FIXATION DISPARITY

MOVING TO COMPUTERS

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ABSTRACT

Fixation disparity has many clinical applications. A method for evaluating fixation disparity is described. Fixation disparity was measured by means of limits within which nonius alignment was perceived. A Z-100 Zenith computer with a ZVN-1360-B Zenith RGB monitor was used. Computers have proven to be useful during clinical applications to diagnose, monitor, and train binocular anomalies. The procedure of the experiment, clinical findings and future applications will be presented.

key words: fixation disparity, forced vergence, binocular fusion lock, vergence facility.

INTRODUCTION

In normal binocular vision, fixation disparity is a small misalignment of the two eyes under the conditions of binocular fusion. The small disparity(misalignment) that occurs is due to the presence of Panum's fusional area. Panuums fusional area allows for sensory fusion in spite of a slight binocular misalignment of the two eyes. Because of this, diplopia is not perceived and fixation errors pass unnoticed. If the fixation error is divergent in nature than it is called exo disparity, if the error is convergent in nature it is referred to as eso disparity.

The measurement of fixation disparity incorporates two special reference lines introduced into the binocular field of view. These lines which are called nonius (Ogle 1950) are each seen monocularly. They are located axially so that the vernier alignment can be made without the possibility of the adjacent ends being fused binocularly.

Fixation disparity is determined by subjected alignment of the two nonius lines. The magnituded of fixation disparity can be varied by changing the amount of stress on the system controlling binocular fusion.

If stress is put on the system to cuase forced convergence and forced divergence, then a graphic representation called a fixation disparity curve can be generated. The curves are generated by installing before the subjects, various amounts of prism and changing the direction of the prism, the resultant fixation disparity is then measured.

The four basic types of fixation disparity curves are shown in Fig. 1. The most common (typeI) is sigmoid shaped and has a tendency for verticality on both ends. Type II curves lack the downward portion of the curve on the base-out side and type III lack the upward portion on the base-in side. A type IV curve is a sigmoid terminating in horizontal lines. The relative frequency of the curve types is given in Table 1, in which Saladin and Sheedy's (1979) data are compared to Ogle's.

There are also four discriptive characteristics of a fixation disparity curve. The first is the curve type. The second is the vertical axis intercept (Y intercept) which is a measure of the angular amount of fixation disparity with no induced prism stress. The third is the horizontal axis intercept (X intercept or associated phoria) which is the amoumt of prism needed to neutralize the fixation disparity to zero. The fourth point of interest is the slope of the curve as it crosses the vertical axis. These four characteristics are represented in Fig. 2.

Fixation disparity curves have been primarily used for research rather than incorporating them into practice. This is due to the lack of clinical methods for measuring curves. The cost - benefit ratio has basically eliminated this procedure in the office environment.

Practices can not afford spending time and expense performing this clinical test. The task should be made simple enough so that the optometric technician can perform the test. Therefore, a computer with the capibilities to measure fixation disparity and provide a curve which would allow for diagnosis and treatment of binocular disorders would be beneficial.

METHOD

Subjects: Sixteen subjects were originally run to test the computer program,(Saladin and Hammack). Several changes were made. Then after the new program was developed, ten subjects were tested. The subjects were randomly selected.

Apparatus: The subjects used a Zenith (ZVN-1360-B) long persistance colored monitor which was connected to a Zenith (Z-100) computer. A Silver Reed (EXP-555) printer also assisted in producing the data. After entering the appropriate information the subjects were seated 1 meter away from the screen.

The subjects were given red-green glasses with red over the right eye. The return key was punched and two nonius lines were displayed inside two circles. A full diagram of the display and its dimensions are shown in Fig. 3.

To stimulate forced vergence, the seperation of the nonius lines needed to be controlled. Since the subject was 1 meter away from the screen, 1 centimeter equaled 1 prism diopter, (see Fig. 4.). To stimulate convergence (eso disparity) the red circle and nonius line appeared on the left side of green circle and nonius line. The reverse is true for divergence.

