A COMPARISON OF THE TITMUS AND T.N.O. STEREOACUITY TESTS

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The purpose of this paper is to compare the Titmus stereoacuity test with the T.N.O. random dot test, and to compare the extent to which scores on each are affected by ocular deviation, visual acuity, and age.

Both tests measure stereoacuity and utilise a book, held at 40 cm from the eyes, combined with special spectacles. Both require co-operation from the patient in indicating the stereoscopically displaced element(s) on each plate.

The tests differ in their methods of differentiating the right and left eye patterns, Titmus using polarisation, and TNO using complementary colours. Another major difference is that Titmus plates have bold contour lines defining each item which is to be compared with another for depth difference, while in TNO the borders of the perceived item are defined by the depth difference itself. The only contours in TNO are the short low contrast ones of individual dots, so similar to surrounding dots that there is little to guide heterophoric eyes into position for fusion.

Additionally, the range of disparities, and the levels tested within the range, differ for the two tests. For the purpose of this study, the stereoacuity required for the Titmus "fly" was estimated at 2400 seconds of arc, and that for the TNO screening pages as approximately 2000 seconds. These being included, the total range for Titmus is from 2400 to 40 seconds, while for TNO it is from 2000 to 15 seconds. Within those ranges, Titmus tests at 10 levels, TNO at 7 levels. The only level common to both is at 60 seconds.

SUBJECTS AND PROCEDURE

Fifty-four orthoptic patients were randomly selected. The age, sensory state, type of deviation, and angle of deviation were then noted.

Each patient was investigated using the commercially supplied Titmus and TNO stereoscopic tests. The order of presentation of the tests varied. Each was carried out as follows:– the patient's most recent optical correction was worn and good illumination was placed above the test book, which was held 40 cm from the eyes and parallel to the patient's face and glasses. The patient was allowed time to adapt to the test, and given encouragement by gentle sideways movement of the test book, and progression to one or two items beyond that on which he first faltered. Results were recorded in seconds of arc, according to the last correct answer.

RESULTS

Overall, of the 54 patients investigated, 45 showed some evidence of stereopsis on the Titmus test, and 37 on the TNO test. Nine showed no perception of depth on either test.

Further breakdown of the figures is shown in the following tables, which examine the relationships of stereoacuity to other variables.

STEREOACUITY AND TYPE OF DEVIATION

Stereoacuity scores on both tests are grouped according to the binocular disorders present, set out in order of increasing severity, namely Convergence Insufficiency, Heterophoria, Intermittent Squint, and Constant Squint. All patients in the first three groups used bifoveal fixation. No bifoveal fixation was recorded for those in the constant squint group, which included some small angle squints, or microsquints.

It will be seen that all convergence insufficinecy patients had fine stereoacuity, appreciating disparities of 60" or less. The proportion of patients with fine stereoacuity is progressively less in the following groups. One exceptional patient in the intermittent squint group had 15" stereoacuity; she had already undergone orthoptic treatment, and gained good control.

Seven patients in the constant group, and two with intermittent squint, showed no stereopsis on either test. The latter two had manifest deviations in the near testing position, due respectively to A exotropia and convergence excess.

These results support the belief that the less the stress or disruption to bifoveal single vision, the better the chance of good stereoacuity, on either test.

DEVIATION ANGLE AND STEREOACUITY

The measurements of deviation (see figure 2) in prism dioptres were made with correcting spectacles worn, and for fixation at 1/3 metre. It can be seen that most acuity scores of 60" and better are associated with exodeviations, and most of the zero scores with esodeviations. Nearly all patients with 40" acuity or better have deviation angles less than five dioptres.

Five patients had a hypertropia or hyperphoria; in four of these stereoacuity was defective.

VISUAL ACUITY AND STEREOACUITY

Stereoacuity is compared with the visual acuity of the worse eye (optical corrections being worn) in figure 3. It can be seen that visual acuity below 6/9 in one eye is associated with stereoacuity below 140 seconds, and that fine stereoacuity is linked with visual acuity of 6/6 or better.

AGE AND STEREOACUITY (Figure 4)

The possibility of reliable responses from patients under the age of 5 years often determines the popularity of a test to be used by orthoptists. Of the patients aged 5 years and younger who indicated any awareness of binocular depth perception, all but one did so on both tests, the youngest being an exceptional 2 year old.

