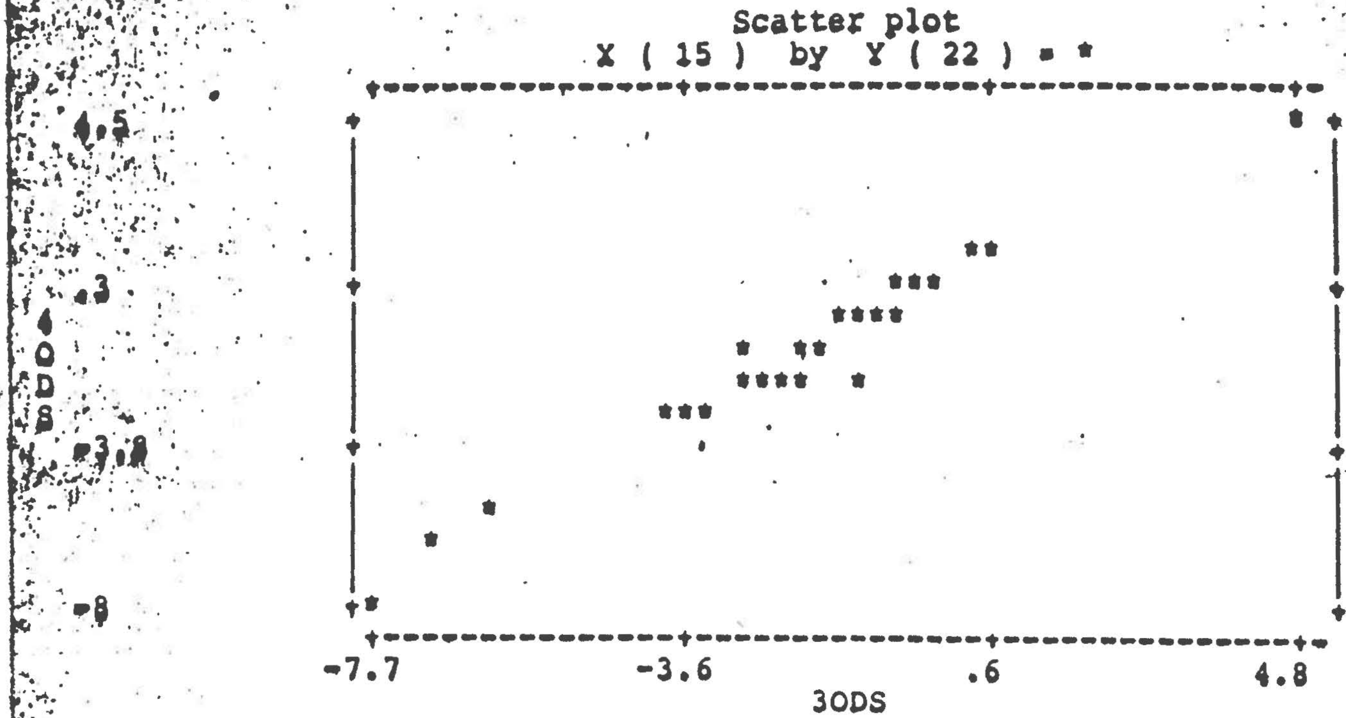


Figure 3