The procedure started by finding the angular amount of fixation disparity with no induced prism (y intercept). The program was designed to alternately test the base-out, base-in limit. The base-out component started with 3 prism diopters which increased by increments of 3 until 15 prism diopters were in place. The base-in component started with 2 prism diopters and increased by increments of 2 until 8 prism diopters was reached

To further enhance peripheral binocular fusion, letters were placed outside the existing circles (see Fig. 3, and 4.). These letters were equal in color to the circle it was placed over. After finishing all 9 components of the test, the subject was instructed to punch p to print the data.

RESULTS

The results are shown graphically in Fig. 5. and 6. Ten subjects were tested, each curve represents one subject. The curves show a varibility from subject to subject.

The convergent or eso disparity component seems to be eliminated in almost all of the graphs. This is due to the absence of proper fusion locks in the periphery. The absence of fusion locks diminishes the ability for consistent accommodative responses which cause a decrease in the ability for binocular fusion. Yeager and Boltz have demonstrated that a background consisting of various sized letters, horizontal and vertical lines viewed on a computer screen will stimulate normal binocular fusion. The background used in their computerized fixation disparity program is shown in Fig. 7.

The majority of the graphes show a steep slope. The steeper the slope the less the binocular system is able to adapt to prism induced stress. The steep slope in this experiment represent the inability of the subject to adjust for the base-in stress demand. The slope also has a tendency to increase as the size of the fusion contour grows and its strength weakens (Saladin and Carr).

Yeager and Boltz used vertical and horizontal lines to improve the slope. The fusion contour in the experiment needs to be strengthened by increasing contrast, sharpening borders and to a certain extent, increasing the number of contours.

DISCUSSION

The objectives of this study have been realized. The results do show that nonius lines can be perceived in alignment over a wide range of disparities. The range has been shown to be diminished due to a paucity of peripheral binocular fusion locks. Yeager and Boltz have shown that increasing horizontal, vertical, and peripheral fusion locks have increased the range of disparities. These fusion locks also have been shown to decrease the steepness of the slope towards a normal response.

Forced vergence curves consisting of several points should be generated on all patients. A screening process should also be done on patients with few or no complaints.

The clinical usefulness of this computerized fixation disparity test could possibly be used for prism prescribtions, orthoptic training in the form of vergence facility testing, but for the major and most important use is to monitor functional progress during orthoptic training.

A computer fixation disparity program is presently being used at UHCO clinic and has given valuable insight to the binocular statis of many patients.

ACKNOWLEDGMENT

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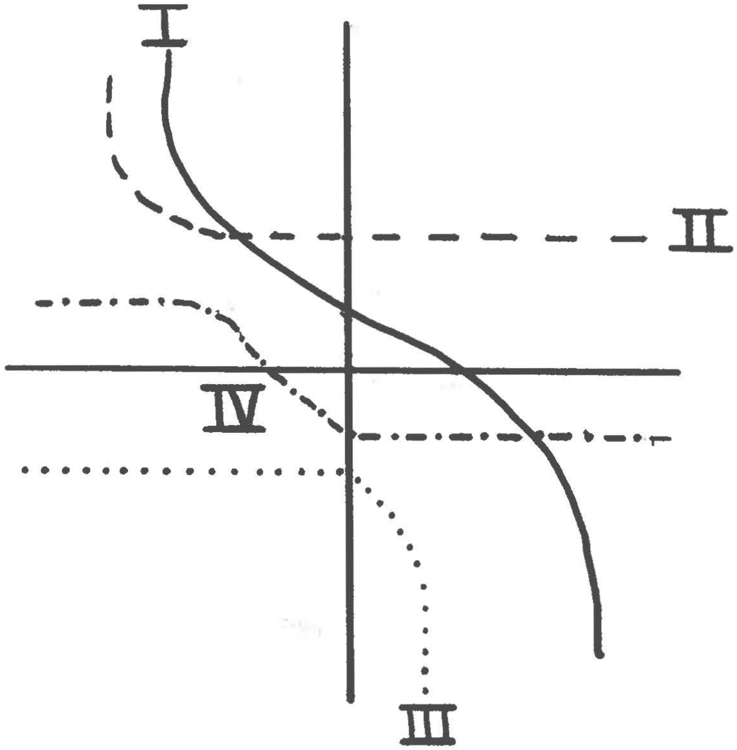


Fig.1. Four basic types of fixation disparity curves. The position of each relative to the abscissa and ordinate, may be different(up, down, right, or left) from that shown in this example.

