

Practical Station 1: Form vision

Form vision is the ability to discriminate spatially separated visual stimuli. It is demonstrated by testing visual acuity, which is defined as a measure of the resolving power of the visual system. The most common way to measure the eye's resolving power is to ascertain the visual angle subtended at the eye by the smallest detail of finite size the observer can detect in a target.

Historically, the Minimum Angle of Resolution (MAR) was considered to be 1 minute of arc ($1/60^{\text{th}}$ of a degree) since it was thought that this was the smallest angle between two stars in space that could still be resolved as separate. It has since been established that the resolving power of the visual system of a young healthy person is usually better than this, however.

Why is visual acuity described in angles? **To prevent the distance of presentation affecting the level of vision measured as closer objects are easier to see.**

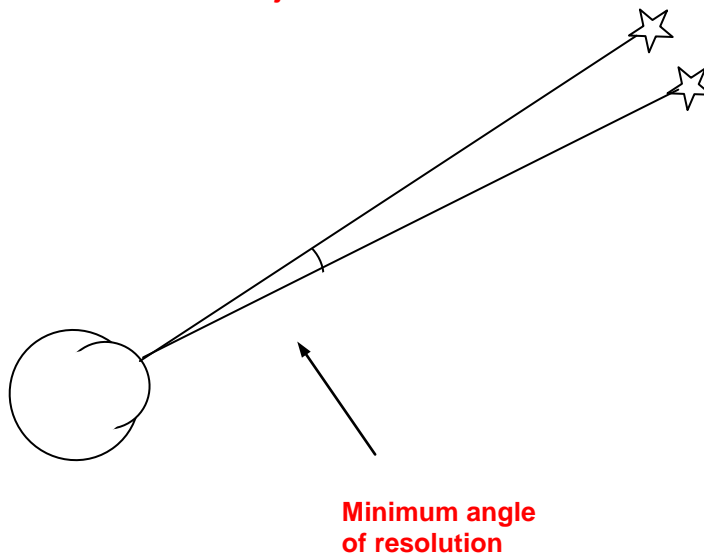


Diagram copyright University of Auckland Staff

Visual acuity charts

These charts have been designed such that each limb of each letter subtends 1 minute of arc whilst the whole letter subtends 5 minutes of arc. Each letter is therefore constructed on a 5x5 grid (Figure 1). Vision measurements are usually recorded at ____ metres in New Zealand.

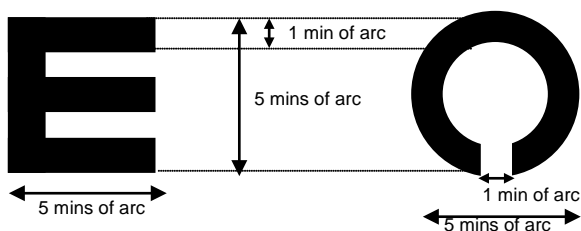


Figure 1

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Visual acuity is recorded as a ratio of the test distance / the distance at which the correctly read letter would need to be from the subject, for its components to subtend 1 minute of arc at the eye.