DISTRIBUTION OF SCORE PAIRS

Figure 5 shows the frequency of the score pairs obtained from each patient. The figure in any cell tells how many people gained the particular scores indicated by the line (Titmus) and column (TNO) which cross at this point. The heavy black lines enclose all score pairs which may be accepted as equivalent, in view of the different disparity levels used in each series.

Any score on either test means that the patient's real stereoacuity is at least as high as the score indicates, but is less than the value of the next item beyond it in the series. To take one example, a TNO score of 480" means that the patient has 480" acuity at least, but falls short of 240" acuity. A Titmus score of 400" comes within this range; therefore the cell TNO 480" x Titmus 400" is enclosed in heavy lines. Outside these lines are score pairs which cannot be reconciled in this way.

These points being understood, we may proceed to compare the test results.

COMPARISON OF RESULTS ON TITMUS AND TNO

There is appreciable difference in the score distributions for the two tests. The Titmus distribution (right hand column of fig. 5) has 3 maxima, at zero, 200", and at 40". The TNO distribution (bottom line of table) has two maxima, at zero and at 60". It appears that anyone who passes TNO at the 480" level is apt to go right on to the 60". The Titmus scores are more evenly distributed.

If we ignore four pairs of equivalent, or nearly equivalent, scores near the centre of the table, we have 4 distinct groups to consider. In two, all paired scores show equivalent acuity. The other two groups are of scores consistently higher on one test than on the other.

FIGURE 1

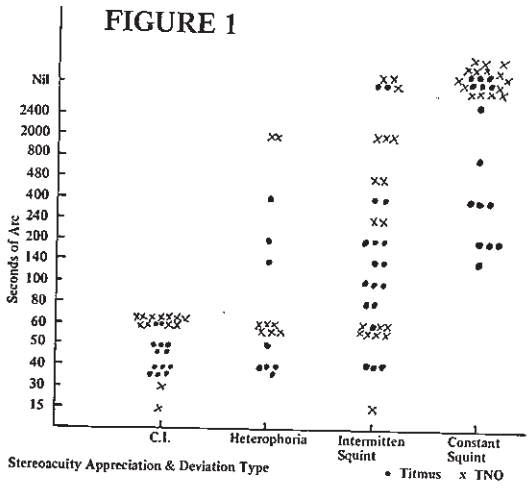
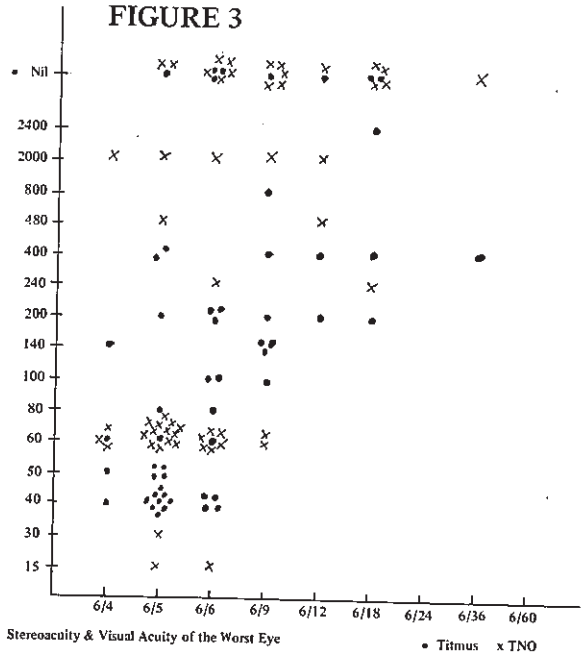


FIGURE 3



ZERO OR MINIMAL ACUITY ON BOTH TESTS

This group of 9 cases is within heavy lines, at the bottom right corner of the table. In all of these, there was manifest squint in the near testing position, 7 being cases of constant squint. Visual acuity of the worse eye ranged from 6/5 to 6/18.

One patient in this group was credited with a pass on the Titmus Fly plate. Walraven (2) claimed that patients responsive to the Fly but failing on the screening plates of the TNO test, could not be proved to be using binocular single vision. This confirms a personal view that without supportive evidence, stereoscopic appreciation of the Fly must generally be viewed with scepticism. Exceptional are the cases of young children who spontaneously reach forward to grasp the wings, with fingers well above the plate. This evidence is convincing enough.

