Stereo Acuity Rating in Different Age Groups as Tested on Titmus Optical Stereo Tests

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This paper is based on a pilot study carried out on sixty cases of different age groups who were subjected to this new test at random for evaluation of stereo acuity rating (SAR). The study indicated that SAR measured as reciprocal in seconds arc disparity, declined with age. Subjects having binocular single vision (BSV) defects had poor rating when compared with those having good BSV. The usefulness of the test lies in screening the cases for stereopsis and its quantitative measurement for subsequent deterioration.

STEREOPSIS is considered to be the highest grade of binocular function involving motor, optical and neural components of both eyes in achieving normal stereo acuity threshold. It employs contour discrimination by vernier acuity which is ten times more sensitive than visual acuity[5]. Earlier tests employed for depth perception were neither quantitative nor excluded monocular depth determinants. 3 D Vectograph technique developed in the past decade has made it possible to refine this test[3].

Titmus Optical Stereo Tests (TOST), commonly called Titmus fly test, utilize this medium to make it a quantitative test and precludes other monocular depth determinants also. The other variants are wirt, RDE and AO custom projecto-o-chart stereo tests utilizing the same medium.

Vectograph format permits stereoscopically visible and astereoscopically invisible characteristic of the figure when viewed through a polarised glass. The disparate images when fused produces stereopsis. Deterioration of visual functions with age is a common occurrence. Whether it happens with stereopsis has not been documented. This study was undertaken from that angle. TOST was chosen because of easy availability.

Methods and Material

Sample was randomized and sixty cases from those attending the eye out patient department (OPD), divided into two groups (Table I):

(a) Binocular Single Vision (BSV) group of 48 normal subjects having vision of 6/6 N5 in each eye having age distribution of below 15 yrs, 16 to 40 years and above 40 years, equally divided in 48 cases.

(b) Non BSV group of 12 cases having one or more anomalies of binocular vision with mixed age distribution ranging from 7 years to above 40 years.

Battery of three tests on TOST were administered to each subject by a trained technician under standard conditions of testing as given in the

instruction manual of tests. The test object was held at 40 cm straight before the eyes to maintain proper axis of polarization and polaroid viewer was worn over the glasses when used. The three test are:

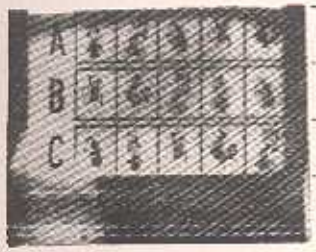
(a) *Fly Test (Fig 1)*—The common house fly is universally known and recogised even by a child and when seen stereoscopically with wings raised, repulsive action is added psychologically. If seen asterioscopically, it appears flat. Presence or absence of binocular association determines whether R & L at thebottom of the picture are simultaneously perceived or not. It measures 3000 arc second disparity raised wing level tips.

(b) *Animal Test (Fig. 2)*—There are three rows-A, B, C-each having five animals and one of them in each row appears raised in decreasing heights from A to C having stereo acuity of 400, 200, and 100 arc seconds disparity respectively. The remaining animals appear flat.

THE HOUSE FLY TEST

Fig. 1

THE ANIMAL TEST



TEST OBJECT	SCORE (SAR) IN SECONDS	ANIMAL SEEN FORWARD
CAT	400 SECONDS	
RABBIT	200 SECONDS	
MONKEY	100 SECONDS	

STEREO TESTS
TITMUS

Fig. 2

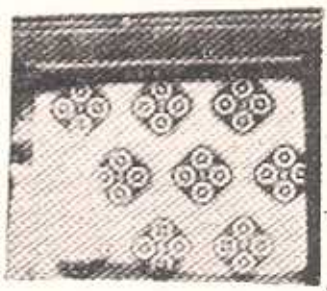
(c) *Circle Test (Fig 3)*—This is a refined quantitative test. The test objects are arranged in nine groups of four circles in three rows. One of the circle in each group is seen raised in decreasing height from 1 to 9 giving a range of 800 to 40 arc seconds disparity respectively.

The complete testing kit comprises of fly, animals and circle tests and a polarised viewer worn by the subject during the test (Fig. 4).

Results and Discussion

(a) *Sex distribution*—(Table II) Both the groups i.e. BSV & non BSV, showed male preponderance. In view of more males attending the eye OPD, it was of no significance.

