

Visual acuity testing in young children

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Various tests are in common use for determining the visual acuity (VA) in children, and this paper reports the results of an investigation into some of them in regard to their accuracy, acceptability, and comparability.

Early assessment of the VA is desirable in order to detect any abnormality, but through lack of co-operation and comprehension, it cannot usually be carried out until the age of 3½ years. Visual tests used for children younger than this are based on the responses elicited by an object that can just be perceived, such as small white balls on a black background (Sheridan, 1969), sugar balls, "hundreds and thousands" (Keith, 1968), or optokinetic nystagmus (Lewkonja, 1969), but such tests are not comparable with acuity tests because they measure a much lower degree of vision; the former are testing only the minimum visible while the latter may not be testing the foveal vision at all.

Extensive studies have been carried out by Pugmire and Sheridan (1957, 1960) and Sheridan (1960, 1963, 1969) on visual tests suitable for young children and retarded children, and as a result they developed the Stycar vision tests, the single letter part of which has been included in this survey.

Materials and methods

The tests were carried out by two qualified orthoptists, each working independently in the ophthalmic departments of separate hospitals; 35 children were tested at one centre and 39 at the other. The 74 children formed the following age groups:

<i>Age (yrs)</i>	<u>3-4</u>	<u>4-5</u>	<u>5-6</u>	<u>6-6½</u>
No. of children	12	26	23	13

The children were assessed first on their performance and understanding and secondly on the visual acuity that they achieved with the test.

The tests investigated were Snellen's test type, Beale Collins and Clement Clarke pictures, Landolt broken ring, Sjögren's hand test, Stycar single-letter test, E test, and Ffooks test.

Snellen's test type This is the ordinary card of letters used for adult testing.

Beale Collins (Fig. 1) and *Clement Clarke* (Fig. 2) picture tests These are composed of pictures of varying sizes, the child being asked to name them in turn. The optotypes of the former, used in Group I, are twice the size of Snellen's optotypes, while those of the latter, used in Group II, are the same size as Snellen's, but the details of the pictures were often smaller than the limbs of the Snellen letters.



FIG. 2 *Clement Clarke picture test*

FIG. 1 *Beale Collins picture test*

Sjögren's hand test (Fig. 3) This consists of pictures of hands printed on cards which are held up so that the fingers point in differing directions. The Snellen equivalent of the symbols was changed a few years ago and the new values were used in this investigation.

E test This is probably the most commonly used test in the United Kingdom; it can be carried out in several ways. The E's may be printed on a chart as the ordinary Snellen chart, they may be in the

form of rotatable letters on a chart (used in Group I) (Fig. 4), or they may be individually printed on cards or on the sides of a cube (used in Group II). The child may be asked to communicate his answers by pointing his fingers in the direction of the limbs of the E, or by holding up a wooden E to correspond with the test E.

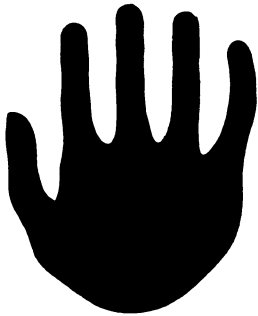


FIG. 3 *Sjögren hand test*

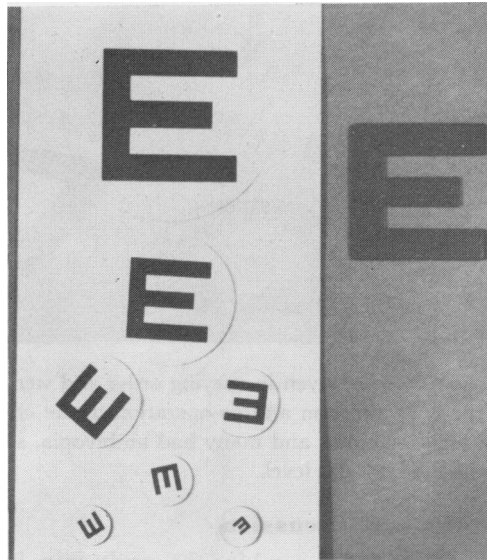


FIG. 4 *E test—Chart with rotating letters and E for child to hold*

Landolt broken ring test This was commonly used in the past for illiterates and is similar to the E test in that the broken ring is printed in various positions and the subject is asked to indicate where the break in the ring is present.

Stycar single-letter test card (Fig. 5) This uses the principle of matching letters. The child is given a card with seven letters printed on it, and another card is held up at the standard distance with one letter printed on it, and the child is asked to point to the corresponding one on his card. The Sheridan-Gardner test is virtually the same as this but it also includes a near vision card.

Ffooks test (Fig. 6, overleaf) This uses only three symbols—a circle, a triangle, and a square—printed on the sides of a cube and, as in the Stycar test, the child is given a card with the three symbols and has to indicate which one he sees on the cube (Ffooks, 1965).

