Comparison of the measures of stereopsis using 4 different methods

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Purpose: To determine the agreement between 4 different clinical methods for measuring stereoacuity in near vision in two populations groups: children and university students.

Introduction:

The coordination of two eyes in binocular vision is important to the visual perception of depth or for the agility to see three-dimensionally (stereopsis).

Stereoscopic visual acuity (SVA) can be measured by several clinical test some one polarized, some one anaglyphs and other whit real disparity.

Methods:

- Measurements were performed in healthy young subjects (n=55; 21.5±1.56 years old) and children (n=64; 8.5±0.45 years old) . None of the subjects had strabismus, amblyopia, ocular disease or previous history of eye surgery. Monocular best corrected visual acuity at far and near distances ≥ than 0.0 logMAR were required.
- The methods used (*Figures 1 to 4*) were two polarized test: Randot (R), Titmus-Wirt (TW); an anaglyph test: TNO (TNO); and a real stereopsis' test: Frisby (F). All of them were performed following the specifications of each method and under controlled conditions of illumination (L≈450lux).
- For the analysis, the measures of stereopsis were transformed into a logarithmic scale.
- Finally, it was analyzed the agreement of the different stereoacuity results with the standards clinical pass/ fail criteria for each one.

Figure 1: Randot test

Figure 2: Titmus-Wirt test


Figure 3: TNO test

Figure 4: Frisby test

Results:

- The range of stereoacuity results in both groups were 20"-70" for R, 40"-70" for TW, 15"-480" for TNO and 20"-85" for F.
- The table 1 shows the young and children sample's results comparing all the test two by two.

	Differences				T-student		Bland and Altman (CI 95%)			
	Mean (Log)		Median ("arc)		P-value		Lower limit (Log)		Upper limit (Log)	
	Young	Children	Young	Children	Young	Children	Young	Children	Young	Children
R-TW	-0,27 ± 0,11	-0,28 ± 0,08	20	20	<0,001	<0,001	-0,48	-0,43	-0,06	-0,13
R-TNO	-0,33 ± 0,31	-0,32 ± 0,23	30	35	<0,001	<0,001	-0,94	-0,78	0,27	0,14
R-F	0,02 ± 0,16	-0,05 ± 0,19	0	0	=0,399	=0,052	-0,29	-0,43	0,33	0,33
TW-TNO	-0,06 ± 0,30	-0,04 ± 0,22	20	20	=0,112	=0,152	-0,65	-0,48	0,52	0,40
TW-F	0,29 ± 0,09	0,23 ± 0,20	20	20	<0,001	<0,001	0,10	-0,16	0,47	0,62
TNO-F	0,35 ± 0,29	0,27 ± 0,27	40	40	<0,001	<0,001	-0,21	-0,27	0,91	0,81

