VISION ASSESSMENT IN CHILDREN

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INTRODUCTION

The snellen or logMAR chart is the most common tool used for general visual assessment. Consisting of letters or numbers in decreasing sizes, it helps the practitioner determine how well the patient is able to resolve details of high contrast.

However, this method of vision testing is often subjective and highly dependent on the response of the patient. It can be quite a daunting task with patients who do not have the skills to comprehend the required task and respond accordingly, especially in infants and very young children. The good news is that the accuracy of vision testing can be greatly improved with the practitioner having a good knowledge of how to get the best response from the patient, with the right prompting and suitable adjustments to the test setting.

One can always rely on examination of physical signs when a child's visual acuity cannot be assessed, but having an accurate idea of the child's visual status is indeed useful. It can save a child from developing amblyopia, or allow a child's amblyopia to be managed before it becomes irreversible. It can also save the child's family trouble, stress and money with unnecessary visits to specialist clinics when it correctly detects that the child's visual status is normal.

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TERMINOLOGY

Vision vs Visual Acuity

- Visual acuity (VA), in clinical usage, refers to the ability to discriminate fine detail when the refractive error of the eye has been corrected
- Vision (V), on the other hand, refers to the ability of the unaided eye to discriminate fine detail
- Vision with glasses (Vcgls) is the ability to discriminate fine detail when existing glasses are worn.

Each of these measures of visual performances is made monocularly (R & L) and sometimes binocularly as well.

Amblyopia

Amblyopia is a medical term, which describes poor visual development not caused by any eye disease. It is characterised by poor vision that is not correctable by refractive aids. The main causes for amblyopia, or poor visual development, are the following:

- High uncorrected refractive error
- Strabismus or misalignment of the eye
- Clouding/obstruction of the normally clear visual pathway e.g. cataract, ptosis or other abnormalities.

Amblyopia is treatable in most cases. However, the success of treatment is largely dependent on compliance with the treatment protocol as well as the initial level of vision, the length of time the vision has been poor and the age of the child. The treatment of amblyopia usually requires the patching of the 'good' eye in order to 'force' the amblyopic eye to work. Since the success of the treatment decreases with age, it is important to diagnose amblyopia early in order for appropriate treatment to be administered.

Luminance and Contrast

Luminance has a profound impact on visual acuity. In the dark, there is poor contrast and detection of large objects can be extremely difficult. Increased luminance can improve contrast and improve visual acuity.

There must be adequate luminance when a vision testing chart is used so as not to interfere with the results produced.

VISUAL DEVELOPMENT IN CHILDREN

The ability to see 6/6 vision, accommodation, ocular muscle co-ordination and stereopsis are all developed by the age of 6 months in humans. This is a general developmental milestone. Some children may develop later than others, thus it is normal for a child to present with 6/7.5 vision and still be within the normal limits. It is also important to note that even if a child of 6 years of age presents with 6/7.5 vision, it could be due to the fact that the child may have lost concentration during the vision testing and not necessarily due to refractive error.

The maximal critical period in humans, as suggested by research, is from just after birth to 2 years of age. Thus any visual disruption from birth till approximately 4 years of age may lead to an eye turn and/or amblyopia. It is therefore important for the child to have his/her eye check at 9 months to 1 year of age.

POINTS TO NOTE WHEN TAKING VISUAL ACUITY

Occlusion

It is important that an occluder or an opaque card be used for occlusion for vision testing. This reduces the chances of the child peeping from gaps between the fingers, should the mother's hands be used to occlude. If however, the child is very uncomfortable with the occluder, the tester must make sure that the mother uses her palm to cover the child's eye and not her fingers in order to obtain a reliable visual acuity result. Alternatively, for very young children who might strongly object to occlusion, a stick-on patch may be used.

Pinhole

The pinhole test should be done when checking vision if vision is 6/12 or more. The purpose of the test is to differentiate poor vision as a result of uncorrected refractive error from pathological anomalies. If it is purely or partially refractive error, vision will improve with pinhole. However, if pinhole shows no improvement the defect is due to the latter.

TYPES OF VA TESTS

Visual acuity tests may be divided into 2 groups: qualitative and quantitative. While the former is an objective assessment of the child's visual acuity, the latter is mainly subjective. Quantitative VA tests are favoured over qualitative as it gives the examiner a better idea of the child's vision.