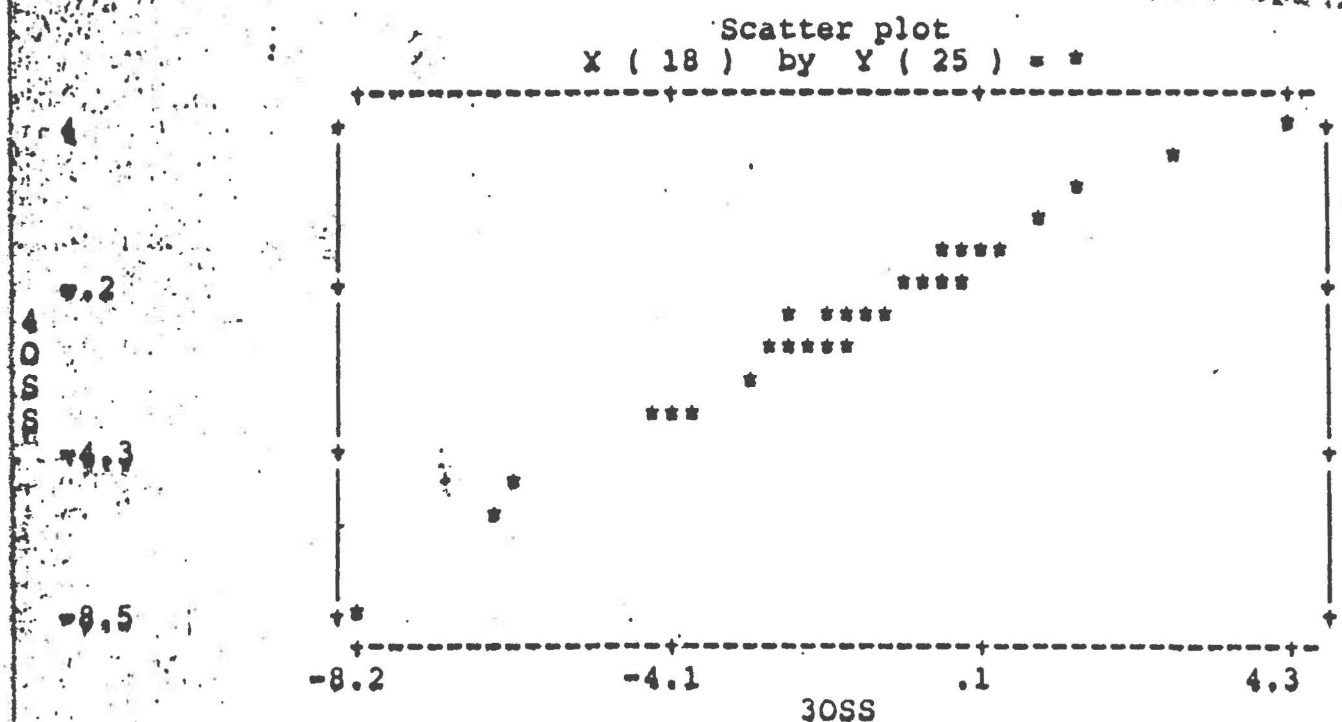


Figure 4

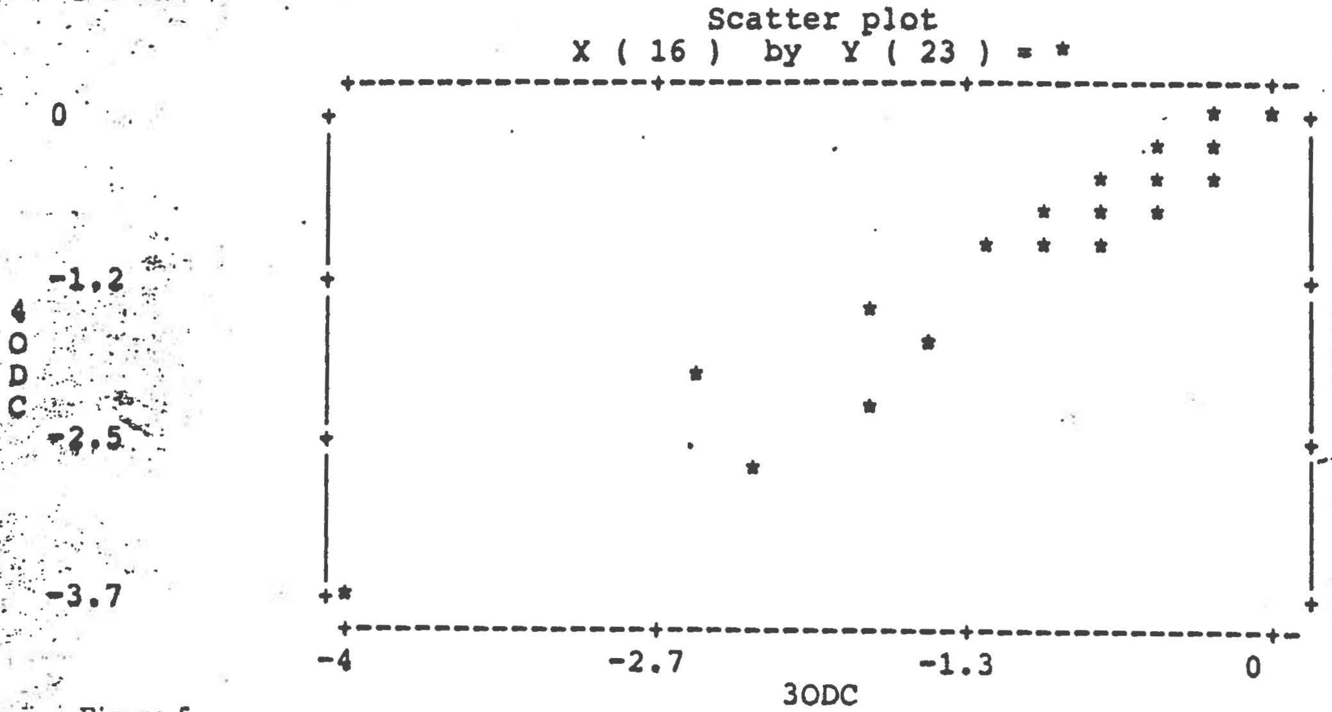
