



# A Comparison of Three Tests of Stereo Acuity

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## PURPOSE

Testing of stereo acuity is a standard part of the routine optometric examination. The basis of all stereo tests is by using disparity, the subject identifies the shape that appears to be closer. One of the first clinical tests, which is still widely used, is the Titmus Stereo Test, also known as the Wirt Stereo Test, but called by most, the Stereo Fly. This test is a two-page design with the Stereo Fly on the right-hand page and the Wirt Circles on the upper part of the left-hand page (see Figure 1). The lower part of the left page has the Animal test for children. The Wirt Circles test shows four circles each in one corner of a diamond shape. The graded circles on the Wirt Circles go from 800 down to 40 seconds of arc. Limitations of the test include: a top limit of 40 seconds of arc and monocular cues to depth.



FIGURE 1: Titmus Stereo Fly with Wirt Circles. We specifically used the Wirt Circles in the upper left panel which go from 800 to 40 seconds of arc stereo demand.

Random dot stereograms were invented in the 1960's by Bela Julesz and several clinical tests have been made for use by the eye care professions. The Randot Stereo test (see Figure 2) is also a two-page design with one page containing Randot shapes and the other page containing Wirt circles and animals, similar to the Stereo Fly. Unlike the Stereo Fly test, there are 3 Wirt circles arranged horizontally on a random dot background. The graded circles in this test go from 400 to 20 seconds of arc. Random dot tests have less potential for monocular cues to be present or even discernable at all but the stereo targets with the largest amount of depth.