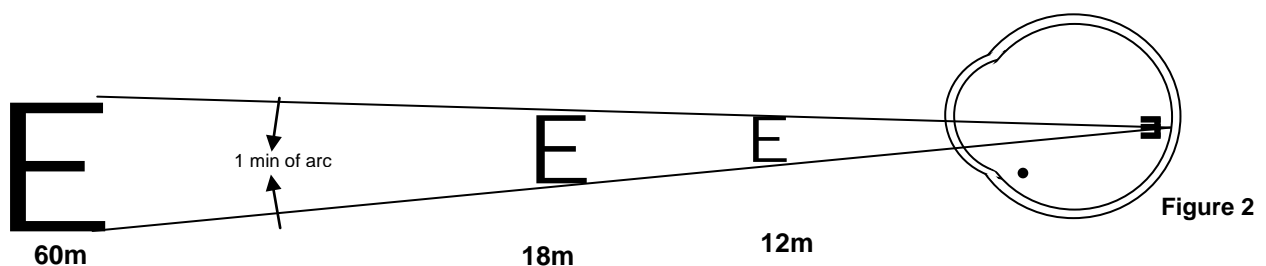
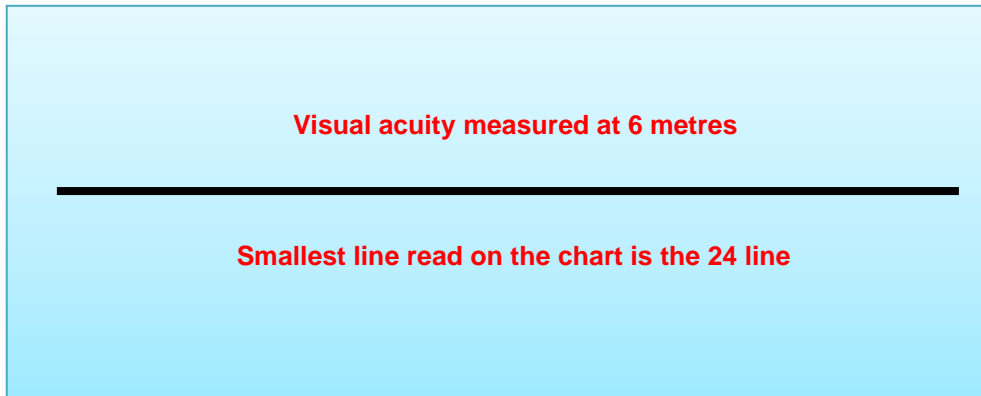


Figure 2

Describe the visual acuity ratio of 6/24:



Vision is traditionally measured with the Snellen chart (Figure 3) at 6 metres from the patient. However, the progression in letter size between the lines on this type of chart is not constant and, therefore, charts with log-based increments are now more popular (LogMAR charts). Illiterate E charts are useful in cases where the patient cannot read the standard letter chart (Figure 3).



Clinical assessment of visual acuity

Important things to remember when assessing visual acuity:

- 1) High contrast chart
- 2) Lights on
- 3) Monocular acuities
- 4) Test best corrected vision/pinhole

Low contrast vision

However, the visual world comprises varying shades of grey rather than clear black on white. Therefore, to emulate the 'real' world, vision can also be tested on low contrast charts, but this is less common (Figure 4).

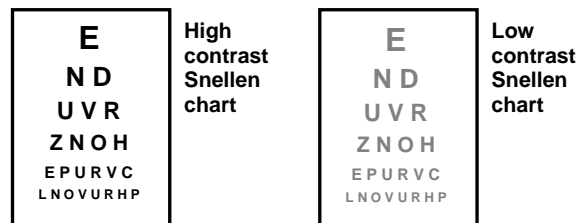


Figure 4

Assessing near vision

Near vision assessment is made with standardised charts. These charts present passages of text, with progressively smaller fonts, which the patient is required to read aloud to the examiner. The passages chosen for these near vision charts are intentionally complex to deter patients from guessing.

Assessment of vision in children

Assessing vision in pre-school children can be difficult as they are not familiar with the letters used on the standard letter charts. Various testing procedures have been introduced to overcome this problem.

Matching tests

The Sheridan Gardiner, letter-matching test consists of a flip-chart with single letters, of varying size, printed on separate pages. The examiner holds this chart at a distance of 6 metres (standard testing distance) from the child (Figure 5a). The child, holding in front of them a card with the letters marked on it, points to the appropriate letter (Figure 5b). The examiner presents progressively smaller letters to determine the limit of resolution.

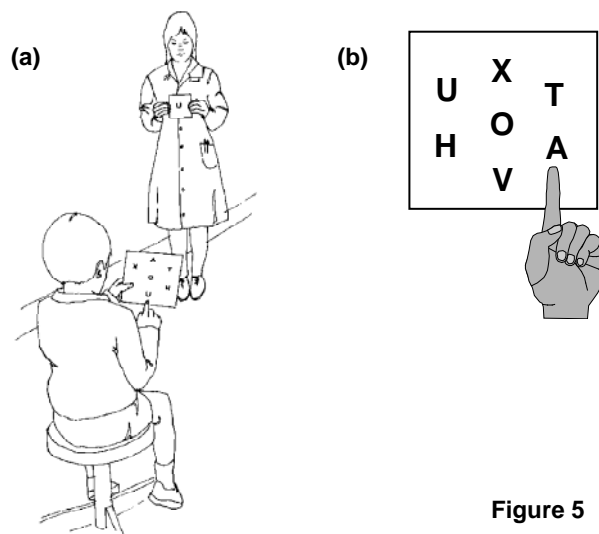


Figure 5

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Practical Station 2: Colour Vision