Table. 1. Relative frequency of the curve types. Type I curves are most frequent, followed by Type II, Type III, and Type IV in that order. The differences among the data in the table are most likely due to the populations from which the samples were shown.

	Distance		Near	
Type	Olge%	Saladin and Sheedy%	Ogle%	Saladin and Sheedy
I	57.5	68.3	57.2	58.2
II	30.0	26.7	22.1	27.6
III	9.0	0	13.4	8.2
IV	3.4	5.0	4.9	7.2

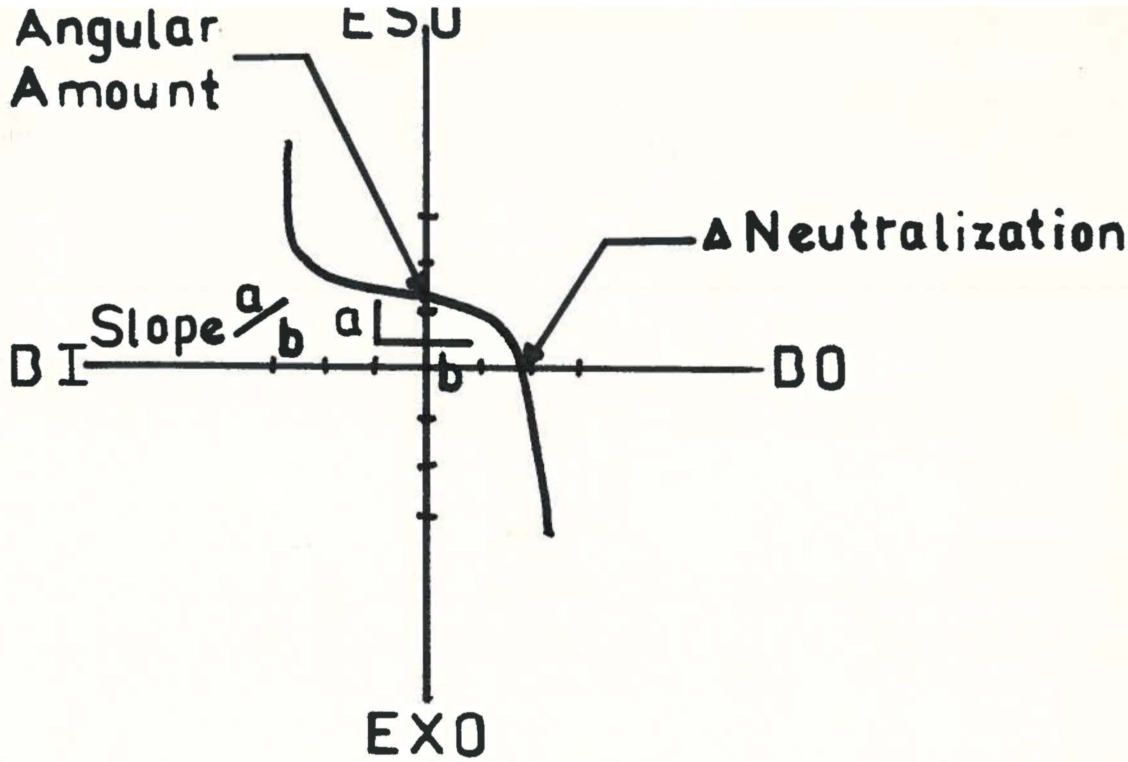
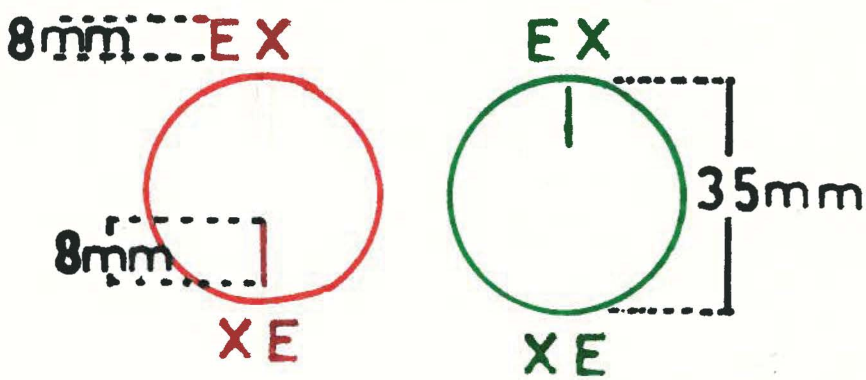


