

COMPARATIVE STUDY OF THREE DIFFERENT STEREOPSIS TESTS: TNO[®], FLY STEREO ACUITY TEST[®] AND STEREO TAB[®], IN STUDENTS IN HIGHER SCHOOL

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INTRODUCTION:

Stereopsis is the perception of depth based on retinal disparity that can be fused for single vision (fine stereopsis). Global stereopsis depends on the process of random dot stimuli and local stereopsis depends on contour perception^{1,2}.

Stereopsis evaluation can be made through two types of procedures: anaglyphic, through the use of filters green/red or red/cyan; and vectograph, through the use of polarized filters³

The anaglyphic assessment is associated with random dot stereograms where there are no specific contours. There's lack of form only if there is retinal horizontal disparity associated with corresponding retinal areas – global stereopsis³ - TNO[®] and StereoTAB[®].

The vectographic assessment is associated with tests of stereograms with outlines, which provide the viewer perceived monocular outlines - local stereopsis³ – Fly Stereo Acuity Test[®]. The retinal horizontal disparity in local stereopsis, does not depend on any other reference to the corresponding area of retina, facilitating the fusion process and reducing the need for precise oculomotor control³.

StereoTAB[®], is an electronic test, with an application for tablets, that uses random dot stereograms and red/cyan filters.

The TNO[®], uses a random dot pattern with red/green filters, allowing each filter to isolate the corresponding color image in each eye, occurring disparity. Since there is no global stereopsis in the absence of local stereopsis, we choose this test as a reference in this study (gold standard)⁴.

MATERIALS AND METHODS:

Subjects - Forty-nine students from Escola Superior de Tecnologia da Saúde de Lisboa (ESTeSL), with between 18-26 years of age were included.

Exclusion criteria:

- vision acuity (VA) of less than 0.8 to near vision and/or distance vision

- heterophorias with slow recovery and heterotropias.

Before stereopsis study was tested the binocular vision:

- cover test to near (nf) and distance fixation (df)

- vergences (convergence and divergence) to nf and df with a fixated object

- near convergence point

The VA was measured monocularly in both distance: 33 cm and 6 m with ETDRS scale.

Stereopsis was measured on each subject using:

- TNO[®], test plates V-VII (15 a 480 seconds of arc) with red/ green filters in fotopico environment, a 40 cm (Figure 1);

- Fly Test[®], the nine stes of four circles (20 a 4000 seconds of arc) with polarized filters in fotopico environment, a 40 cm (Figure 2);

- StereoTAB[®], with red/cyan filters, in mesopico environment a 50 cm. The values of stereopsis depend on the pixel density of the tablet used. In this case, ranged between 65 and 655 seconds of arc (Figure 3).

It was considered normal stereopsis ≤ 65 seconds of arc and abnormal stereopsis > 65 seconds of arc⁵.



Figure 1. TNO[®]



Figure 2. Fly Stereo Acuity Test[®]



Figure 3. StereoTab[®]

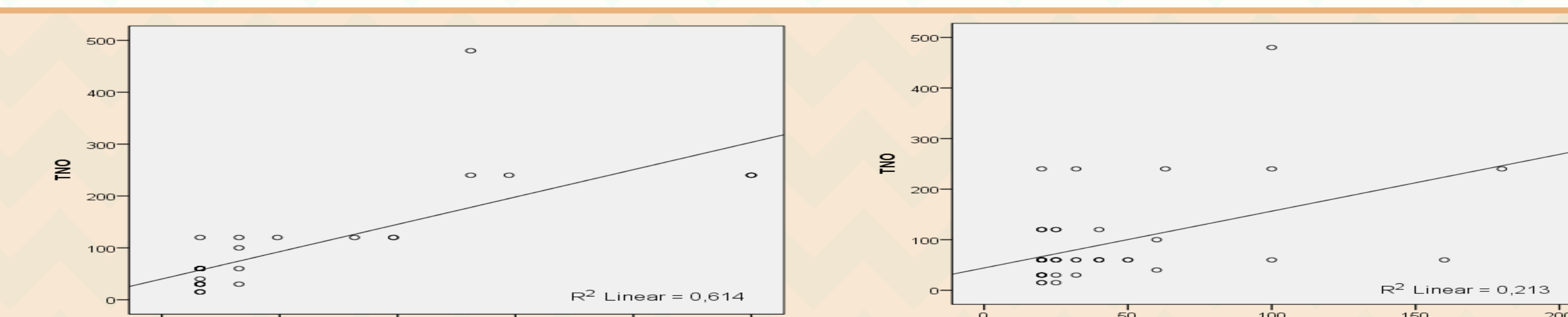


Figure 5 e 6: Scatterplot of TNO vs Stereo TAB and TNO vs FlyTest.