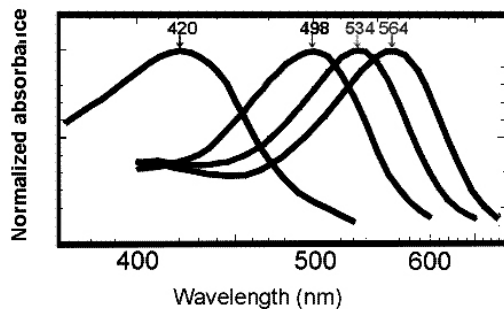
Colour vision.

The light sensitive elements of the retina consist of rods and cones. Of these, only cones are responsible for colour vision. There are three different cone types each containing a different photopigment. These photopigments absorb light across a range of wavelengths but each have a peak sensitivity in different parts of the visible spectrum.

The three cone types are:

- **Red** (peak sensitivity 564nm)
- **Green** (peak sensitivity 534nm)
- **Blue** (peak sensitivity 420nm)

Rods have peak sensitivity at 498nm (see figure below).



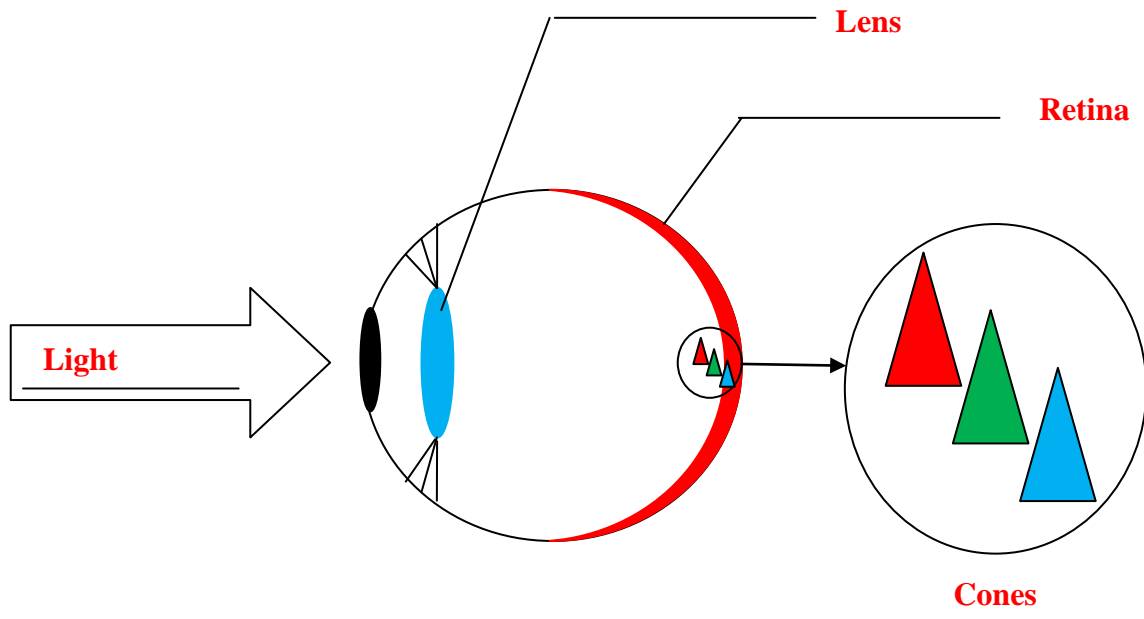
Bowmaker & Dartnall, 1980.
"Visual pigments of rods and cones in a human retina."
J Physiol 298:501-11.

Colour vision involves the comparison of the relative absorption of light from these different cone types (cones themselves are colour blind; they just respond to the number of photons at each wavelength present in a stimulus).

