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# Routine eye examination

## Part 2 – Vision and acuity

This month, **Bill Harvey** and **Andy Franklin** look at the measurement of vision and acuity in the consulting room. C7813, one general CET point, suitable for optometrists and DOs

Visual acuity is a measurement of a patient's ability to resolve detail. It usually involves directing a patient to identify targets, at a set distance, which are of ever decreasing size and typically of high contrast until they can no longer be identified. The recognition of high contrast targets at the highest spatial frequency is useful for standardised assessment, but is not representative of the visual environment within which the patient lives.

Thus it will not truly represent the patient's visual ability. The unaided visual acuity (usually called the vision) is useful in estimating refractive error before assessment and represents important baseline data where a patient does not use, or perhaps does not need to use, their correction all the time. The acuity with their current correction is known as the habitual visual acuity and the resultant visual acuity after refraction. Full correction of the current refractive error is known as the optimal visual acuity.

It is essential for an optometrist to note either the vision or habitual visual acuity prior to any clinical assessment, in case of any legal action taken as a result of the examination. Both monocular and binocular acuity should be noted as there may be a discrepancy, such as when a nystagmus patient shows significant acuity improvement when in the binocular state.

Although there are several ways to specify target size on test charts, the most widely used system was introduced by Snellen in 1862. He assumed that the 'average' eye could just read a letter if the thickness of the limbs and the spaces between them subtended one minute of arc at the eye. Thus the letter E would subtend five minutes of arc vertically. Snellen notation requires the acuity allowing the eye to resolve such a letter to be noted down as a fraction with the viewing distance (usually in metres and commonly 6m) over the distance at which such a target would subtend five minutes of arc vertically. Thus at 6m a 6/6 letter subtends five minutes of arc vertically, a 6/12 letter 10 minutes and a 6/60 letter 50 minutes. The Snellen fraction may also be written as a decimal, eg 6/6 = 1, 6/12 = 0.5 and 6/60 = 0.1.

An alternative is to record the minimum angle of resolution (MAR). This relates to the resolution required to resolve the elements of a letter. Thus 6/6 equates to a MAR of one minute of arc, 6/12 to a MAR of two and 6/60 to 10. The logMAR score is the log10 of the MAR, so is zero for 6/6 and one for 6/60. This means that targets smaller than the 6/6 letters, which would be expected to be resolved by a young healthy adult, would carry a negative score value. Some acuity values are shown in different notation in Table 1.


**Figure 1** Standard Snellen chart

**TABLE 1**
**The relationship between different acuity scales**

| Snellen | Decimal | MAR | logMAR |
|---|---|---|---|
| 6/60 | 0.10 | 10 | 1.000 |
| 6/24 | 0.25 | 4 | 0.602 |
| 6/12 | 0.50 | 2 | 0.301 |
| 6/6 | 1.00 | 1 | 0.000 |
| 6/4 | 1.50 | 0.667 | -0.176 |

### LogMAR notation

Though Snellen notation is still in widespread use, there are criticisms of the standard Snellen chart as shown in Figure 1.

There are fewer large letters so providing an unequal challenge to those

**PRODUCT LIST**
**These are some of the UK suppliers of instruments needed to measure vision and acuity**

- BIB Ophthalmic Instruments
- Birmingham Optical Group (Nidek)
- Buchmann
- Carleton
- Grafton Optical
- Haag Streit
- Institute of Optometry
- Keeler
- Norville
- Optimed
- Thomson Software solutions
- Topcon
- Sussex Vision