Fig.2. The graph that is illistrated above represents the four discribtive characteristics of a fixation disparity curve,1) slope,2) angular amount of fixation disparity,3) amount of prism needed for neutralization of the fixation disparity,4) type.



See two circles? Try to bring them together. Stay double? Press space bar. See a circle? Align the vertical lines with arrow keys.

Fig.3. This diagram illisrates the measurements, the peripheral fusion locks and the directions that the subject was to use while performing the experiment.

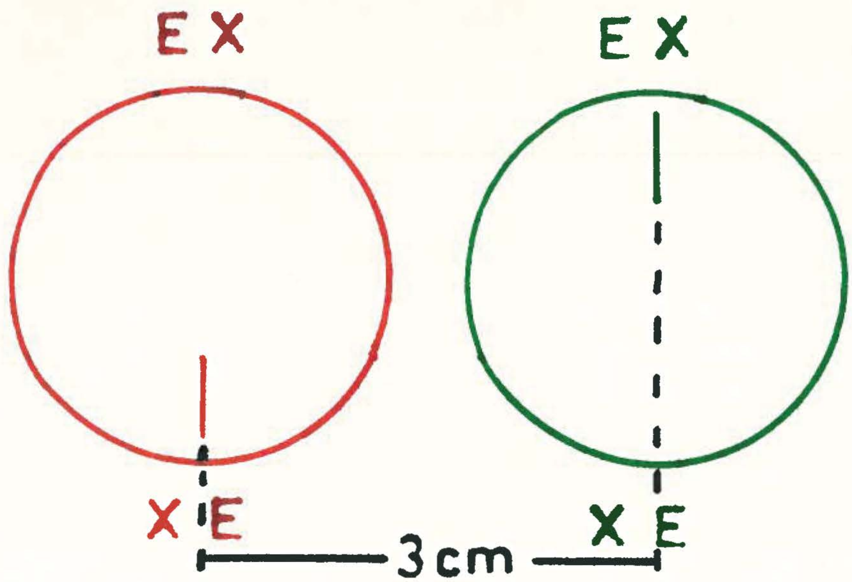


Fig.4. This diagram shows the relationship between the nonius line seperation and prism diopters. For a three centimeter displacement of the nonius lines and the subject sitting one meter away, we get a three prism diopter demand.

