Lecture 1: Visual Acuity (VA and its Measurement)

- Define visual acuity
- Detail the methods used to determine visual acuity, including recognition, detection, resolution and vernier acuity
- Describe in detail how distance and near visual acuity are assessed and recorded clinically
- Understand the different clinical tests available to assess visual acuity for different populations
- Explain the design principles of various vision charts
- Recognise normal and abnormal visual acuity values
- Appreciate the main factors and conditions that may affect visual acuity

Visual acuity – Introduction

✓ The ability of the eye to discriminate fine detail
✓ First test in the optometric examination
✓ May provide an indication of amount of ametropia or refractive error
✓ May indicate some pathology or disorder
  - Cataract reduces visual acuity
✓ A criterion for a person’s fitness to drive and for entry into some professions
✓ Also important for legal reasons
✓ Used to assess adequacy of spectacle correction

Visual acuity: Types

✓ Human eye is capable of resolving objects of different levels of complexity...
  - Detection
  - Discrimination
  - Resolution
  - Recognition
✓ Several types of ‘visual acuity’ based on the complexity of the task

1. Detection
   ✓ The threshold of vision in the normal eye
   ✓ 5-14 quanta of light for perception
   ✓ May be measured using dark adaptometry or luminance increment thresholds (spot of light against a dark background)

2. Discrimination
   ✓ Ability of visual system to distinguish an object from its background
   ✓ Under good conditions line subtending as little as 0.5 secs of arc can be seen (if long enough)
   ✓ Disc of about 30 secs can be seen

3. Resolution
   ✓ Ability to detect gratings or checkerboard patterns, mainly in research
   ✓ To resolve –
     - See as separate, two objects or point sources of light
   ✓ Minimum angle of resolution typically 30-40secs of arc

4. Recognition and form vision
   ✓ Ability to detect letters, words, orientation of gap in Landolt ‘C’
   ✓ Minimum angle of resolution is about 1 min of arc

Vernier acuity (hyperacuity)

✓ Entirely different aspect of vision to what we measure clinically
✓ Discrimination of small displacements of a target
  - E.g. stereoscopic acuity
✓ Accurate to 10 secs of arc (2-5 secs in some people)
  - i.e. less than one cone diameter (20 secs of arc)

Visual acuity – Limitations

✓ What determines visual acuity of the human eye and what are the limitations?
✓ Visual acuity limited by neural factors (size of foveal cones) and optical factors (aberrations and diffraction)
Visual acuity – Limitations: Receptor theory

- Based on diameter and separation of foveal cones
- This theory predicts the limit of resolution to be about 49 secs of arc

![Diagram of foveal cones](image)

Visual acuity – Limitations: Wave theory

- Based on wave-like nature of light, airy disc
- Rayleigh criterion predicts theoretical limit of resolution to 47 secs of arc

![Diagram of Rayleigh criterion](image)

Visual acuity – Limitations: Resolution and pupil size

- Another factor limiting resolution is pupil size
- In theory as pupil diameter increases, visual acuity improves
- However, due to aberrations, visual acuity actually gets worse with increasing pupil diameter
- Optimal pupil size 2.0 – 2.4 mm for maximum resolution under photopic conditions

Visual acuity – Terminology

- Instead of ‘limit of resolution’, clinically we use the following terms:
  - Vision: or unaided vision – size of the smallest line of letters on the test chart that can be read by the patient unaided
  - Vision with glasses (habitual VA): size of the smallest line of letters on the test chart that can be read by the patient with their existing spectacles
  - Visual acuity: size of the smallest line of letters on the test chart that can be read by the patient after their refractive error is corrected
  - Measure RE (OD) LE (OS) BE (OU)

Visual acuity – Distance charts

- Test distance
  - Standard is 6m (far enough not to stimulate accommodation)
    - 6m because this is the distance the eyes are relaxed and are not accommodating anymore
  - In U.S. 20 feet is used (approx 6m)