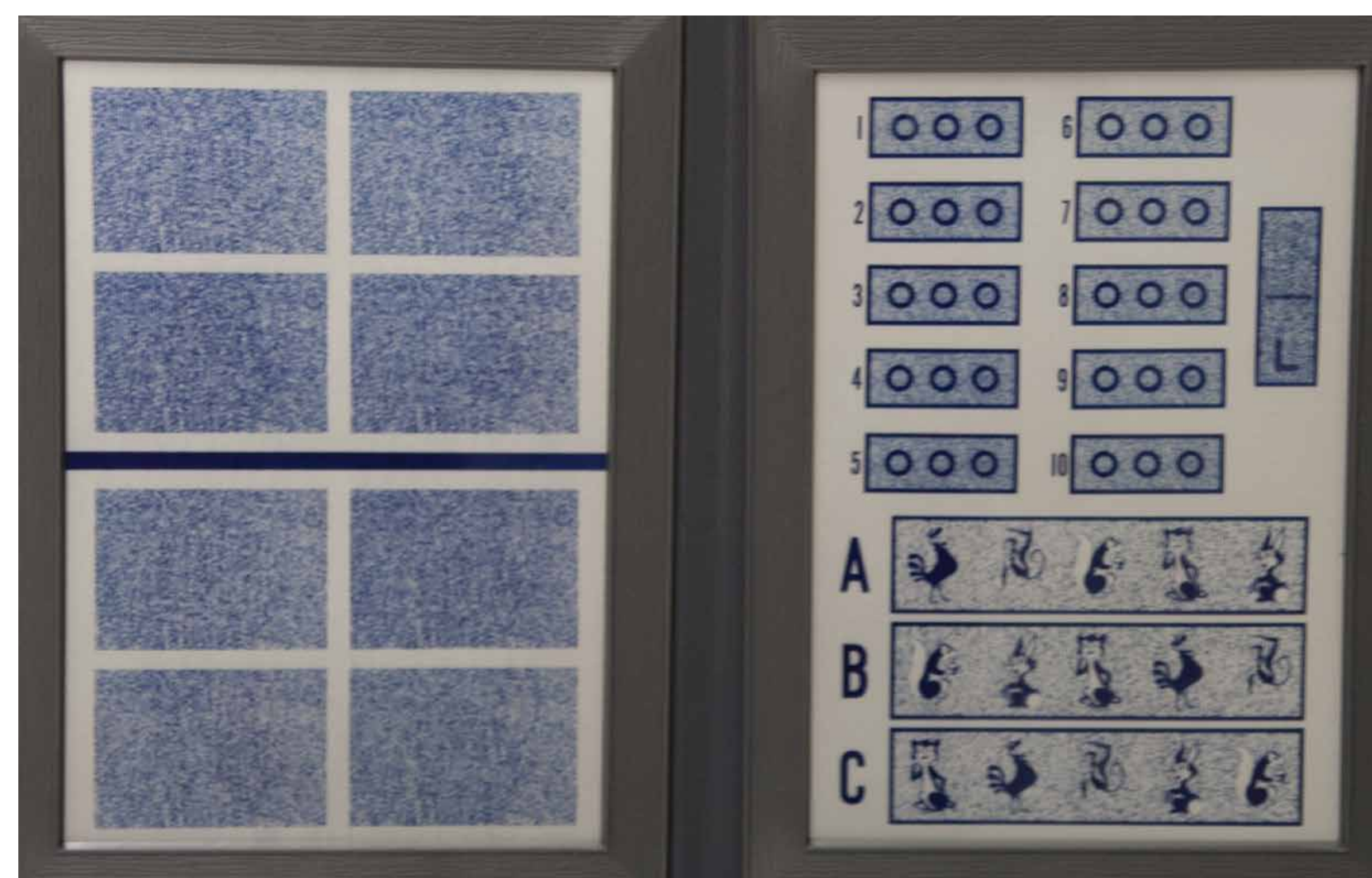


FIGURE 2: Randot Stereopsis with Wirt Circles. The Wirt Circles here go from 400 to 20 seconds of arc. Gradations below 40 seconds of arc include 30, 25 and 20. These Wirt Circles are contoured with a random dot background.

The Random Dot 3 Stereo Test (see Figure 3), is also designed with multiple tests. The larger targets are Lea symbols. The "Wirt equivalent" design has all the circles done with random dot patterns, both the background and the figures. The disparity on this test goes from 160 to 12.5 seconds of arc.

The purpose of this study was to compare the results of the three tests of stereopsis mentioned above to see to what degree they gave similar results. The three tests are: Wirt Circles of the

Randot Stereopsis (WCRS), Wirt Circles of the Stereo Fly (WCSF) and Random Dot 3 (RS3).