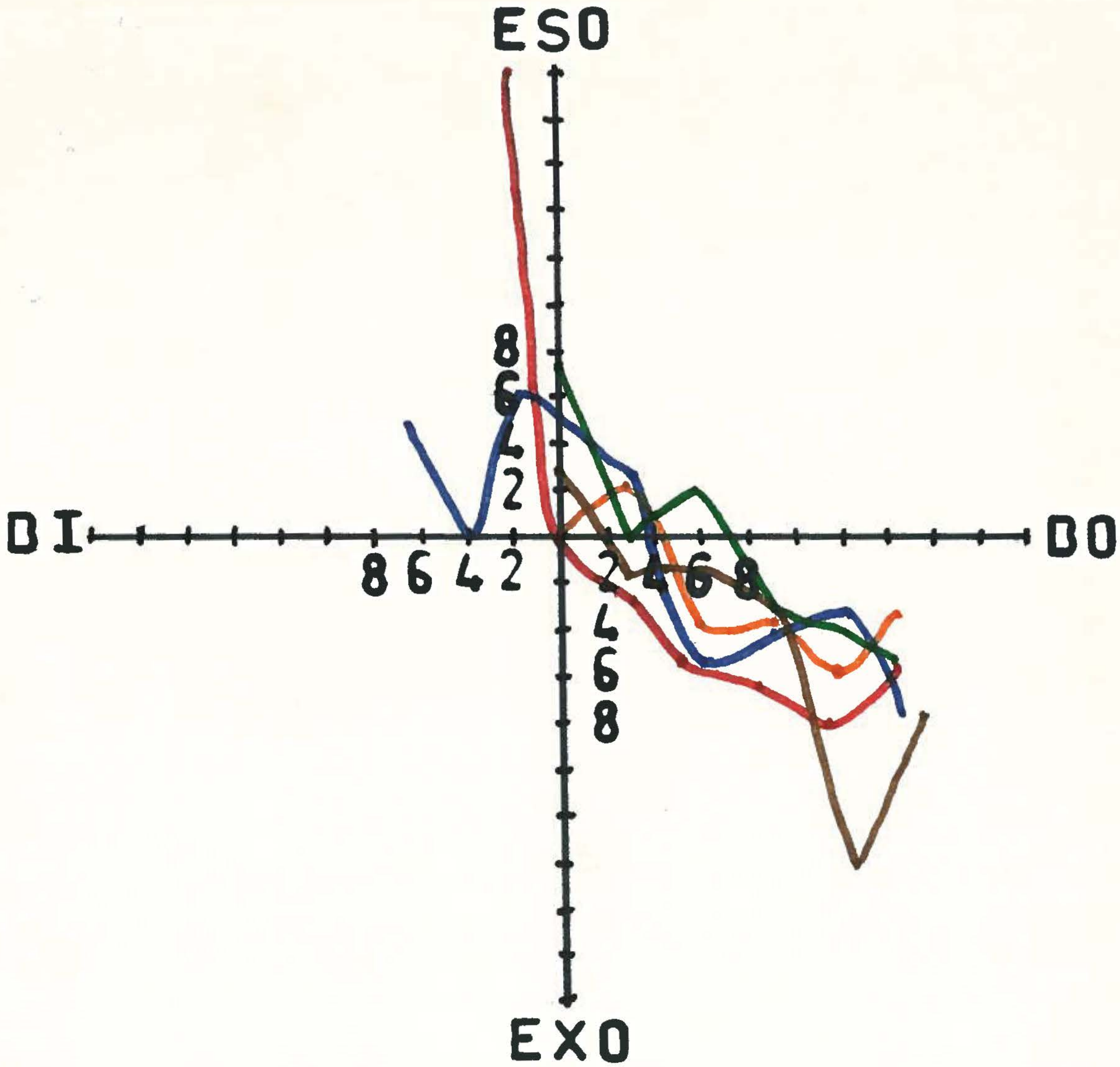


Fig.5. This graph shows 5 fixation disparity curves. Each curve represents one subject. Notice that for each curve the slope is steep and that there is an absence of the eso component.