*Table 1: Results in young and children samples.*

- In both groups the differences between the values converted into a log scale were not statistically significant for any test (p>0.05).
- In both groups, applying the Bland & Altman analysis, the more reduced confidence interval at 95% were found comparing the R vs TW test (Graph 1 *and 2*) and R vs F test (*Graph 3 and 4*).
- In both groups the concordance was ≥95% in TW vs TNO tests and TW vs F tests.
- In children was obtained a high concordance TNO vs F tests.
- The lower agreement in the group of adults was between the R vs F tests (74.5%) and for children between the R vs TNO tests (78%).
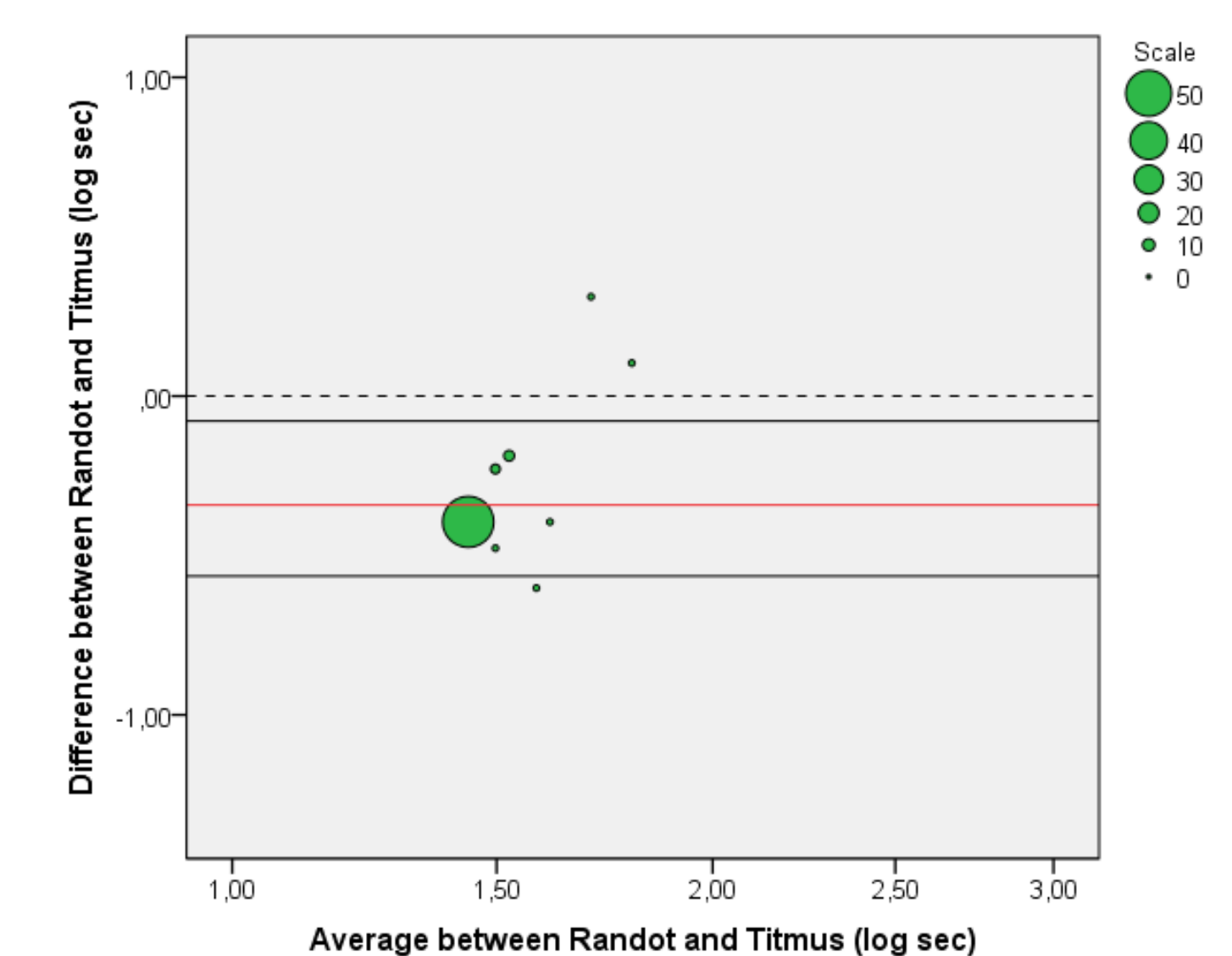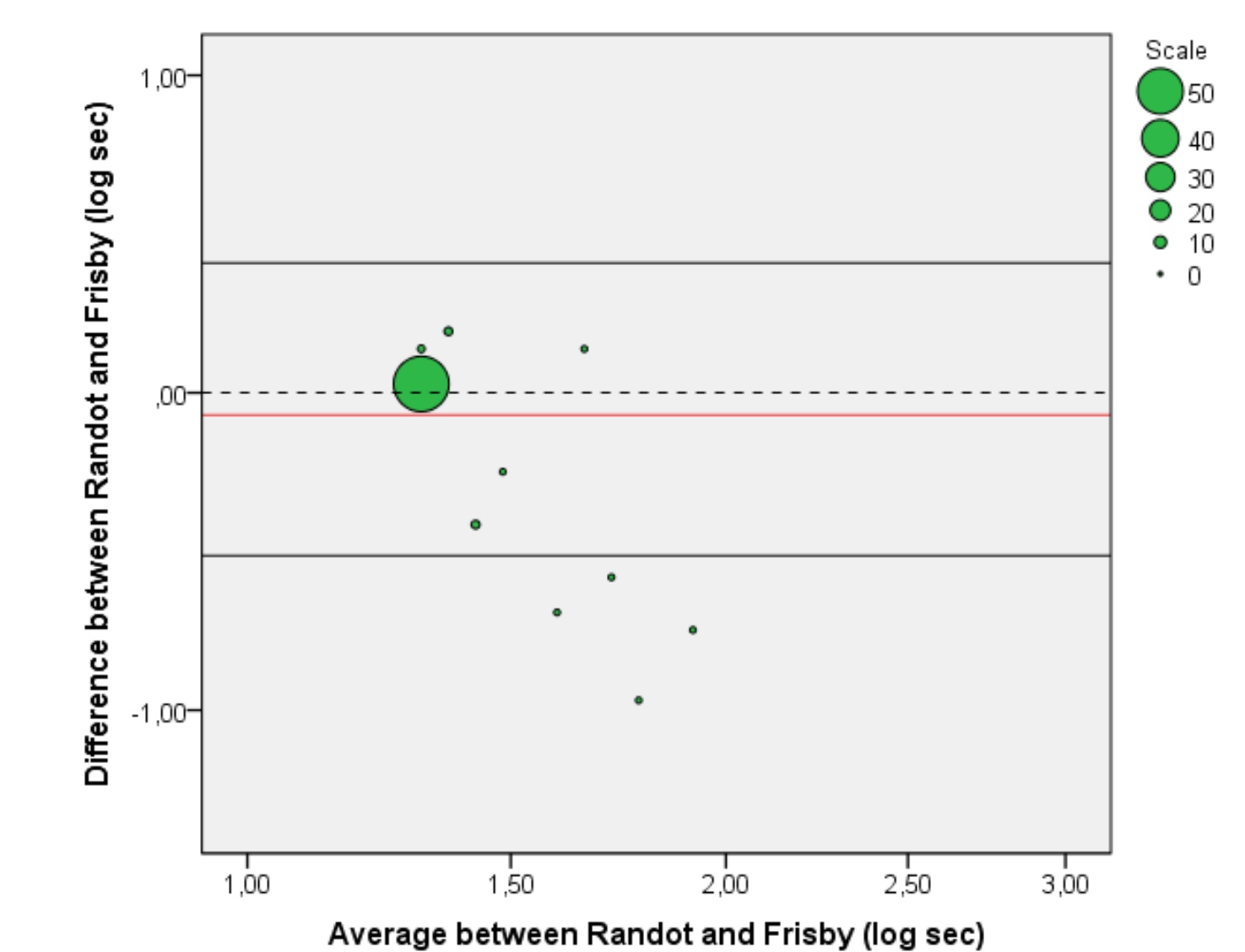