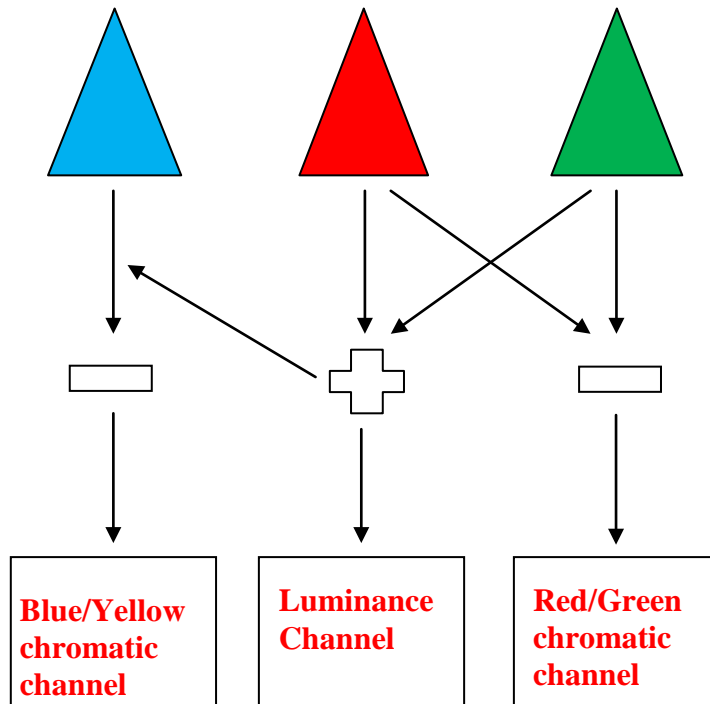
Ganglion cells at the retinal level differentiate the relative responses of the L and M cones to give inputs to red/green colour perception (L-M) and the relative responses of the S cones with the L and M cone responses to give inputs to blue/yellow colour perception (S-[L+M]).

The luminance of objects is encoded by the comparison of the addition of the outputs of L and M cones (L+M). Ultimately however colour appearance is due to further combinations of the outputs of these ganglion cell responses in the cortex combined with other influences from visual memory as well as cultural and linguistic interpretations.