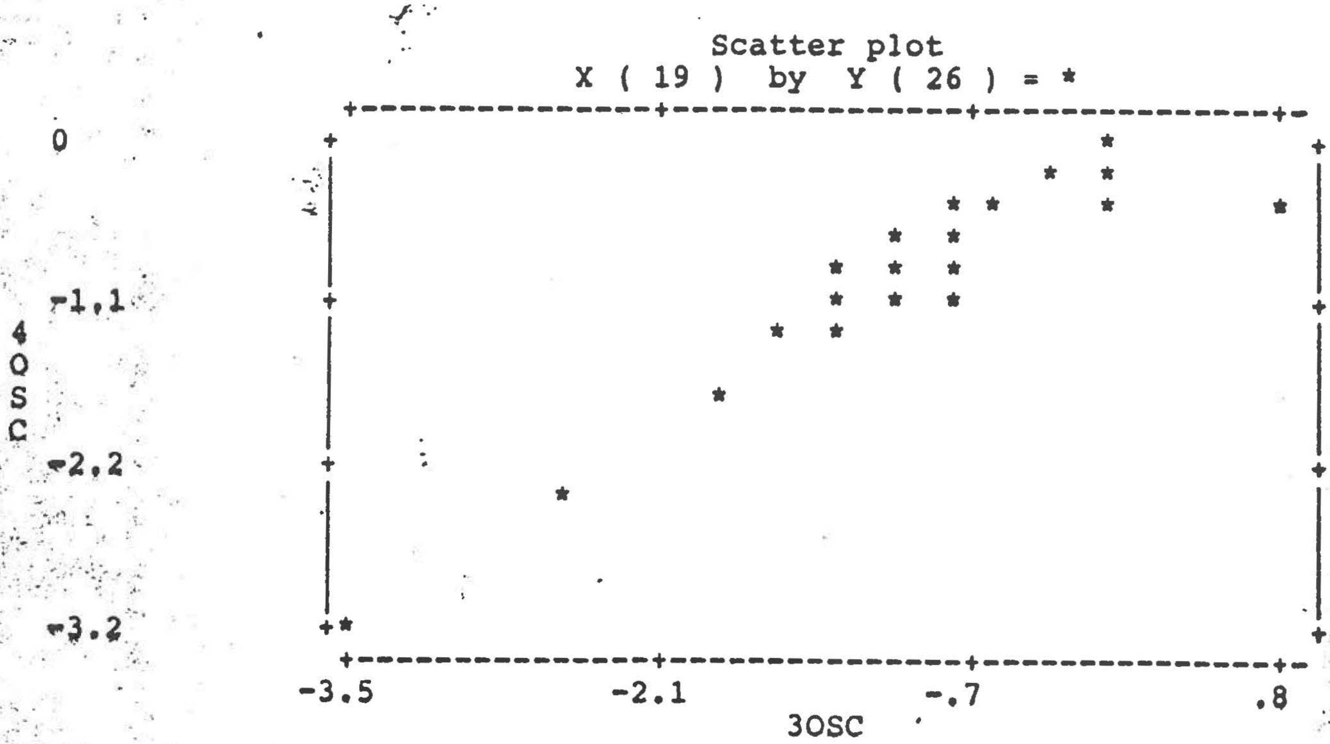


