

## Understanding and Evaluating Visual Field Tests

Dr. Fiona Rowe  
University of Liverpool

### Goals

- Principles of perimetry
- Static and kinetic perimetry
- Manual and automated perimetry
- Units of measurement and test strategies
- Analysis of data
- Interpretation of results
  - Normals
  - Pathology
  - Artefacts

### Perimetry

- A measure of the sensitivity of the eye
- Boundaries
- Light sensitivity at determined locations
- Diagnostic assessment of visual field
  - Detection of pathology
  - Progression of pathology

### Parameters of visual field assessment

- Size of stimulus
- Luminous intensity
- Anatomical features
- Patient ability
- Examiner technique

### Normal visual field

60 degrees  
60 degrees  
75 degrees  
100 degrees

### Types of visual field loss

- Generalised
- Localised

### Visual pathway

### Visual field loss

### Visual field assessment

- Static
- Kinetic

### Static perimetry

In static perimetry, the size and location of the test target remain constant.

The retinal sensitivity at a specific location is determined by varying the brightness of the test target.

The shape of the island is defined by repeating the threshold measurement at various locations in the field of vision.

### Static perimetry

### Kinetic perimetry

In kinetic perimetry, a stimulus is moved from a nonseeing area of the visual field to a seeing area along a set meridian. The procedure is repeated with the use of the same stimulus along other meridians, usually spaced every 15°.

In kinetic perimetry, one attempts to find locations in the visual field of equal retinal sensitivity. By joining these areas of equal sensitivity, an isopter is defined.

The luminance and the size of the target is changed to plot other isopters. In kinetic perimetry, the island of vision is approached horizontally. Isopters can be considered the outline of horizontal slices of the island of vision.

### Hill of vision

Static; luminous values

Kinetic; map of isopters

### Manual Perimetry

- Confrontation
- Amsler chart
- Goldmann perimetry
  
- Bjerrum screen
- Friedmann campimetry

### Confrontation

- Qualitative assessment
- Identifies peripheral boundaries of visual field
- Assessment of response to target in each quadrant of the visual field
- Assessment of colour contrast in the central field and within each quadrant

### Amsler chart

- Assessment of the central 10 degrees of the visual field.
- Consists of black lines on a white chart. Each square of 5mm subtends 1 degree of visual field when held at 30cms.
- Patient states whether any part of the grid is distorted and may draw around this on the chart.

### Kinetic perimetry

- Plot of isopters
- Kinetic

### Basic strategy

- I4e as standard peripheral target
- I2e as standard central target
- III4e as DVLA target
- Movement of target (Goldmann)
  - 2/3 degrees per second (but subject to bias)
- Movement of target (Octopus)
  - 0 to 10 degrees per second
  - Recommended is 5 degrees per second

### Reliability

- Calibration
- Fixation monitored by examiner
- Reticulated telescope/monitor
- False negative checks

### Size and luminosity

- Target size
  - O (1/16 mm<sup>2</sup> through to V (64mm<sup>2</sup>))
- Target luminosity
  - Set 1. Four grey filters
  - Set 2. Five grey filters
- Bowl luminosity set at 31.5 apostilbs
- Target brightness set at 1000 apostilbs

### Normal result

### Glaucoma result

### Glaucoma progression



### Neuro defect



### Automated Perimetry

- Octopus
- Humphrey system
- Frequency Doubling Technology
- Henson
- Medmont

### Static perimetry

- Threshold sensitivity
- Programme choice

### Reliability

<p><b>Octopus</b></p> <ul style="list-style-type: none"> <li>• Computerised calibration</li> <li>• Fixation control</li> <li>• Automated eye tracking</li> <li>• Head sensors</li> <li>• False positive checks</li> <li>• False negative checks</li> </ul>	<p><b>Humphrey</b></p> <ul style="list-style-type: none"> <li>• Fixation loss</li> <li>• False positive response</li> <li>• False negative response</li> <li>• Gaze tracking</li> <li>• Vertex tracking</li> </ul>
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### Positioning

- Response button
- Central light target
- Diamond light pattern
- Occlude relevant eye
- Use of chin rest and forehead bar
- Centre pupil with cross
- Position trial lens
- Lid position

### Test strategies

- Screening
- Threshold

### Screening Strategies

**Two Zone / Threshold Related** Determines whether the patient sees a stimulus or not at an intensity level expected for that patient. Use for general screening exams.