THE CIRCLE TEST (TOST)



TEST OBJECT	CORRECT ANSWER	SCORE (SAR) (IN SECONDS)
1	BOTTOM	800 SECONDS
2	LEFT	400 SECONDS
3	BOTTOM	200 SECONDS
4	TOP	140 SECONDS
5	TOP	100 SECONDS
6	LEFT	80 SECONDS
7	RIGHT	60 SECONDS
8	LEFT	50 SECONDS
9	RIGHT	40 SECONDS

Fig. 3

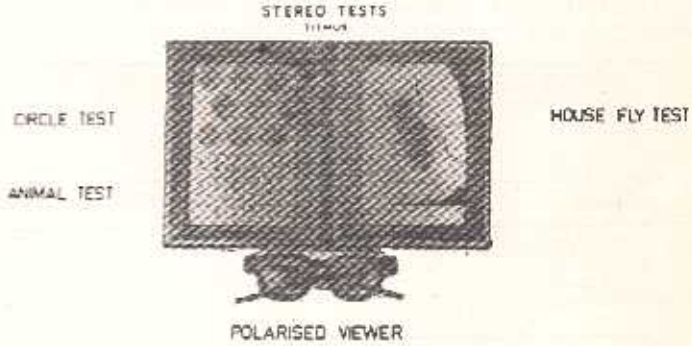


Fig. 4

(b) *Fly test response*—(Table III) It was graded as good if the wings of the fly were perched at a height of 2 cm or more, fair if perched less than 2 cm and poor if it appeared almost flat.

Table—I

Distribution of cases (N-60)

Age Group (Yrs)	BSV Group No	%	Non-BSV Group No	%
<15	16	(26.6)	2	(3.3)
16 to 40	16	(26.7)	8	(13.3)
>40	16	(26.7)	2	(3.4)
Total	48	(80)	12	(20)

Table—II

Age & sex distribution of cases (N-60)

Groups	BSV Group (<15)		(16 to 40)		(>40)		Non-BSV Group Mixed	
Sex	M	F	M	F	M	F	M	F
No.	9	7	10	6	13	3	8	4

Total	No	(%)		No	(%)
Males	32	(53.5)	Males	8	(13.3)
Females	16	(26.7)	Females	4	(6.7)

Table – III

Fly test response N-60

Stereo acuity rating (SAR) 3,000 seconds arc disparity

Group	Age Yrs	Good %	Fair %	Poor %	Total %
BSV Group	<15	33.3	—	Nil	
	16-40	29.2	4 1	Nil	
	>40	27.1	6.3	Nil	
Total	48	43(89.6)	5(10.4)	—	48(100)
Non-BSV Group	Mixed age	R only-5 L only-3 Alternatively -3	3 (25.0)	9 (75.0)	12 (100)

Table—IV

Animal test response (N-60)

Group	Age	Identified ABC	Identified A&B	Identified A only	Failed to identify
		100 SAR %	200 SAR %	400 SAR %	400 SA %
BSV Group	<15	(29.9)	(4.0)	—	—
	16-40	(25.0)	(6.5)	(2.0)	
	>40	(19.0)	(8.5)	(4.0)	(8.0
Total	48	35 (73.0)	9 (19.0)	3 (6.0)	1 (2.0
Non-BSV Group	Mixed age 12	1 (8.4)	3 (25.0)	4 (33.0)	4 (33.3

In the BSV group, none had suppression of either eye 43 cases (89 6%) gave good, 5 cases (10.4% fair and none failed. Stereo acuity threshold wa age related with shift to right in increasing numbe in the age group of 16-40 years and above. In non BSV Group 5 cases had left eye suppression, three right and four alternate suppression 9 cases (75% gave poor, 3 cases (25%) fair and none gave good response. Richard et al cited by Kurt[1] using Random Dot stereogram E test (RDE) in 150 normal children having BSV also showed good results in 86% and poor to failure in 14% which he termed as stereo blind. Our results are in agreement with him. It was later found that microtropia could be the cause of failure on account of defective BSV. In the non-BSV group, Kurt et al[1], in a study of 65 cases of amblyopia in age group of 3-4 years, got good results in 79% cases, on fly test and those who failed had apparently milder dysfunction. This is contradictory to our observation, probably younger age group in his study made more subjects to pass the test inspite of BSV defects since our cases were in the range of 10 to 50 years.

