# VISUAL FIELDS IN GLAUCOMA

## AUTHOR

**Sarah MacIver:** University of Waterloo

## PEER REVIEWER

**Jane-Ann Grogg:** Indiana University

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## INTRODUCTION

The ultimate goal of glaucoma management is the preservation of a patient's visual function and quality of life. The detection of visual field defects in these patients is one way to assess the impact of a glaucoma patient's visual function and monitor for progression of the disease.

## HILL OF VISION

The concept of a "hill of vision" is a useful representation of the relative sensitivity in the retina at various locations (Figure 14.1).

The peak of the hill is at the fovea and drops off rapidly towards the periphery with a sheer drop to the base of the hill occupying the spot where the optic nerve head is located. The temporal field of vision is larger than the nasal field.

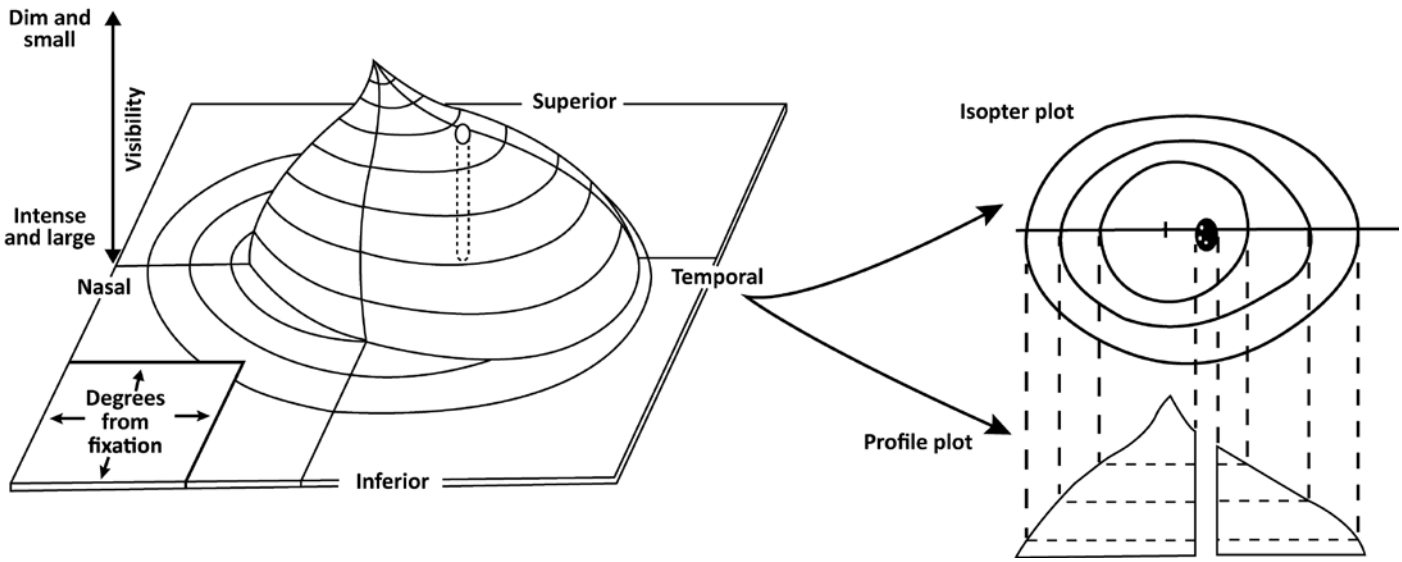


***Figure 14.1:*** *The hill of vision*

## REVIEW THE PLOTS

A numerical sensitivity plot gives the threshold values for all points checked during the visual field test (Figure 14.2 left).

The grey scale plot (Figure 14.2 right) graphically demonstrates regions of visual field loss and decreased sensitivity with darker grey tones.