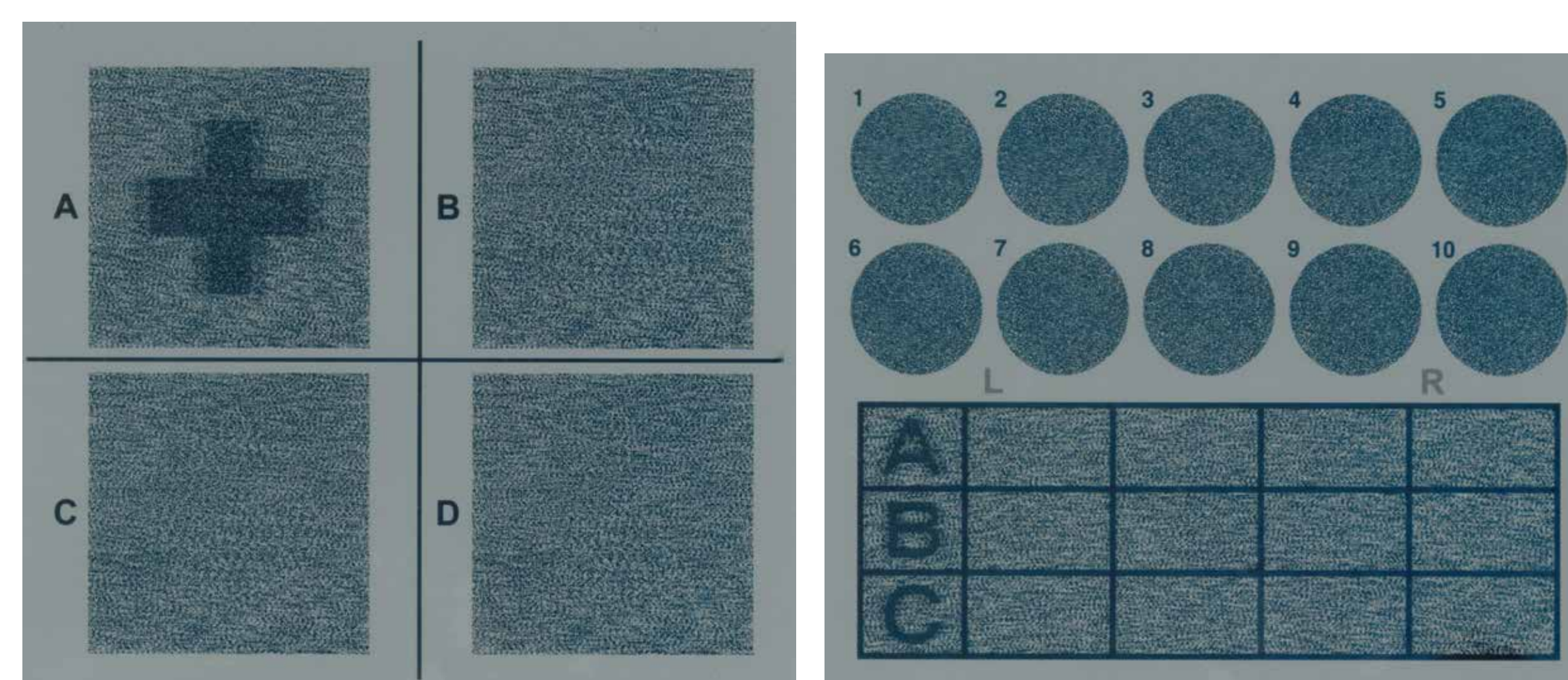


FIGURE 3: The Random Dot 3 stereo test, which has both the figures and the background all done with random dot patterns. The 10 circles arranged in two rows of five each range from 160 to 12.5 seconds of arc demand. Gradations below 40 seconds of arc include 32, 30, 25, 20, 16 and 12.5. The figures in the larger boxes in the upper panel and in the boxes in the lower panel are Lea Symbols.



FIGURE 4: The Wirt Circles that are part of the Titmus Stereo Fly test. In this picture only the left images are seen. In diamond number 1 in the upper left the lower circle is seen displaced to the right. This asymmetry is a potential monocular cue to depth. In diamond number 2 the left most circle is displaced to the right.