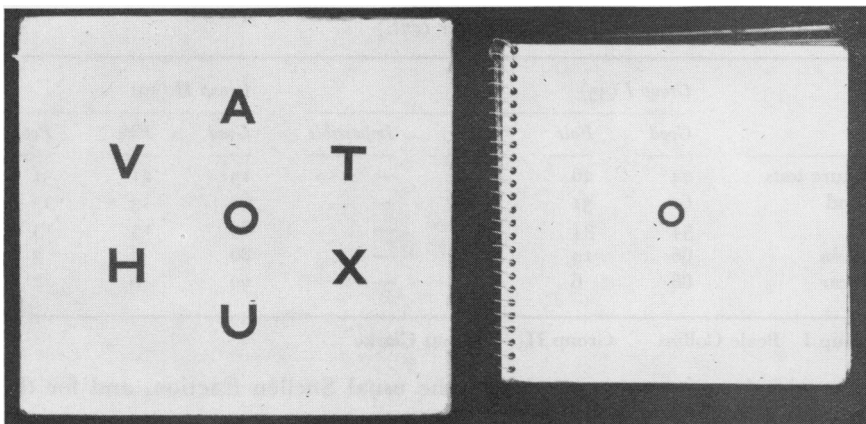
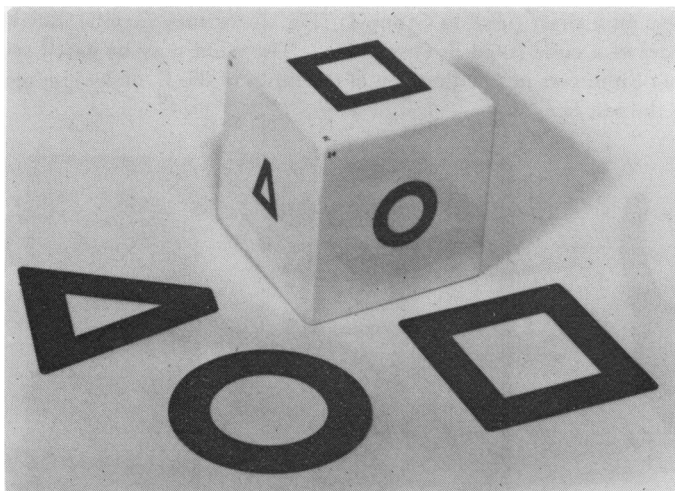


FIG. 5 *Stycar test—Seven-letter card with single-letter test card book*

FIG. 6 *Ffooks test*

The tests were given in varying order and were carried out at one or two attendances depending on the concentration and co-operation of the child. Most of the children were attending for the treatment of squint and many had amblyopia, so that the tests compared various grades of vision, not just the normal level.

Results and discussion

It was intended to combine the results from both groups, but it was found that they differed too markedly so they are presented separately. The results with the Snellen's types and the Landolt ring were so poor that they were eliminated from the investigations. There was usually a good correlation between the performance of a test and the visual acuity achieved. Performance was graded as good, fair, poor, and impossible (Table I). All the age groups are presented together as the results were similar in the separate groups. The Stycar and the Ffooks tests were better performed than the others. The Beale Collins Test published by Davidson gave good results, the E-chart (Group I) was relatively poor, and the Clement Clarke Pictures were particularly bad. There is probably a certain degree of variation due to the different examiners because in Group II 13 per cent. of the children found some tests impossible, compared with none in Group I.

Table I *Performance and cooperation (per cent.)*

<i>Test</i>	<i>Group I (35)</i>				<i>Group II (39)</i>			
	<i>Good</i>	<i>Fair</i>	<i>Poor</i>	<i>Impossible</i>	<i>Good</i>	<i>Fair</i>	<i>Poor</i>	<i>Impossible</i>
*Picture tests	74	26	—	—	15	21	51	13
Hand	60	31	9	—	61	13	13	13
'E'	54	34	12	—	69	15	13	3
Ffooks	86	14	—	—	80	5	3	12
Stycar	88	6	6	—	90	6	2	2

*Group I Beale Collins Group II Clement Clarke

The visual acuity was recorded as the usual Snellen fraction, and for the purpose of comparison it was scored as follows:

Less than 6/60 = 0; 6/60 = 1; 6/36 = 2; 6/24 = 3; 6/18 = 4; 6/12 = 5; 6/9 = 6; 6/6 = 7.

The scores for each test were added up in the different age groups (Table II) together with the totals for all ages in each test. The number of eyes tested are shown at the top of each column and only the numbers in each vertical column can be compared. It can be seen that the Stycar results are the highest in six out of eight columns, indicating that the best visual acuities were recorded with that test. The cube E (Group II), Beale Collins (Group I), and the Ffooks test were the next best, while the E chart (Group I) and Hand were fair, and the Clement Clarke picture (Group II) was poor.