Graph 1: Bland and Altman comparison between Randot and Titmus-Wirt in young sample.
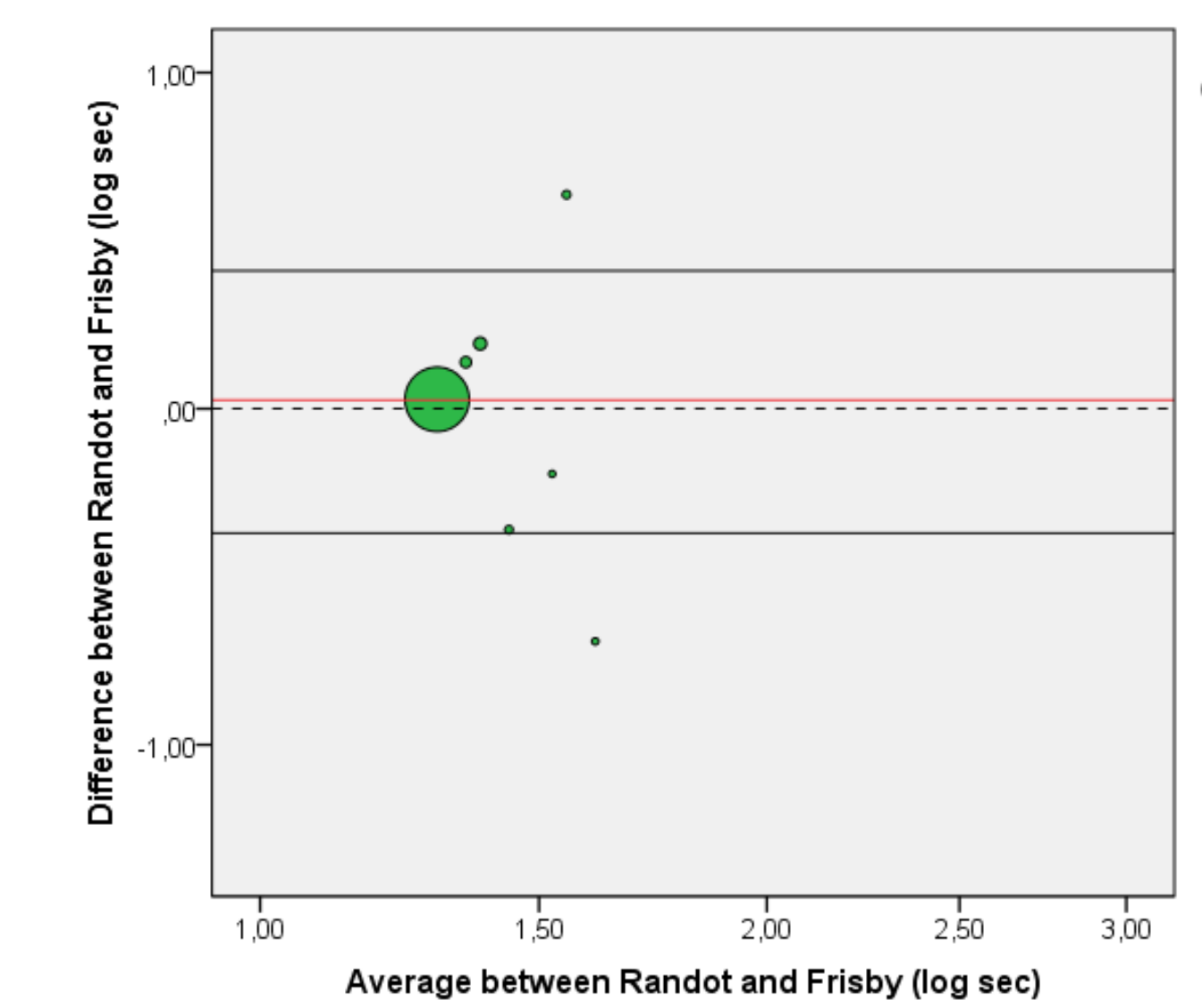
Graph 2:Bland and Altman comparison between Randot and Frisby in young sample.
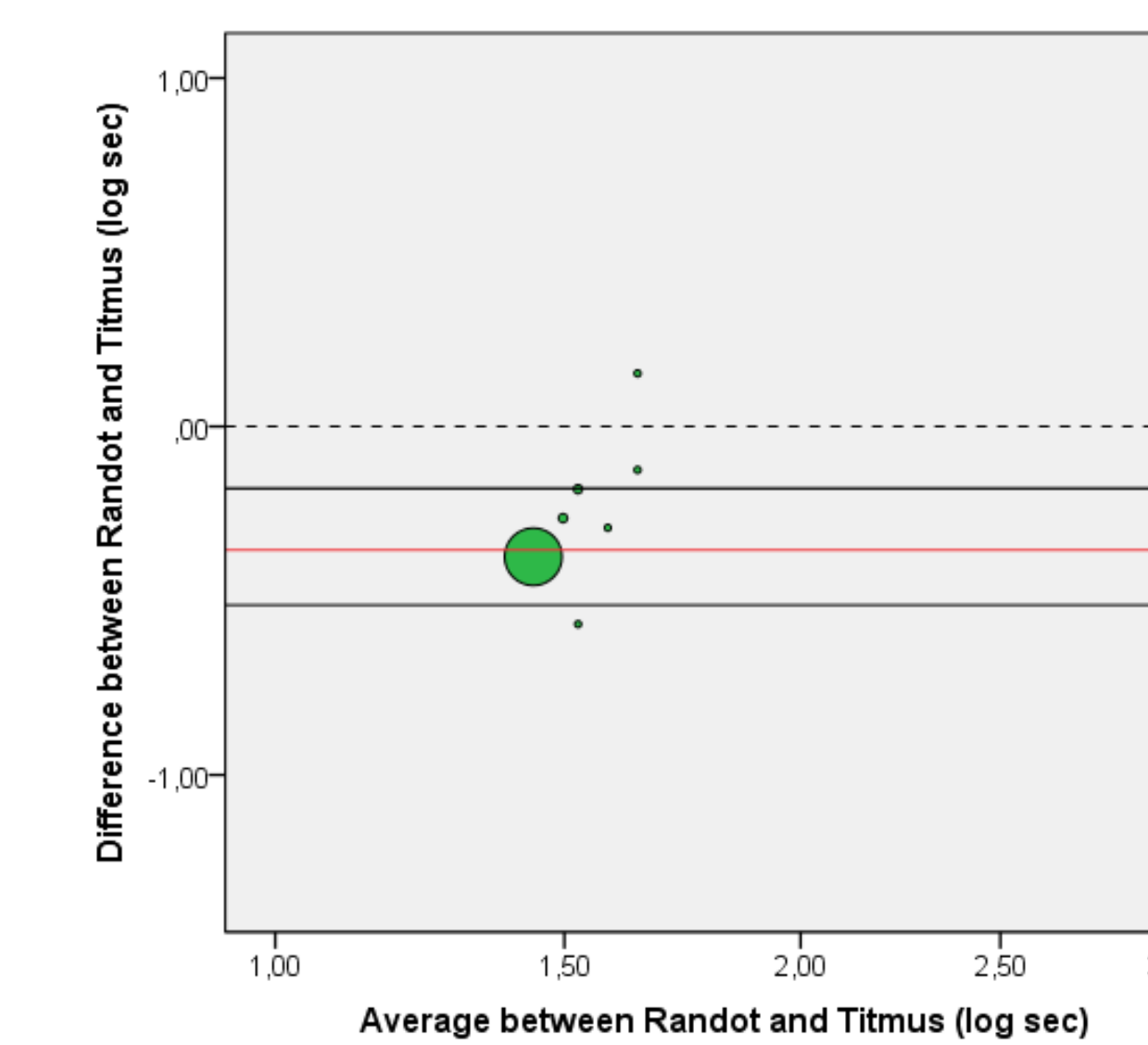
Graph 3: Bland and Altman comparison between Randot and Titmus-Wirt in children sample.