HIGH STEREOACUITY ON BOTH TESTS

The paired scores within heavy lines at top left of the chart record 23 cases with stereoacuity of 60" or better on both tests. They include all cases of convergence insufficiency, five of the eight cases of heterophoria, and four of the seventeen with intermittent squint. All had vision of 6/6 or better in both eyes.

STEREOACUITY HIGHER ON TITMUS THAN ON TNO

This group comprises 16 cases. (See right hand columns above heavy lines in Figure 5.) Nine cases, of which eight were classed as constant squints, showed no stereopsis on TNO tests; the remaining five could manage a TNO screening test (2000"), but no more. All showed stereoscopic ability on the Titmus test, their scores ranging from 800" to 100".

The study of Frisby, Mein, Saye, and Stanworth is relevant here. Patients who demonstrated some response to the Titmus test were selected for the study, which examined their responses to two random dot stereogramms. Both stereograms subtended 12 minutes of arc (720") and were projected in turn on to a screen in front of the patient. A contour outlined the area of disparity in one stereogram; the other had no contour but was otherwise identical.

Frisby's results disclosed that in the presence of fully functional binocular single vision, contours were of no advantage. In patients with reduced binocular function (typically, with microtropia) contours were necessary to enable stereoscopic appreciation, and in patients with more severe binocular defects, contours were again of no advantage. It is at least probable that in the group of cases we are now discussing, the absence of contour lines was the reason for low stereo ability on the TNO tests.

STEREOACUITY HIGHER ON TNO THAN ON TITMUS

The fourth group came as a surprise. Five patients, all scoring at 60" on the TNO series, failed to reach the same level on Titmus. Their Titmus scores ranged from 200" to 80", their ages from 5 to 8 years, and vision of worse eye was 6/6 or better.

Why should these children find the TNO tests easier? Possibilities are that they are helped by the greater area of the disparate elements in the TNO plates, and that the hard-line definition of competing forms on the Titmus plates actually distracts attention from disparity. The emphasis on form definition while a child is learning to read may to some extent inhibit attention to depth. It is not uncommon for a child to give up at the 100" or 80" level on Titmus, and then to complete the test accurately when asked to "guess" the rest.

CONCLUSION

The Titmus and TNO stereotests are both effective measures of stereoacuity where binocular single vision is well established.

The Titmus test will allow stereo appreciation to be recognised if any is present, regardless of the patient's maturity, deviation type or angle, and visual acuity. It is fairly discriminating in the middle range of disparities, providing a means of demonstrating improvement under treatment.

The TNO may be used with advantage to screen visual defects, being effective where bifoveal single vision is used. Its range extends to higher stereoacuity levels than does the Titmus series.