**Three-Zone** Determines whether the patient sees at the expected level, has a relative scotoma, or an absolute scotoma. Use for general screening when differentiation between relative and absolute scotomas is required.

**Quantify Defects** If patient does not see at the expected level, this strategy determines how deep a defect is at a particular location. Use when information about the depth of defects is desired. Wise useful when a threshold exam was necessary but the patient was incapable of taking a threshold exam. Now SITA (and FastPac) strategies cover for this patient.

**Single Intensity** Uses one intensity level and tests all points in the field using that level. Does not adjust to patient's hill of vision. Use for disability screening, ptosis / blepharoplasty verification or very fast general screening exams.

**Age Corrected (Screening Mode)** Sets Two-Zone, Three-Zone or Quantify Defects to a normal hill of vision based on the patient's age.

### Threshold Strategies

- **Full Threshold**
  - Thresholds each point in the visual field. Uses the 4-2 bracketing strategy.
- **FastPac**
  - This algorithm can reduce thresholding time up to 40%.
  - Limited STATPAC printouts are available with FastPac. Uses the 3-1 bracketing strategy.

## Threshold Strategies

**SITA – Swedish Interactive Thresholding Algorithm (HFA II only):**

- **SITA Standard**
  - Designed to gather twice as much information per unit time than the Full
  - Threshold algorithm. Cuts test time in half relative to a Full Threshold test.
- **SITA Fast**
  - Designed to gather twice as much information per unit time than the FastPac algorithm.
  - Cuts the test time in half relative to a FastPac test.
- **Blue-Yellow or SWAP (Short Wavelength Automated Perimetry)**
  - Allows for earlier glaucoma detection. May be used with 30-2 or 24-2 threshold patterns.

## Humphrey statistical analysis

- Statpac
- Global indices
  - Mean deviation
  - Pattern standard deviation
  - Corrected pattern standard deviation
  - Short term fluctuation
- Glaucoma hemifield test
- SITA

## SITA applications

1. Smart questions
  - Determines choice of stimulus brightness dependent on patient responses
2. Smart pacing
  - Takes into account patient reaction times
3. Knowledge of termination
  - Terminates when a required number of stimuli presentations are achieved at given locations
4. Post examination process
  - Analyses information at each point and neighbouring points combining reliability indices

## Threshold tests

- Standard; 2-4dB steps
- Fastpac; 3dB steps
- 24-2 versus 30-2 programme
  - 24-2; 54 points; ~5mins per eye
  - 30-2; 76 points; ~8mins per eye
- SITA standard versus SITA fast
  - 24-2 standard; ~5mins per eye
  - 24-2 fast; ~3mins per eye

## Humphrey Static Programmes

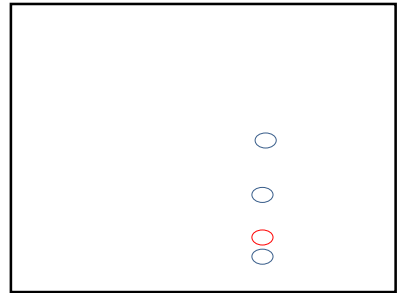
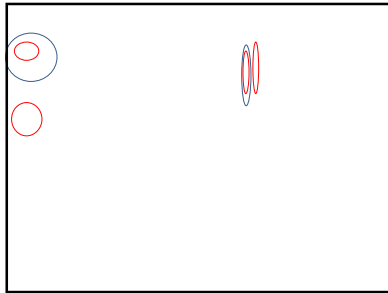
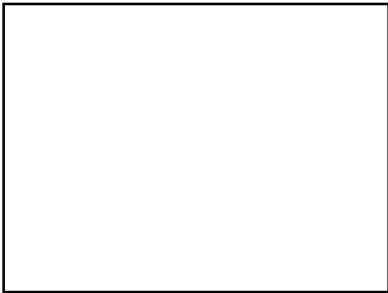
- *Central*
  - 24-2, 30-2
- *Peripheral*
  - 60-4, nasal step
- *Speciality*
  - 10-2, macula