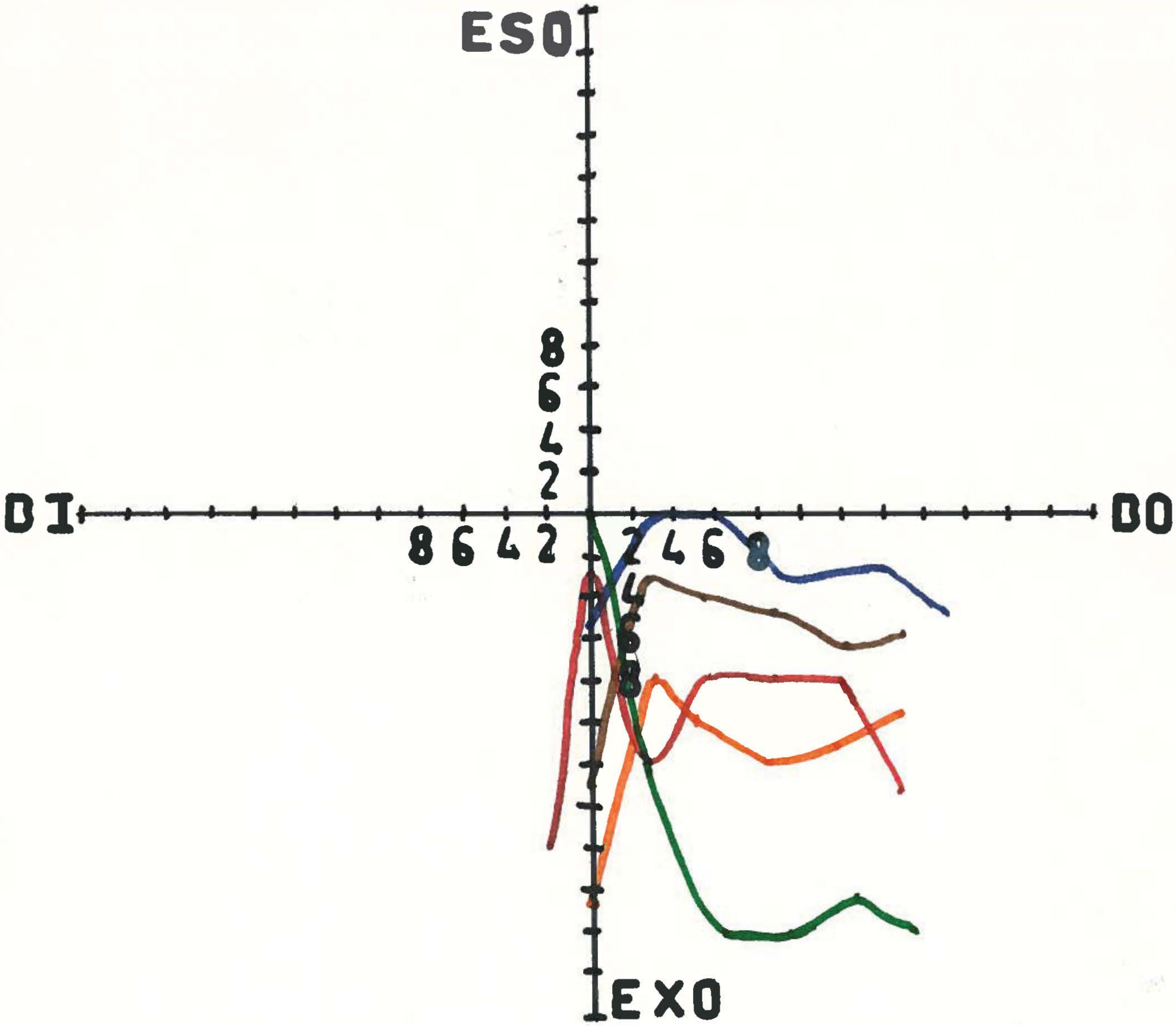


Fig.6. This graph also shows 5 fixation disparity curves Each curve represents one subject. These subjects also demonstrated a steep curve and the abscence of the eso component.

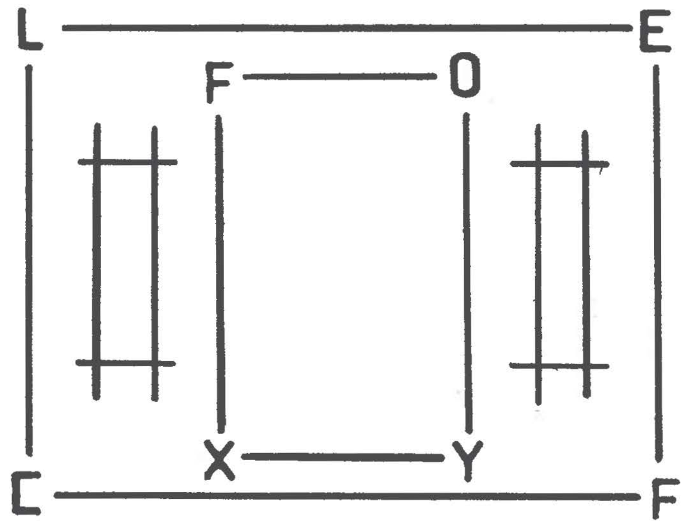


Fig.7. Representation of Yeager and Boltz Fixation Disparity display. Note the increased horizontal, vertical and peripheral binocular fusion locks. also when complete binocular fusion occurs the extreme peripheral letters at the top and bottom form an E.

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