FIGURE 2

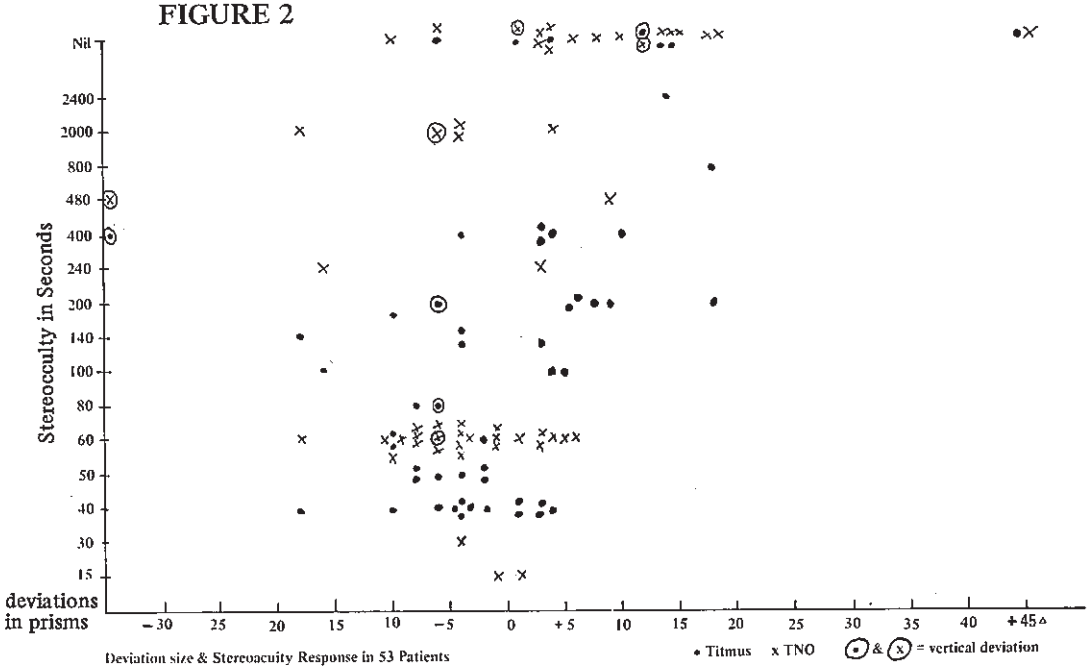
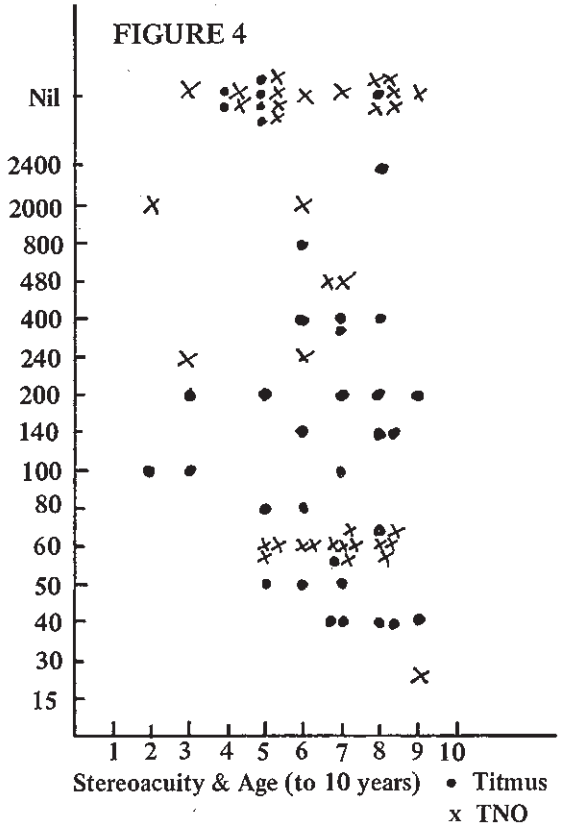


FIGURE 4



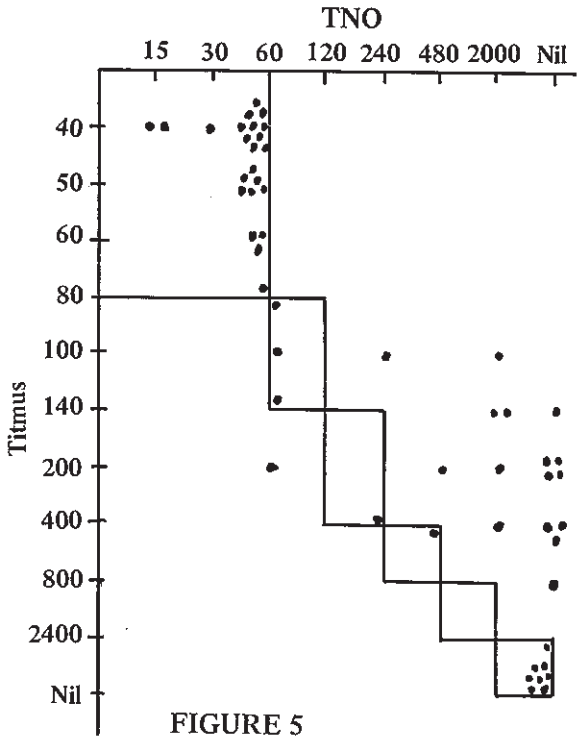


FIGURE 5

REFERENCE

Frisby, J. P., Mein, J., Saye, A., & Stanworth, A. (1975: Brit.J.Ophthal., 59, 545.

Walraven, Frances (1975): Amer. Med. J., vol. 8, no. 5, 873.