The association analysis of TNO[®] with StereoTAB[®] it was obtained a Phi and Cramer's V = 0.848 (p=0,000), with contingency coefficient (CC) of 0.647. In turn, the association of TNO[®] with the Fly Test[®], it was obtained a Phi and Cramer's V = 0.256 (p=0,74) with CC 0.248. Spearman's correlation coefficient showed a positive correlation between TNO[®] and StereoTAB[®] (r = 0.784). The ROC curve (Figure 7) of StereoTAB[®] is close to the corner (0,1) of the unit square. With an area under the curve (AUC) of 0.934 compared with Fly Test[®], with an AUC of 0.588, showing that StereoTAB[®] achieved the highest performance.

The study of sensitivity and specificity of the StereoTAB[®] and FlyTest[®], having the TNO[®] as gold standard, there is a 92.3% sensitivity for the StereoTAB[®] and 23.1% for the FlyTest[®] and a specificity of 94.4% equal on both tests.

There was no association between the Stereopsis measured by each test and independent variables (symptomatology, optical correction, near convergence point and vergences).

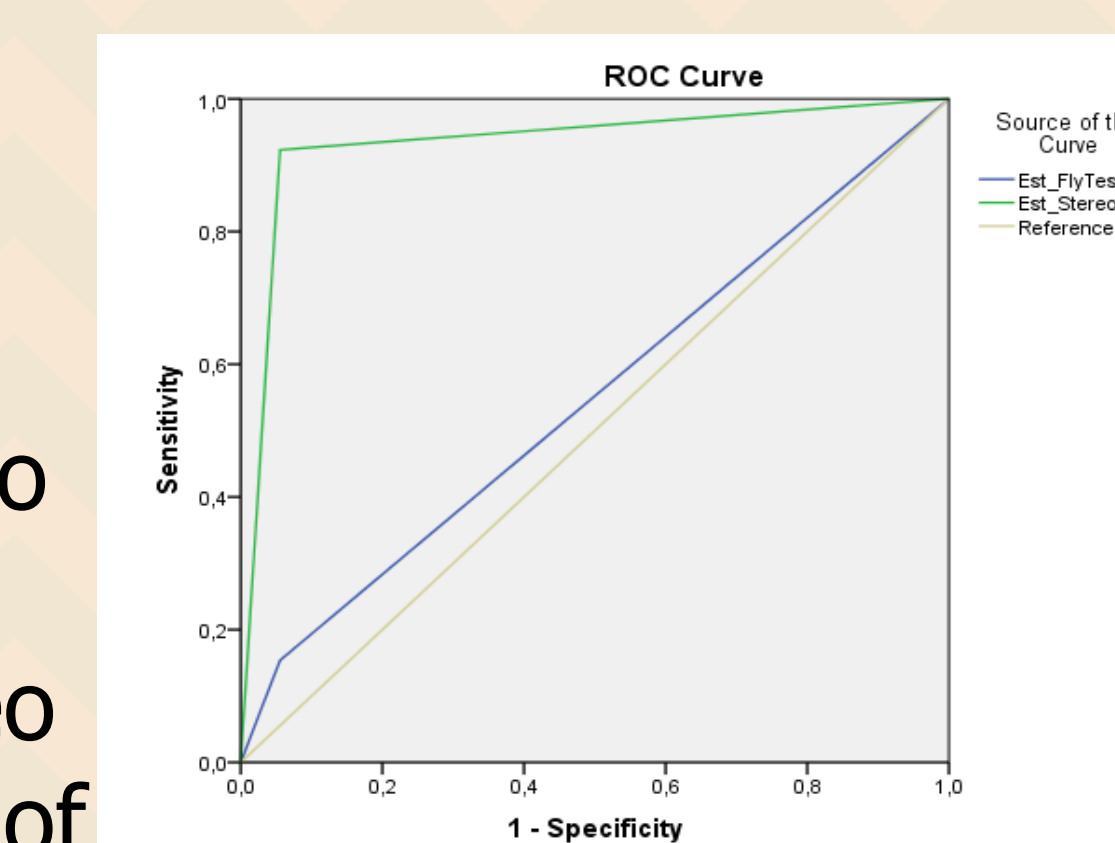


Figure 7. ROC curve of Stereopsis tests tested

AIM:

- ❖ Comparison of stereopsis values using three different tests to evaluate the results of local and global stereopsis: Fly Stereo Acuity Test[®] (Fly Test[®]), StereoTAB[®] and TNO[®], considering the last one as a gold standard.
- ❖ Study of the correlation of stereopsis between all tests
- ❖ Study of the correlation between the TNO[®], the Fly Stereo Acuity Test[®], and the StereoTAB[®]
- ❖ Comparison of the accuracy of Fly Stereo Acuity Test[®] and the StereoTAB[®]
- ❖ Study of the sensitivity and specificity of the Fly Stereo Acuity Test and StereoTAB[®]
- ❖ Analysis of the correlation between vergences, near convergence point correction and symptomatology in relation to the results obtained in each test
- ❖ Determination of the applicability of StereoTAB[®] in clinical study.

RESULTS:

The sample was composed by 49 individuals: 38 (77.6%) were female and 11 (22.4%) males, with average age of 21.53 ± 1.52 years. Average values of Stereopsis: TNO[®] = $87.04'' \pm 84.09''$

Fly Test[®] = $38.18'' \pm 34.59''$

StereoTAB[®] = $124.89'' \pm 137.38''$.

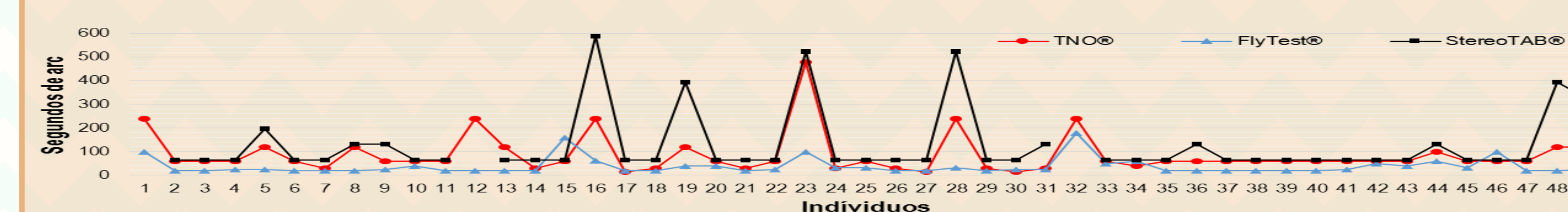


Figure 4: Distribution of Stereopsis values obtained in the three tests, for individual

Figure 4, shows that there is a certain standard of responses between the values of the TNO[®] and StereoTAB[®], with a tendency to be higher (< stereoscopic vision). In turn, the Fly Test[®] shows better results of stereopsis.

Values obtained in all tests were abnormal (28.6% in StereoTAB[®], 26.5% in the TNO[®] and 10.2% in Fly Test[®]).

DISCUSSION/CONCLUSION:

Fly Test[®] achieved the best values of stereopsis for studying the local stereopsis. Our results meet other studies^{3,6}.

The coefficient of determination of the scatter plot, it turns out that there is a pattern at 61.4% of individuals where the greater the stereopsis in TNO[®] is greater that of the StereoTAB[®].

Phi Association coefficient and CC, it was found that there is a strong association between the TNO[®] and the StereoTAB[®], showing a significant positive correlation in the results, as opposed to the weak association between the TNO[®] and the Fly Test[®]. The highest value of AUC was obtained by StereoTAB[®], indicating that the accuracy is higher, showing the best discriminatory power. The Fly Test[®], is a good test to detect people who have normal stereopsis, considering the values obtained for specificity. Taking into account the high values of sensitivity and specificity in the StereoTAB[®] test, this is indicated for individuals who correctly sensing the stereopsis abnormal and normal, making feasible its application, with advantage of being a digital test, with easy access.