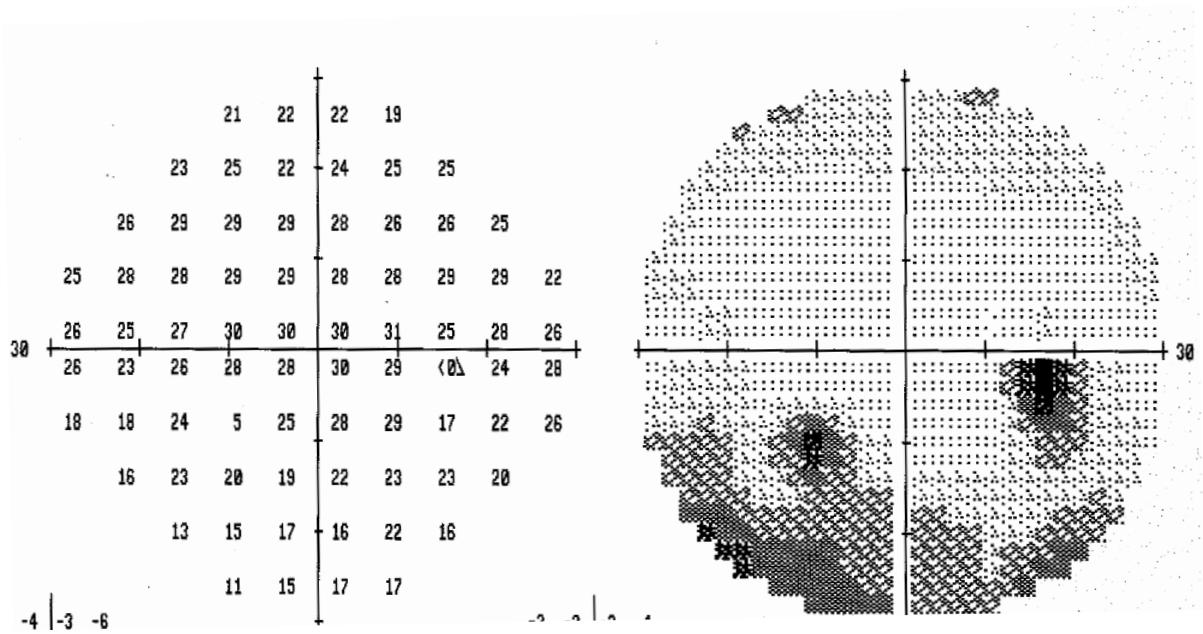

***Figure 14.2:*** *Numerical sensitivity (left) and grey scale visual field plots (right)*

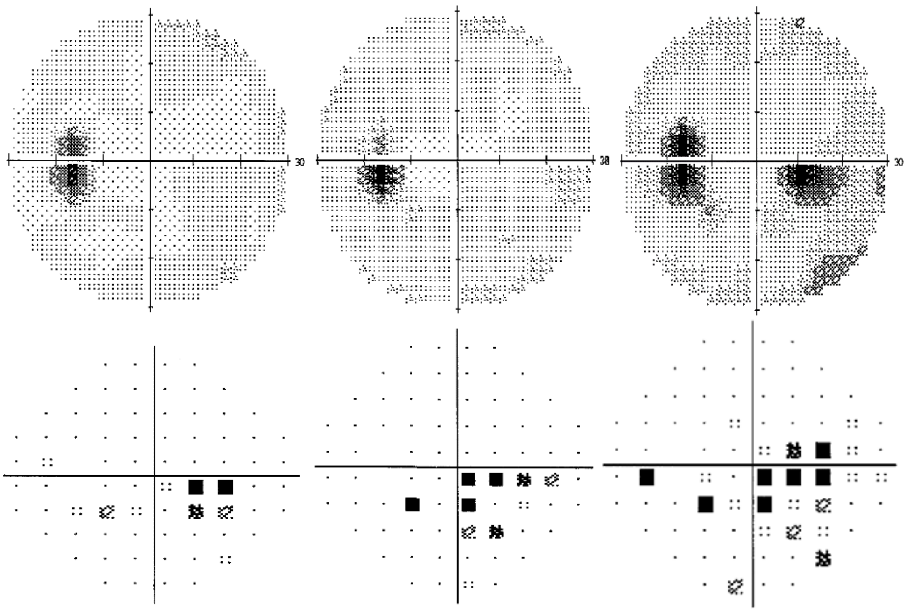

***Figure 14.3:*** *Increasing loss of visual field. This figure demonstrates the limitations of the grey scale plot. Just looking at the grey plot alone, one might miss subtle visual field defects from early glaucoma as can be seen in the two images on the left side.*

# PROBABILITY MAPS

## TOTAL DEVIATION AND PATTERN DEVIATION

Each test location is graded as normal or abnormal compared to a normative population and given a p-level if difference is statistically significant.