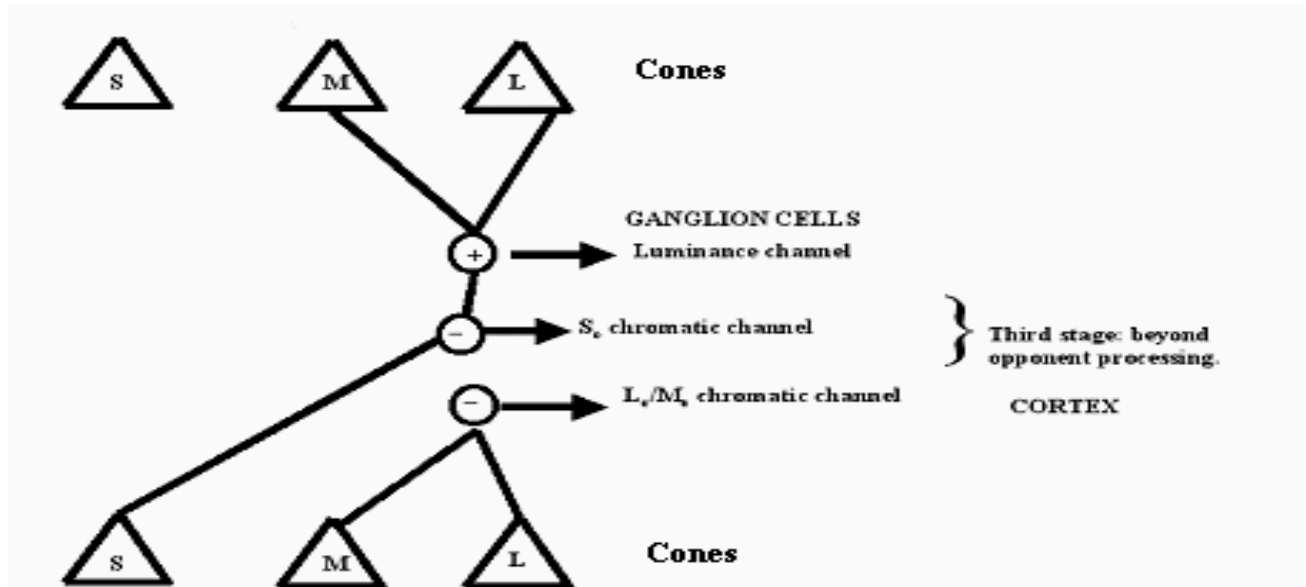
Label the diagram



Describe the three channels that compare relative absorption



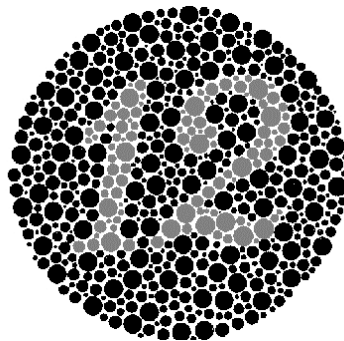
Colour Vision cont.



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Colour Vision Testing

The colour vision tests used in this practical (which are also used clinically) exploit the above facts of colour vision processing in order to analyse both acquired and inherited colour vision deficiencies.



“Ophthalmology. An Illustrated Text” Batterbury & Bowling, Churchill Livingstone, 1999. P14. ISBN 0443-05537-8

Ishihara plates:

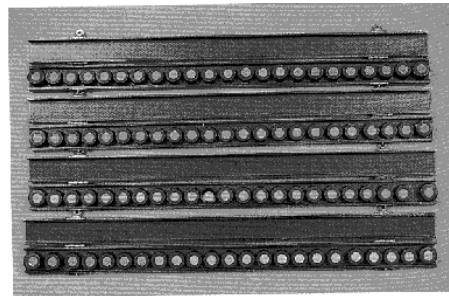
These test for red/green deficiencies (protan/deutan defects) only. They are very sensitive but not necessarily specific and they do not assess the severity of the colour vision defect.

There are five types of Ishihara plates:

- 1) **Alternating:** colour normal subjects see one number while colour defectives see another.
- 2) **Appearing:** colour normal subjects see nothing while colour defectives see a number.
- 3) **Disappearing:** colour normal subjects see a number while colour defectives do not.
- 4) **Diagnostic:** colour normal subjects see two numbers while protanopes or deuteranopes see one of the numbers according to the defect.
- 5) Plates for use with **Uncooperative** patients. **Can also be used to explain the test.**

Colour vision testing (cont'd)

Farnsworth Munsell 100 Hue test: This test analyses colour discrimination as well as diagnosing colour defects; can diagnose protan, deutan, tritan defects as well as their severity. This test aids in the diagnosis of colour discrimination ability especially with respect to vocational guidance. Contraindications for use of the test are the time taken to administer, learning and experience effects and its more complicated scoring methods.



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	Pros	Cons
Ishihara Plates	<ul style="list-style-type: none"> • Fast • Readily available • Tests for the most common colour vision deficiencies 	<ul style="list-style-type: none"> • Screening - does not diagnose colour vision deficiency type or severity
Farnsworth Munsell 100 Hue Test	<ul style="list-style-type: none"> • Gives detailed results including type and severity of colour vision deficiency • Tests for all types of colour vision deficiencies 	<ul style="list-style-type: none"> • Time consuming

Prevalence of colour vision deficiencies:

8% of males (1 in 12) and 0.5-2% of females have defective colour vision.

If the total population of New Zealand is 4.5 million and about half these are males (2.25 million) then approximately **180,000** New Zealanders have some form of inherited colour deficiency.

Colour vision deficiencies can be acquired due to ocular and systemic pathology, drug interactions and side effects, toxicity and pollution causes. Therefore, the prevalence of colour vision deficiencies within the New Zealand population at any one time is not an insignificant number.

Accurate testing and diagnosis as well as an understanding of the perceptual difficulties associated with colour vision deficiencies is essential to assess and advise these people with regard to their visual performance.

Occupations with colour vision restrictions:

- 1. Pilot**
- 2. Police**
- 3. Army Officers**
- 4. Ship Captains**