Figure 5



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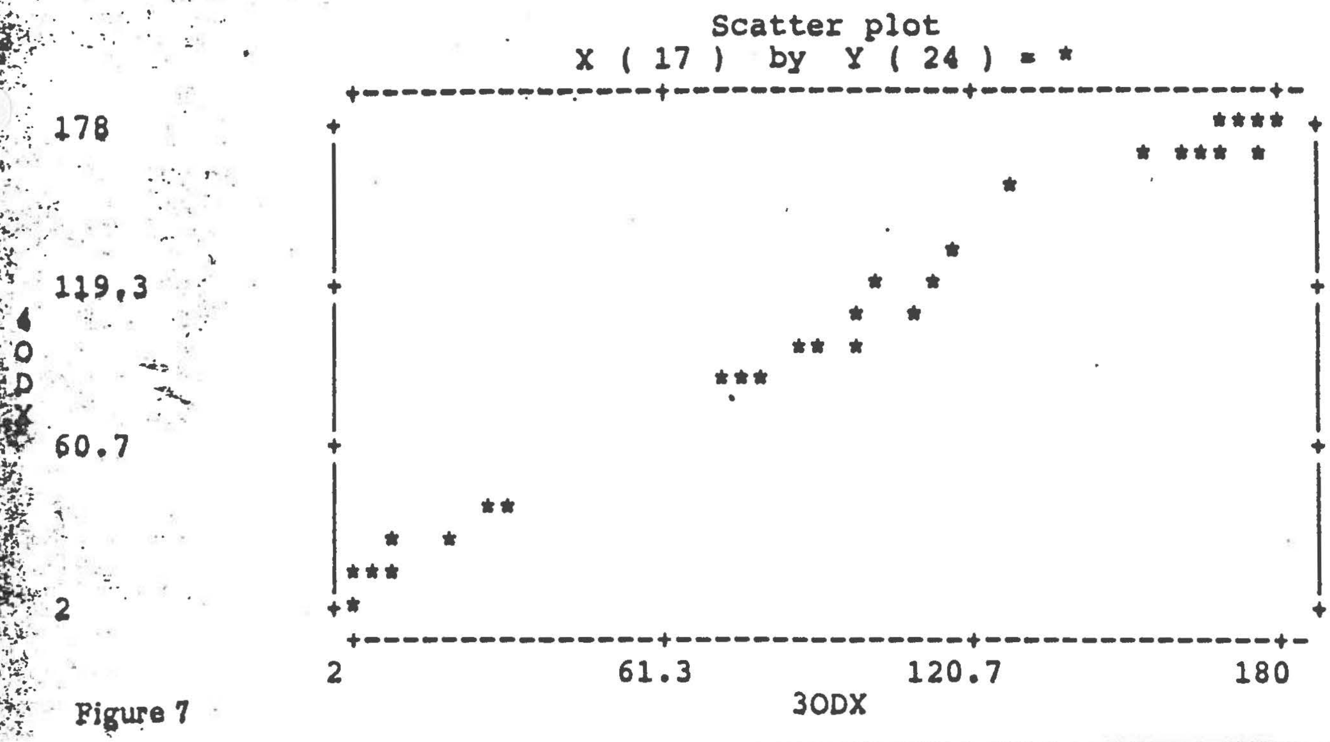

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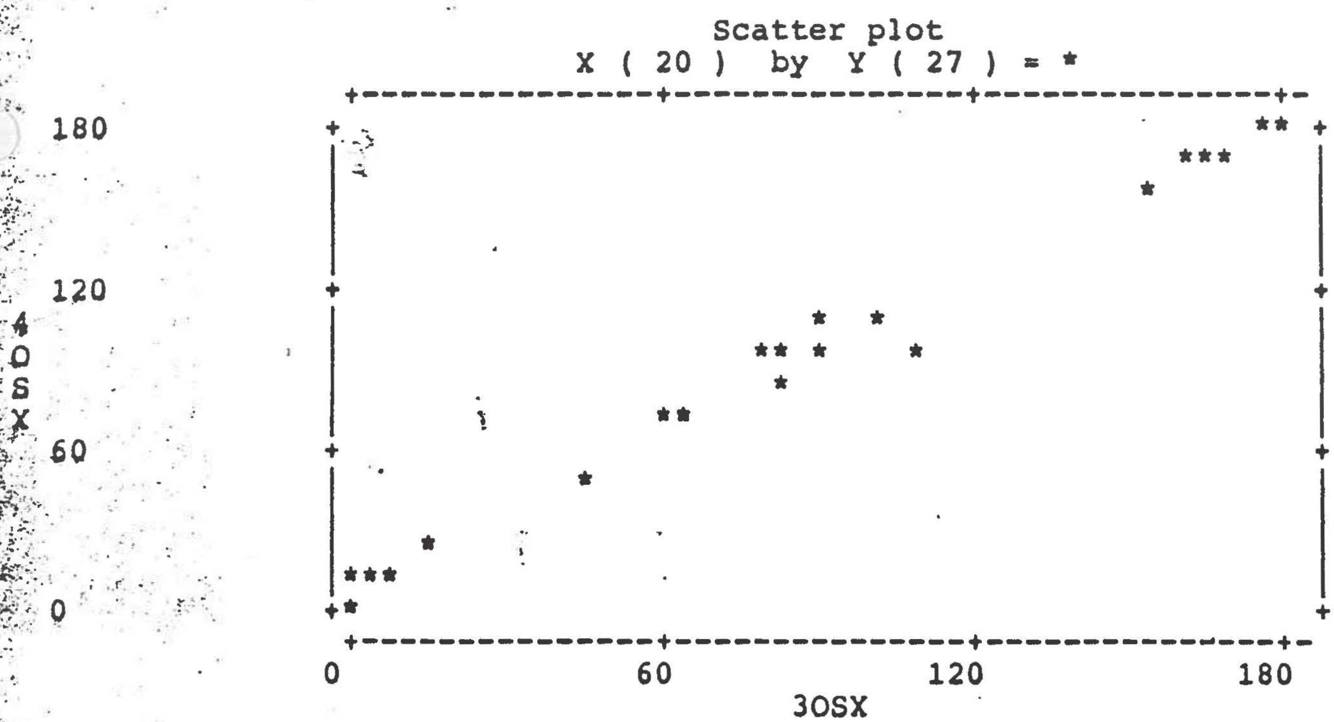