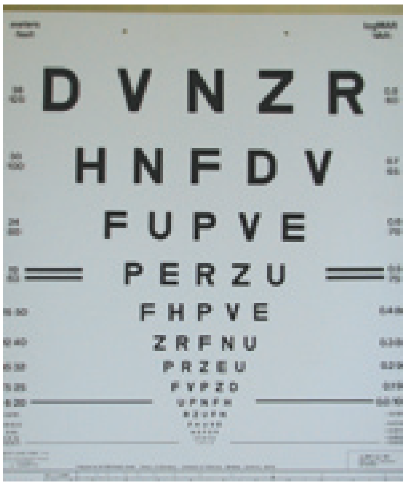


**Figure 2** Bailey-Lovie chart

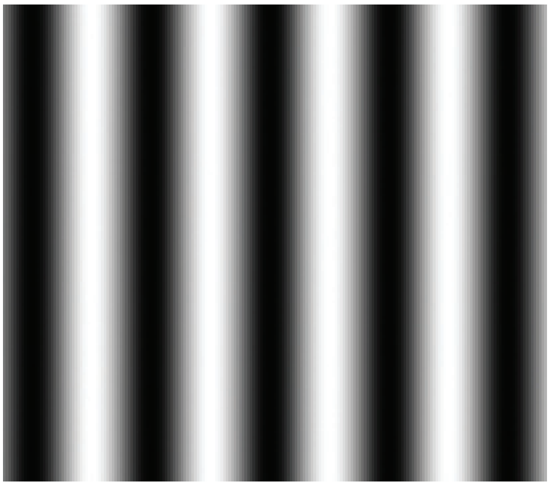

**Figure 3** The ability to resolve the grating reduces as the contrast is reduced

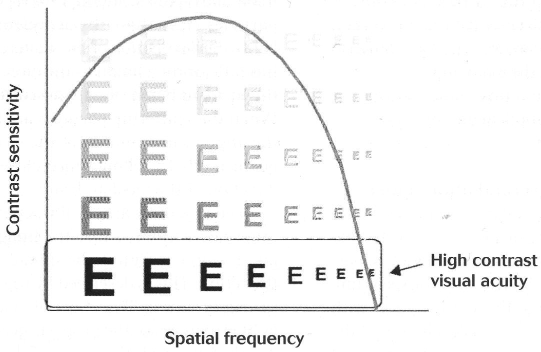


**Figure 4** The contrast sensitivity function curve

with reduced vision. The letter spacing reduces, leading to crowding on lower lines, the line separation is not regular so the challenge changes on reading down the chart – meaning that moving charts to different working distances alters the demand on acuity. A useful way to understand this is as follows: If a patient can just about see the 6/12 line at 1m, one might expect them to be able to just resolve the 6/24 line at 2m. However, because the 6/12 line has more letters which are closer together then this is actually a harder task than the 2m 6/24 target. The two are not comparable. For this reason, moving the standard Snellen chart is not useful when changeable working distances are required.

LogMAR charts, such as the Bailey-Lovie chart (Figure 2), address some of these shortcomings by having spacing between letters on each line related to the width of the letters and between rows relating to the height of the letters, and an equal number of letters on each line. This provides a constant task as the patient reads down the chart, allowing it to be viewed at different working distances and the acuity to be more easily correlated. Such charts have been found to give greater repeatability of measurement and be more sensitive to detect interocular acuity differences.

LogMAR scores may be noted on record cards, either relating to the smallest target line size seen or using the visual acuity rating where 0.02 is added for every letter missed on the line. So where a patient just manages the 6/6 line and no more they are scored as zero. If they miss two letters on this line they are scored as 0.04. Until this notation becomes universally accepted, Snellen notation is still appropriate for referrals and inter-professional communication. Most logMAR charts in use are calibrated for a working distance of 4m.

When one has to reduce the distance, for example for a low vision patient, it is useful to remember to add 0.3 to the score for every time the distance is halved. For example, the ability to read the top line at 4m would be scored as acuity of 1.0. At 2m, this would be scored as 1.3.

Where letter recognition is not possible, for example with small children or patients of different literacy, a whole range of picture and line targets are available. Some require identification, others matching of targets with a separate key card. For the very young, the use of gratings of different spatial frequency next to blank targets may be presented to see if the infant's attention is directed to the grating. Such preferential-looking tests have been found to show good repeatability in paediatric assessment.

## Contrast sensitivity testing

There is a strong argument for assessing the contrast sensitivity of patients during a routine eye examination. However, because of the relative difficulty in assessing changes in quality of vision during the refraction and correction process, together with variations in recording of results, the assessment is rarely included in all but specialised routines (such as the assessment of the visually impaired).

The ability to resolve targets varies significantly with the contrast of the target. The visual world a patient inhabits is one of varying target size and contrast and, furthermore, diseases affecting vision may affect the ability to resolve these targets in a selective manner. The use, therefore, of high contrast targets for acuity testing has been criticised as non-representative of the visual world and less than sensitive at reflecting visual reduction due to disease. If a patient is shown a sine-wave grating of a constant spatial frequency, as shown in Figure 3, their ability to resolve the grating reduces as the contrast is reduced until a point is reached when it can no longer be resolved. This point, the contrast threshold (the reciprocal of which is called the contrast sensitivity), is different for different spatial frequencies and the plot of the threshold values against spatial frequency is described as the contrast sensitivity function (CSF), as shown in Figure 4.