## Other tests

- Estermann binocular
- Estermann monocular
  - Bilateral monocular tests for bitemporal hemianopia/quadrantanopia
  - Monocular for VA <6/24 with full field
  - Monocular for VA <6/24 with moderate constriction, aphakia, media opacities
  - Monocular for VA >6/18 with severe field loss

## Printout Generation

- Single Field Analysis
- Overview
- Glaucoma Progression Analysis (GPA)
- Change Analysis
- Three-in-One
- Estermann



Other programmes

- 76 screen
- Macula
- 10-2
- 60-4
- Estermann

76 point screen

10-2

Macula

60-4

Estermann

## Octopus Static Programmes

### Threshold

- G or 32: General testing and glaucoma
- M: Macula testing and parafoveal area
- N1: Neurological disease
- 07: Thresholding up to 70° Eccentricity
- LVC: Low vision central area for end stage
- LVP: Low vision peripheral testing for end stage
- D1: Diabetes testing (program with low central and higher peripheral resolution)
- Estermann
- Custom Tests: Any kind of test location distribution can be freely programmed with a graphical user interface.

## Programmes

### Strategy

- Dynamic: recommended as standard
  - a threshold strategy with adaptive step size (providing 2dB sensitivity resolution in proximity to normal thresholds and larger steps in relative to absolute scotoma) Approximate duration 5-8 minutes per eye
- TOP: fast strategy
  - particularly recommended in children and elder patients due to its short testing time of only 2-3 minutes. Shortens test duration by applying the responses to neighbouring test locations.
- Normal: slow strategy
  - traditional bracketing strategy starting with 40B steps in one direction and after a response reversal with 20B steps to the opposite direction. Takes approximately 8-12 minutes per eye
- 2LT: screening
  - tests for normality at the level of age corrected normals -6dB and non seen at 0dB intensity. Allows quantification of screened areas in subsequent examination phases.
- 1LT: screening
  - checks target visibility at usually 1000asb intensity (depends on program)

## Analysis

- Physiology related test pattern
  - Higher density of stimuli in central field
  - Follow nerve fibre bundle layer patterns







## Analysis

- Values
- Comparison
- Probabilities
- Defect (Bebie) curve
- Diffuse defect
- Global indices
- Cluster Graph
- Polar Graph
- Global Trend
- Cluster Trend
- PolarTrend
- Absolute thresholds
- Scales and defect depth
- Percentile of normality
- Ranking of defect values
- Deviation from 50<sup>th</sup> %
- Mean sensitivity and defect
- Analysis of regional deviations from normal
- All local defects mapped to a representation of the optic disc for structure/function comparison
- Change rate, fluctuation and significance calculation
- Regional change rate and significance calculation
- Pointwise linear regression analysis mapped to the optic disc

## Printout Generation

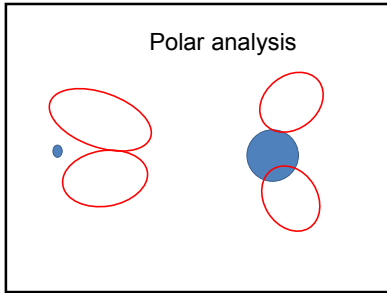
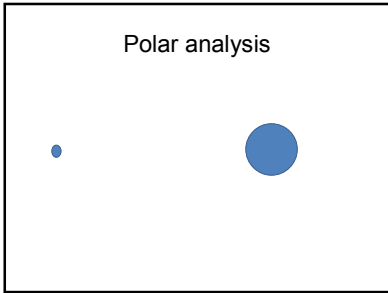
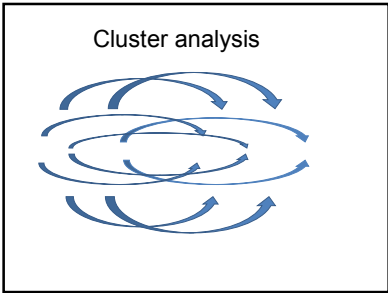
- 7-in-1
- 4-in-1
- Overview
- Estermann
- Kinetic
- One or both eyes
- Series
- Trend