Graph 4: Bland and Altman comparison between Randot and Frisby in children sample.

Conclusions:

1. Studying the relation between clinical tests of stereopsis is a complex task because (1) few tests allow the assessment of stereoacuity threshold due to the lower range of the results is imposed by the measurement tool; (2) the measurement scales are sometimes geometric progressions (TNO and F), or random measurement scales (R and TW), that difficult the analysis of the results.
2. The clinical cut-off criteria showed a high agreement in all cases. The pair of stereoacuity tests that presented a higher agreement was TW and TNO tests in both groups.

References:

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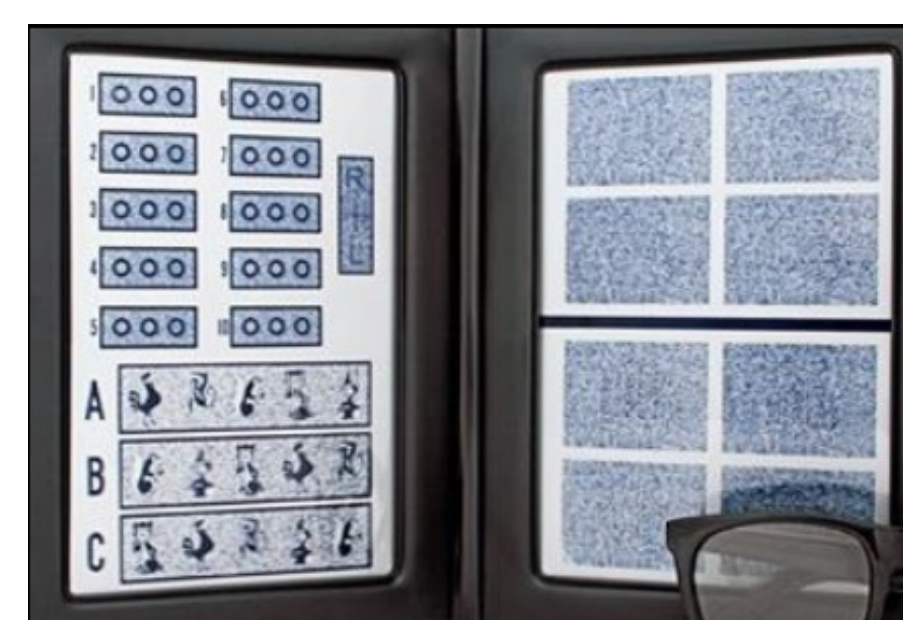3. Howard, Ian P., Rogers, Brian J. (1995) Binocular Vision and Stereopsis. Oxford University Press Inc. Pàgs. 8-30 i 645-657. ISBN: 0-19-508476-4.