Table II Total scores by age group

Age (yrs)		3-4		4-5		5-6		6-6½		All ages	
Group (No. of eyes)		I (6)	II (18)	I (25)	II (26)	I (28)	II (18)	I (10)	II (16)	I (70)	II (78)
Test	*Picture tests	42	20	158	32	170	46	59	39	429	137
	Hand	30	55	136	121	137	102	52	98	355	376
	'E'	36	72	132	140	139	110	60	107	367	429
	Ffooks	42	61	165	136	162	116	59	104	428	417
	Stycar	38	86	168	152	179	118	66	102	451	458

The visual acuities are scored 0-7 as described and the total added up for each test in each age group; the number of eyes tested is shown in brackets:
 *Group I Beale Collins Group II Clement Clarke

Table III shows the average score for each test in each age group; there is considerable variation even in the oldest age group. In the final column the scores for all ages are shown as a percentage of the maximum possible score. There is a variation of 19 per cent. in Group I and of 58 per cent. in Group II, but if the Clement Clarke picture test is excluded the variation is 16 per cent.

Table III Average score with each test

Age (yrs)		3-4		4-5		5-6		6+		All ages			
Group (No. of eyes)		I (6)	II (18)	I (26)	2 (26)	I (28)	II (18)	I (10)	II (16)	I (70)		II (78)	
										No.	Per cent.	No.	Per cent.
Test	*Picture tests	7.0	1.1	6.1	1.2	6.1	2.6	5.9	2.4	6.1	87	1.8	26
	Hand	5.0	3.0	5.2	4.7	4.9	5.7	5.2	6.1	5.1	73	4.8	68
	'E'	6.0	4.0	5.1	5.4	5.0	6.1	6.0	6.7	5.2	74	5.5	79
	Ffooks	7.0	3.4	6.4	5.2	5.8	6.4	5.9	6.5	6.1	87	5.3	76
	Stycar	6.3	4.8	6.5	5.8	6.4	6.6	6.6	6.4	6.5	92	5.9	84

Number of eyes tested in brackets.
 In the last columns are given the average acuity in all ages and the percentage of maximum possible visual acuity (7) 6/6 = 100 per cent.
 * Group I Beale Collins Group II Clement Clarke

The range of results that may be obtained in the individual child using the different tests is shown in Table IV, where the score for the worst test is subtracted from the best test, the Snellen, Landolt, and Clement Clarke picture tests being excluded. Out of

Table IV Difference in number of lines between best and worst test for each eye (Snellen, Landolt, and Clement Clarke picture tests are excluded from the analysis)

Group	0	1	2	3	4	5	6	7
I	—	23	30	7	8	—	2	—
II	13	30	15	15	2	1	1	2

148 eyes tested, only thirteen scored the same on all tests; 53 had a difference of one line, 45 of two lines, and 22 of three lines. The higher differences can be disregarded as they indicate failure of comprehension, but nearly half the children showed a difference of two or three lines, which is quite considerable when formulating an assessment of a child's visual performance.

This variation with different tests may be accentuated should the examiner show a preference for one test rather than another; for this reason it is advisable to try several tests or to examine a child on more than one occasion should his sight appear unaccountably bad. The E test in its chart form is probably the most commonly used in hospital orthoptic clinics but it was found to give poorer results than the Stycar and Ffooks tests or the single E's. It is well recognized that young children will respond better to single letters than to lines of letters but it has been questioned whether this is still a true measure of the visual acuity; we think it is because it shows that the visual system can analyse symbols subtending a particular visual angle.

There is very little difference between the results obtained with the Stycar test, the Ffooks test, and the cube E but the first was marginally better, especially in the youngest age group. The Stycar test is easy to explain to young children and is rapidly learnt by most of them, there is no confusion between right and left as sometimes occurs in the E-test and it would seem to be the best to use routinely, but other tests should be available for doubtful cases.

The following tests were found to be unsuitable for estimating the visual acuity of young children: Snellen's test type, Landolt broken ring and Clement Clarke picture card. The Beale Collins picture card gave good results, but its pictures are so large that it is difficult to correlate results on the basis of the Snellen fraction.

Summary

In a comparative study of visual acuity tests for use in young children, it was found that the Stycar test gave the best results, while the single E test and the Ffooks test both gave good results. The Hand test and the E chart were intermediate, while Snellen's test type, Landolt broken ring, and Clement Clarke picture cards gave very poor results and must be considered unsuitable for young children.

References

- FFOOKS, O. (1965) *Brit. J. Ophthalm.*, **49**, 312
 KEITH, C. G. (1968) "Symposium on Paediatric Ophthalmology". Royal Society of Medicine
 LEWKONIA, I. (1969) *Brit. J. Ophthalm.*, **53**, 641
 PUGMIRE, G. E., and SHERIDAN, M. D. (1957) *Med. Offr.*, **98**, 53
 ———— (1960) *Ibid.*, **103**, 177
 SHERIDAN, M. D. (1960) *Brit. med. J.*, **2**, 453
 ———— (1963) *Brit. orthopt. J.*, **20**, 29
 ———— (1969) "Vision screening procedures for very young or handicapped children", in "Aspects of Developmental and Paediatric Ophthalmology", ed. P. Gardiner, R. MacKeith, and V. Smith, p. 39. Clinics in Developmental Medicine, No. 32. Heinemann Medical Books, London