Qualitative Tests

Assessment of Fixation

For very young children, fixation may be assessed using a pen torch to attract the attention of the child. The child should look towards the direction of the light. The examiner may flash the light so as to further attract the child's attention. Alternatively, brightly coloured toys or audio objects may be used. Once the child's interest is captured, the examiner should attempt to occlude one of the

child's eyes. The child may object to occlusion but this response should be compared to that of the other eye. If the objection to occlusion is greater in one eye than the other, this could indicate a poorer vision in that eye. The position of the corneal reflection should also be noted. If the corneal reflection is displaced in one eye as compared to the other, it could be an indication that there is poor vision in the eye that is 'squinting'.

Optokinetic Nystagmus (OKN) Drum

The OKN drum consists of a rotating drum with black and white gratings of equal width around the circumference. The principle behind this is that an eye movement will be elicited when an object moves across the child's field of vision, in this case, the stripes on the drum. There will be a fast movement to the opposite direction to take up fixation on the next stripe. An eye movement indicates that the child sees the grating. This is however a gross estimation of the child's visual acuity.

Quantitative Tests

Forced Choice Preferential Looking (FCPL)

This is based on the knowledge that a child prefers to look at a patterned surface rather than a plain one. The child is shown a card with black and white square wave gratings on one side as contrasted to a plain area of the same size on the other side. If the child constantly looks at the gratings, this would mean that the child is able to resolve the pattern. Since the prints are known spatial frequency, the results maybe converted to Snellen's equivalent and recorded according to what the child can see. The Teller Acuity cards, Keeler cards and the Cardiff Acuity Test are some of the common tests used for preferential looking. (Figure 1)

Catford Drum

The Catford drum consists of a white drum with black dots marked around the circumference. The size of the dot ranges from 2/60 to 6/6 and correspond in size to the Snellen letters when viewed from 60 cm. The drum is mounted on a handle and rotates horizontally by a motor. The principle behind this is that an eye movement will be demonstrated when an object moves across the field of vision. Any corresponding eye movement indicates the child sees the target. The level of vision corresponding to the size of the dot is than recorded.

Illiterate visual acuity tests

Illiterate vision test consists of mainly 2 types:

1. Matching test which require the patient to matching a letter or symbol they see on the chart with a replica held or indicated by the child,
2. Naming the picture on the chart, although this can also be used as a matching test when a replica is available.

Sheridan-Gardiner vision tests

This test uses flip-over cards with test targets such as letters H, O, T, V, A, U, X, with letter size

Figure 1: Principle of construction of Snellen letters. *(Photo courtesy of Mandarin opto-medic).*

ranging from 6/60 to 6/3. The letters are replicated on a separate card, which is held by the child. The child looks at a letter target, which is held out at a specified distance (usually 3 or 6 meters) and points to a corresponding letter on the card he is holding.

This test is easily understood by normal 3-year-olds. There are enough letters to eliminate guessing and the test is quick and accurate.

Illiterate E (Tumbling E)

The capital letter E is represented with the short limbs directed up, down, to the left or right, and is presented in decreasing letter size. The child uses a replica E to copy the position of the limbs he sees, or he can also indicate it by placing his fingers in the same position.

There are limitations to this test. There is a lack of choice of target, and many children are confused with copying right and left orientation.

Kay Picture Test

This test is almost similar to the Sheridan Gardiner vision test in that it uses flip cards with symbols equivalent to the Snellen's letter. The only difference is that the Kay Pictures test consists of simple pictures that are easily recognised by children who may not be able to name letter or numbers yet. The outlines are similar throughout the pictures thus reducing the chances of the child guessing. (Figure 2)

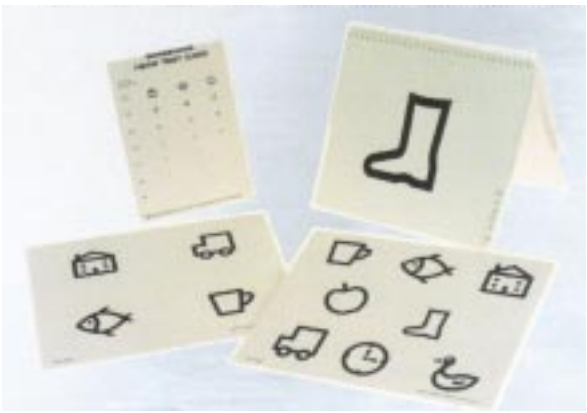

Figure 2. *(Photo courtesy of Mandarin opto-medic).*

Literate visual acuity tests

Snellen Chart

Snellen's chart is imprinted with block letters that decrease in size line-by-line, corresponding to the distance at which that line of letters is normally visible.