C. *Animal test response* (*Table IV*)—It was good if all the three test animals, Cat (400), Rabbit (200) and monkey (100) in lines ABC respectively were seen (100 arc second disparity). fair if only Cat and Rabbit in A & B line (200 arc seconds were seen) poor if only Cat in A line was seen (400 arc second) and failure if all the three were missed (400 arc second). In BSV group 35 cases (73%) gave good, 9 cases (19%) fair, 3 cases (6%) poor and only one case (2%) failed. In the non-BSV group one case (8%) gave good response, 3 cases (25%) fair, 4 cases (33.3%) failed. Strereo acuity threshold age correlation was maintained. These results were comparable with those of Robert et al[6] who in a study of 70 cases on RDE found average threshold of 103 arc seconds in children having BSV and 500 or more arc seconds disparity or even failure in non-BSV cases.

(d) *Circle test response (Table V)* It was good if the subject read circle 5 and above (100 to 40), fair upto circle 4 (220-140), poor upto circle 2 (800 to 400) and failure if none were read (above 800 arc seconds).

In the BSV group three cases (6%) read 1 to 6 or more circles and thus achieved stereo acuity rating (SAR) 80 arc seconds disparity or better. 39 cases (81.9%) read 1 to 3 or more circle, achieving SAR 200 arc seconds or better rating. Six case (12.1%) could read 1-2 circles only achieving 400 arc seconds disparity. Stereo acuity threshold age correlation was maintained as in earlier tests.

In the non-BSV group, seven cases (58.3%) achieved rating of 200 or better arc seconds disparity and five cases (41.7%) 400 or worse arc seconds disparity.

Thus in the BSV group, the stereo acuity threshold of 100 arc seconds shows marked fall on circle test. In the 100 to 200 arc range results of circle and animal tests are somewhat correllated. In the non-BSV group there was sharp cut off at 100 arc seconds on circle test. None of our cases in the BSV group reached a threshold of 60 arc seconds or lower on circle test against a minimum threshold of 14 seconds arc disparity on other allied tests. This is in agreement with Robert et al[6] who also found threshold range of 220 to 59 arc seconds in BSV group and 500 or more arc seconds disparity in non-BSV cases.

Table—V

Circle test response (N-60)

Group	Age	Identification of circles and SAR in seconds arc disparity)					
	Circles	1-7	1-6	1-5	1-4	1-3	1-2
	SAR in seconds	60	80	100	140	200	400
		(%)	(%)	(%)	(%)	(%)	(%)
BSV Group	<15	(2.0)	(4.0)	(12.5)	(8.5)	(5.5)	Nil
	16 to 40	Nil	Nil	(12.5)	(15.5)	(6.5)	(4.0)
	>40	Nil	Nil	(6.3)	(10.5)	(8.1)	(12.1)
Total	48	(2.0)	(4.0)	(31.3)	(29.5)	(21.1)	(12.1)
Non BSV	Circles	1-4	1-3	1-2	1-Only		
Group	SAR in seconds	140	(200)	(400)	(800)		
	(%)	(%)	(%)	(%)	(%)		
	Mixed age group	(33.3)	(25)	(25)	(16 7)		
Total	12	(33.3)	(25.0)	(25.0)	(16.7)		

Therefore, in our cases fly test proved a good screening test for both BSV and non-BSV cases and circle test at 5 and above eliminated all cases of BSV anomalies. The importance of stereopsis as a parameter in visual evaluation of aircrew, although a controversial subject, need not be underrated[3,4]. Consensus of opinion is that in a complicated task like flying, those having slight edge of better stereopsis over their counterpart make all the difference between an incident and an accident, acomplishment and failure of the task at critical moments. This is particularly so in operations like high speed low level flying and vertical take off and landing. Ageing, stress situations and head injury act as aggravating factors in deteriorations of stereoscopic vision[1]. Therefore its evaluation at entry, recategorisation of head injury cases and change over to another type of aircraft requiring better stereopsis has great relevances.

Conclusion

Our study has shown stereo acuity threshold age linked relationship with a shift to higher threshold with advancing age. Deterioration was marked in non-BSV group than in BSV group. This test is simple to perform and being quantitative can be used for subsequent comparison. We failed to achieve a minimum threshold of 24 to 14 arc seconds disparity in normal subjects reported in literature. TOST or its modifications like RDE and American optical custom projecto-o-chart stereo test may be introduced for better visual evaluation and care of aircrew at entry and as a preflight test at squadron level respectively.

References

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