Figure 8

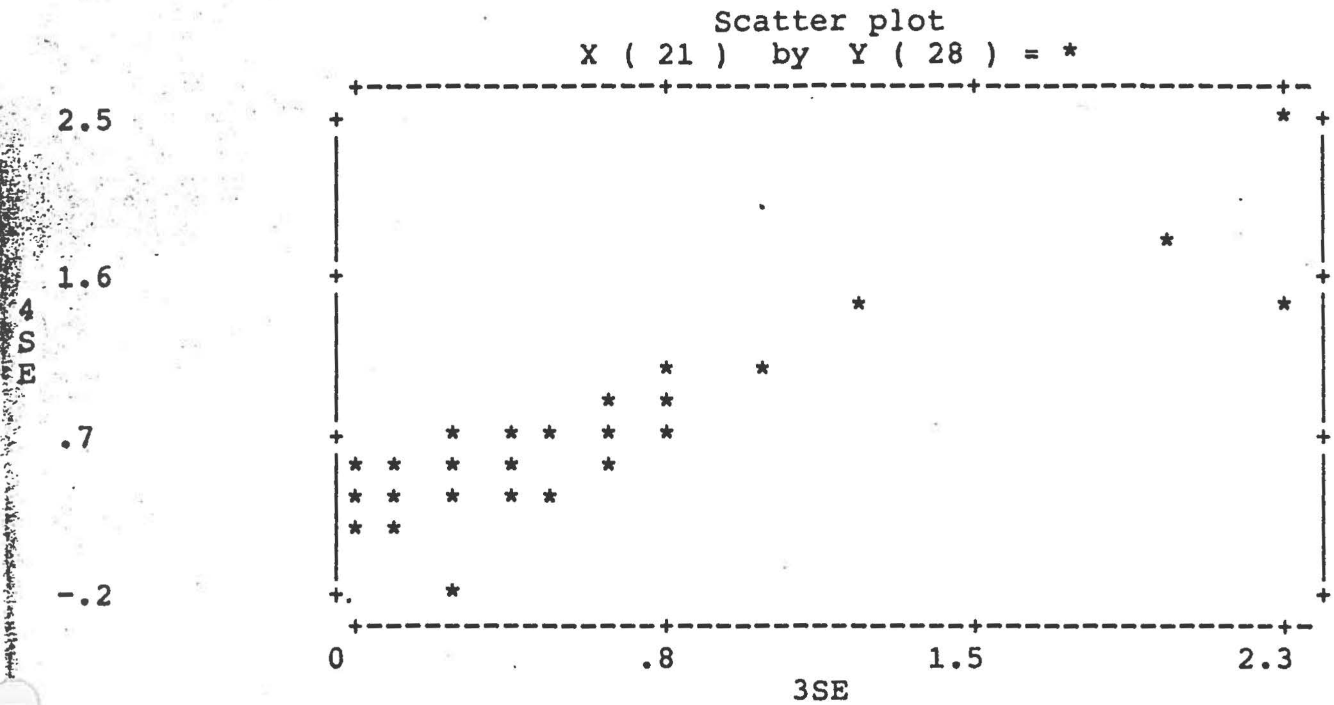

Figure 9

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