Snellen acuity relates to the resolution of a high contrast target of maximum spatial frequency and is, therefore, represented as the cut-off point on the horizontal axis on this curve. This is sensitive to conditions affecting mainly high spatial frequencies, such as refractive error, but less sensitive if lower spatial frequencies are affected, as with cataract, corneal disturbance and contact lens wear.

Increasingly, clinicians are using targets of different contrast to assess the influence upon acuity. LogMAR charts are available in different contrasts, so assessing the patient's ability to resolve increasing spatial frequencies at a given contrast value. Computerised acuity charts, such as the Test Chart PRO shown in Figure 5, allow any contrast value to be preset.

Other charts, such as the Pelli-Robson (Figure 6), use a constant letter size (approximating to one cycle per degree if viewed at 1m) and gradually reducing contrast as the chart is read by the patient. In theory, varying the working distance would allow the whole contrast sensitivity function to be assessed with a Pelli-Robson chart, but in practice this is rarely needed as high and low contrast acuity scores combined with contrast sensitivity at 1m with a Pelli-Robson is usually sufficient to suggest any visual compromise.

## Routine

At the outset of the assessment, the optometrist should establish acuity and


**Figure 5** Test Chart PRO in the consulting room (left) and on a laptop for domiciliary use

vision and the following list represents a few important points to bear in mind when doing so:

- Binocular followed by monocular acuity is useful. The binocular acuity is occasionally different to the monocular (for example, much better in many nystagmus patients). Also this order allows an assessment of acuity prior to the breakdown of a less stable binocular state once an occluder is introduced
- The acuity with current spectacles is useful as it represents the patient's actual experience. It is important, therefore, to simulate as closely as possible the typical viewing conditions for the patient (usually with the room lights on)
- If one eye is known to have poorer vision, this should be assessed first to minimise any learning of targets
- An occluder should be used and checked for correct placement. Use of hands should be avoided as often the patient may see through a gap between fingers not apparent to anyone else
- Any indication of the quality of the acuity should be noted, together with the notation for the minimum target size seen (for example 'blurred 6/12-1, or 6/48 viewed eccentrically)
- For distance acuity, note should be made of the correction being worn and its condition
- For near acuity, a target distance relating to the patient's everyday experience (computer or reading distance) should be adopted. For near visions, the distance at which the best vision is achieved gives some clues about the uncorrected refractive error and this should be noted
- When uncorrected vision is poor, it is better to attempt some sort of quantification than to rely upon imprecise statements such as 'count fingers'. If the patient is mobile they may be moved closer to the chart, though a moveable chart is preferable (as long as the appropriate adjustment is made to the acuity measurement).

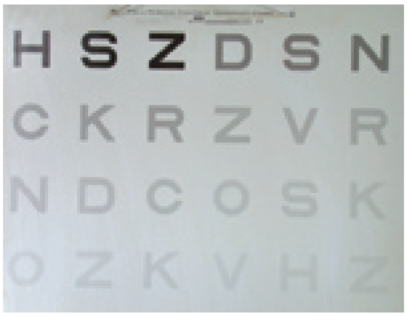


**Figure 6** Pelli-Robson chart


**Further Reading**

Harvey W, Franklin A. *Eye Essentials; Routine Eye Examination*, Elsevier Science 2005.



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## MULTIPLE-CHOICE QUESTIONS

**1 What angle would lines from the top and bottom of a 6/6 letter 'E' subtend at the retina from 6m?**
**A** 1 minute
**B** 5 minutes
**C** 6 minutes
**D** 60 minutes

**2 What is the minimal angle of resolution required to resolve the 6/6 letter 'E' at 6m?**
**A** 1 minute
**B** 5 minutes
**C** 6 minutes
**D** 60 minutes

**3 What is the logMAR equivalent of 6/60?**
**A** 0
**B** 0.1
**C** 0.5
**D** 1.0

**4 A patient reads all of the 0.6 line of a logMAR chart at the appropriate distance and two letters from the line below. What is their acuity?**
**A** 0.6 + 2
**B** 0.62
**C** 0.64
**D** 0.56

**5 A patient reads the 0.6 line of a 4m Bailey-Lovie chart at 2m. What is their acuity?**
**A** 0.6 + 2
**B** 0.3
**C** 0.9
**D** 1.2

**6 What is the normal viewing distance for the Pelli-Robson chart?**
**A** 1m
**B** 2m
**C** 4m
**D** 6

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