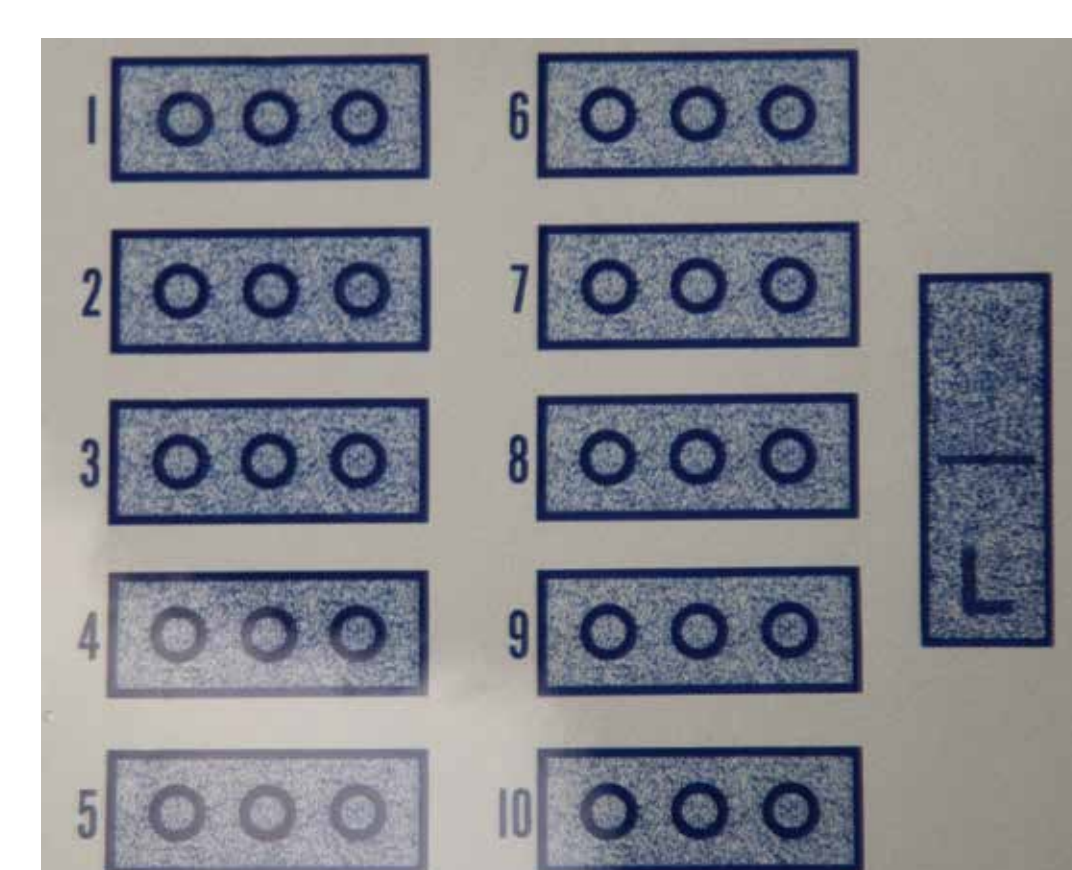


FIGURE 5: The Wirt Circles from the Randot Stereo Test and again only the images as seen by the left eye are seen. Here the subject would have to pick which of the three circles are displaced from where it would be if they were to be symmetrically placed.

## METHODS

122 second and third year SCO students sat as subjects. There were no exclusion criteria. Testing included best corrected visual acuity with the right, left and both eyes, and distance and near cover test.

The order of the three test presentations were randomized. All three tests required the use of Polaroid glasses. Subjects wore their best correction, either in the form of glasses or contact lenses. The Polaroid glasses were worn over the subject's own glasses in those cases where their correction was in ophthalmic lens form. All testing was done at 40 cm with the tests on a stand perpendicular to the line of sight. Lighting was held a constant for all subjects and for all trials by a single subject.

## RESULTS

Because each test had a different endpoint, direct comparison across the entire range of targets was impossible. The maximum disparity for each test is as follows: Wirt Circles with the Stereo Fly Test – 40 seconds of arc, Wirt Circles on Randot Stereopsis – 20 seconds of arc and Random Dot 3 test – 12.5 seconds of arc.

- Over the ranges where the tests covered the same stereo demands there was no statistical differences between the tests. Spearman Correlation Matrix revealed that each test is significantly correlated ( $p < .001$ ). This means that up to 40 seconds of arc, all three tests performed well and they were equivalent to one another. Up to 20 seconds of arc, the Randot Stereopsis tests and the Random Dot 3 test performed the same. Results for each test are illustrated below in Table 1.

TABLE 1

| Test              | % Achieving 40" | % Achieving Max Stereopsis | Max Stereo Value (seconds) |
|-------------------|-----------------|----------------------------|----------------------------|
| Titmus Stereo Fly | 92.11           | 92.11                      | 40                         |
| Randot Stereopsis | 88.60           | 71.05                      | 20                         |
| Random Dot 3      | 91.23           | 45.61                      | 12.5                       |

- There were 83 subjects who achieved 20 seconds of arc on the Randot Stereopsis test. Of those, all but 9 got to 20 seconds of arc or better on the Random Dot 3 test.

## BREAKDOWN BY SUBJECTS

- Strabismic Patients:** The sample included 5 strabismic subjects (4 esotropes and 1 intermittent exotropie). Three of the esotropes were unable to see any target on the Random Dot 3 Test. One of the esotropes was listed as 10 prism diopter esotropie but got 40 seconds of arc on the Stereo Fly, 20 seconds of arc on the Randot Stereo Test and 20 seconds of arc on the Random Dot 3 stereo test. This leads us to believe that the cover test was either recorded incorrectly or the patient was an intermittent esotropie.
- Seven subjects were unable to see any of the targets on the Random Dot 3 stereo test. Three of them were strabismic and were discussed above. One subject who saw nothing on Random Dot 3 got to 50 seconds on the Stereo Fly and 25 seconds on the Randot Stereo Test. The other 3 subjects recorded 40 seconds of arc on the Stereo Fly. When tested on the Randot Stereo test, two got 20 seconds of arc and one got 50 seconds of arc. These four subjects may have used monocular cues to depth. Another explanation is that the test design, the change from contour to full random dot, was enough to account for the differences in thresholds.
- One subject got only to 160 seconds of arc on the Stereo Fly test and 100 seconds on the Randot Stereo test but 50 seconds of arc on the Random Dot 3 test. This was the only subject to show a significantly better result on the full random dot test than the others.