## Interpretation; 7-in-1

- Comparison  Scales and defect depth
- Values  Absolute thresholds
- Probabilities  Percentile of normality
- Defect (Bebie) curve  Ranking of defect values
- Diffuse defect  Deviation from 50<sup>th</sup> %
- Global indices  Mean sensitivity and defect

## Both eye view

4-in-1



### Series

### Choice of Perimeter

Goldmann	Octopus	Humphrey
Manual	Manual	Automated
Kinetic	Automated	Static
Peripheral	Kinetic	Central
Blind spot	Static	Sensitive to early loss
Poor VA / fixation	Peripheral	Repeatability
Advanced defects	Central	Driving
Driving	Sensitive to early loss	
	Repeatability	
	Blind spot	
	Poor VA / fixation	
	Advanced defects	
	Driving	

- ### Common choices
- First visit
    - Screen
    - Pathology
  - Follow-up
  - Constricted field
  - Hydroxychloroquine
  - Peripheral pathology
  - DVLA
- 24-2 SITA fast, G TOP  
 24-2 SITA standard, G dynamic  
 24-2/30-2 standard, G dynamic  
 10-2, LV  
 Macula, M dynamic  
 60-4, Kinetic  
 Estermann

### How perimeters compare?



Screening

Pathology

Constricted

Peripheral

- Factors influencing visual fields;  
Artefacts
- Anatomical features of the face
  - Ptosis
  - Miotic pupil
  - Uncorrected refractive error
  - Refractive corrections
  - Cataract
  - Attention of the patient
  - Technique of the examiner

Ptosis

Ptosis

Ptosis

Miotic pupil

Uncorrected refractive error

Refractive correction; lens rim

Cataract

Fatigue

Aids to interpretation

Knowledge of visual pathway and:

- Related visual field defects
- Related signs
- Related symptoms

Visual field loss

Retina and optic disc

- Reduced visual acuity
- Afferent pupillary defect
- Reduced colour vision
- Reduced contrast sensitivity
- Perceptual problems

### Optic nerve

- Reduced visual acuity
- Afferent pupillary defect
- Reduced colour vision
- Reduced contrast sensitivity

### Optic chiasm

- Postfixational blindness
- Hemifield slide
- See saw nystagmus
- Bowtie atrophy

### Optic tract

- Afferent pupillary defect
- Optic atrophy; asymmetrical

### Optic radiations

- Temporal lobe lesion
  - central achromatopsia, agnosia, alexia, hallucinations, seizures, Bell's reflex
  - normal depth and motion
- Parietal lobe lesion
  - reduced stereopsis, spatial localisation and motion, agnosia, reduced OKN, poor fixation, left/right confusion, Bell's reflex, hemiparesis
  - normal colour and form, discrimination and recognition of faces

### Visual cortex

- 90% without other neurological signs
- Reading difficulties
- Cortical blindness
  - Riddoch phenomenon
  - Anton's syndrome

### Differential diagnosis

- Horizontal meridian respected in retinal and optic nerve head lesions
- Vertical meridian respected in chiasmal and post chiasmal lesions
- Bilateral defects in post chiasmal lesions
- Deterioration of vision, RAPD, fundus abnormalities seen in pre chiasm lesions
- Case history

### Summary

- Refresh basic knowledge of perimetry
- Principles of perimetry
- Choice of test strategies
- Understand results of visual field assessments
- Promote best practice