The letters on Snellen's chart are called Snellen's test type. Each block letter is quite scientific in design so that at the appropriate distance the letter subtends a visual angle of 5 degrees and each component part subtends an angle of 1 minute. (Figure 3)

The letters are constructed on a grid 5 units high and 4 or 5 unites wide. The Snellen letter is measured by the distance (d) where one unit of the grid subtends 1', or at which the letter height subtends 5'.

For example, the 6/9 letter will subtend an angle of 5' at 9 metres, and the 6/12 letter will do the same at 12 metres. A person would have to be able to resolve the gap between the limbs, or in other words, has a minimum angle of resolution of 1',

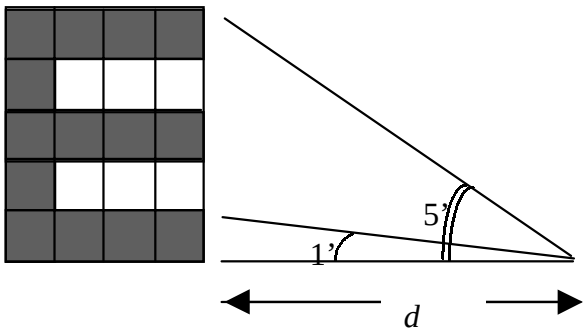

Figure 3

to be considered 'normal' with 6/6 vision.

This chart is easy to use and is widely available. However, the chart lacks certain standardization. It does not have regular progression of letter size, or equal number of letters in each row, and it has variation in the spacing between rows and between letters and even in the type in which the letters are printed. This may result, although infrequently, in non-consistent results when testing with different Snellen test charts, or during repeated testing. (Figure 4)

Figure 4: *(Photo courtesy of Mandarin opto-medic).*

It is conventional for the letters to decrease in size in units of 0.1 logMAR units/row from the top to the bottom of the chart.

If all five letters on the 6/6 line are read the LogMAR score is 0. If one letter is missed on the 6/6 line (all other letters being read on the lines above), the logMAR score is taken as +0.02, 2 letters +0.04 etc. In other words, 0.02 is added for each letter incorrectly read.

The use of the logMAR principle (the geometric progression of letter size and spacing) allows a ready conversion from any acuity fraction using non-standard test distances, to the conventional fraction where 6 is the numerator. The geometric progression also ensures that the acuity test presents letters in equally discriminable increments, and that two-line improvement at any level of acuity will be of benefit to the patient and can be prescribed with confidence. (Westheimer 1979) (Table 1)

LogMAR Chart (Bailey-Lovie Chart)

LogMAR is an acronym for the Log of the Minimum Angle of Resolution. The chart was developed to overcome the shortcomings in the Snellen chart. It was originally proposed by Bailey and Lovie (1976) and has emerged as the test of choice in vision research and is beginning to be adopted in clinical practice.

The logMAR chart contains an equal number of letters on each line and has regular spacing between letters and lines. Letter sizes are in a uniform progression (usually logMAR).

A 6/6 letter subtends 5' of arc vertically. (Snellen Figure). As mention before, 6/6 vision is the same as having a minimum angle of resolution of 1'. Hence logMAR, or log10 of MAR is 0. Therefore a 6/6 letter has a logMAR score of 0.

Table 1. The distance logMAR progression

Standard letter size	6m		Visual Acuity	
(metres)	MAR	(min arc)	$Log^{10}MAR$	Decimal
120	1.26^{13}	20.0	1.3	0.005
95	1.26^{12}	15.9	1.2	0.06
75	1.26^{11}	12.6	1.1	0.08
60	1.26^{10}	10.0	1.0	0.1
48	1.26^{9}	8.0	0.9	0.126
38	1.26^{8}	6.3	0.8	0.159
30	1.26^{7}	5.0	0.7	0.2
24	1.26^{6}	4.0	0.6	0.25
19	1.26^{5}	3.16	0.5	0.316
15	1.26^{4}	2.5	0.4	0.4
12	1.26^{3}	2.0	0.3	0.5
9.5	1.26^{2}	1.59	0.2	0.63
7.5	1.26^{1}	1.26	0.1	0.8
6	1.26^{0}	1.0	0.0	1.0
4.8	1.26^{-1}	0.79	-0.1	1.26
3.8	1.26^{-2}	0.63	-0.2	1.59

CONCLUSION

It is important to obtain an accurate visual acuity from the child as it will determine the type of management that the child will receive. Since a child's attention span is usually relatively short, it is crucial to obtain the child's visual acuity in the shortest possible time. The child's interest should be sustained throughout the test to ensure reliability. Once VA is reliably obtained, the prognosis for the best potential visual acuity is usually good.

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