## DISCUSSION/CONCLUSION

Although the Random Dot 3 test contains finer gradations of stereo acuity, the results of this study show that each test is significantly correlated. The results of this study demonstrate that the Random Dot 3 test is not the most difficult of the 3 stereo tests. Furthermore, the impression that subjects or patients do not achieve as fine a stereopsis value is not supported.

Differences in the results may be attributed to the design of the targets (e.g. Wirt circles compared to Random Dot stereopsis). Additionally, the size and thickness of the Wirt Circles in the Random Dot and Stereo Fly Test, are different (see Figure 6). The circles from the Random Dot stereopsis test have a larger overall diameter but smaller thickness of lines, while the circles from the Stereo Fly have a smaller diameter and larger thickness of lines.

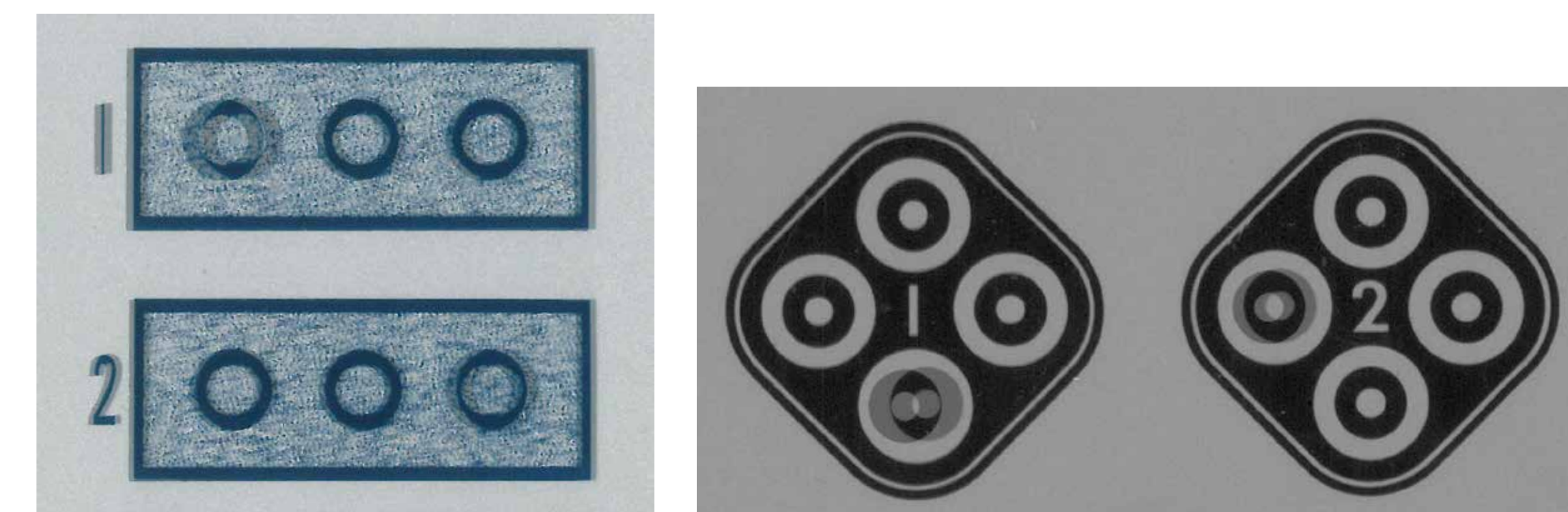


FIGURE 6: Close ups of the two different contoured Wirt Circles with both the right and left images being shown to show the "smudge" effect when viewed without the Polaroid glasses on.

## FINANCIAL DISCLOSURE

Dr. Paul Harris was unpaid and consulted in the development of the Random Dot 3 stereo visual acuity test. He has no direct financial interest in the product nor is he compensated in any way by the manufacturer nor any of the distributors of the test.