- The lower the p-value, the greater the chance the difference occurred by chance – therefore the greater the chance that the defect has clinical significance

- Total Deviation Plot
  - Identifies all test locations that are outside normal limits
  - Points are highlighted when they are worse that those found in the bottom 5%, 2%, 1% and 0.5% of age-related normative database. This is scaled accordingly with a progressive darkening scale.
  - Statistical significance depends upon **test point location** and **test strategy used**
    - Range of sensitivities is larger in the periphery than in the center of the field
  - Looks worse with cataract – will have a greater number of points flagged, and generally an overall reduction in sensitivity.

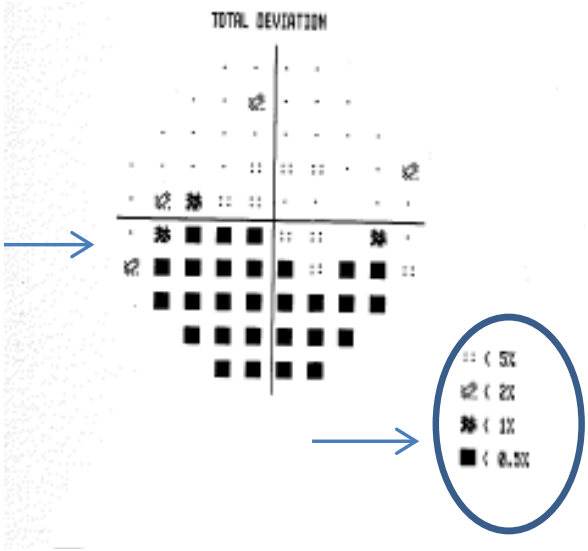


***Figure 14.4:*** *Total deviation plot*

- Pattern Deviation Plot
  - Shows sensitivity losses after an adjustment is made to remove generalized **depression or elevation** of the hill of vision
  - After removing the generalized depression, the pattern deviation analysis **highlights localized loss. Central points given higher weighting of significance**
  - Takes away effect of cataract and small pupil
  - The single most useful analysis for glaucoma

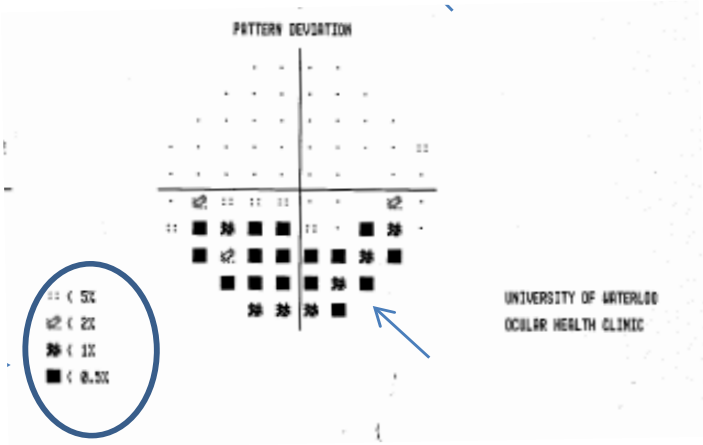


***Figure 14.5:*** *Pattern deviation plot*

## STEPS TO ANALYSING VISUAL FIELD DEFECTS:

1. Is the defect widespread versus localized
2. Does it affect one hemifield (superior/inferior) or both hemifields?
3. How many points are affected?
4. Location of depressed points
5. Severity of depressed points i.e. depth

# GLOBAL INDICES

## MEAN DEVIATION (MD)

- How much on average the field deviates from age-normal
- Average loss for entire field shown in the Total Deviation Plot with higher weighting of points closest to fixation
- Approximately 0 dB in normal fields and -30 dB to -35 dB in extreme field loss
- If significant, probability value is given telling how often the value will occur in a normal population
- P<1% = less than 1% of the normal population has a similar field
- You cannot recognize a pattern of loss from this number
- (-) value: could be anything from cataract, glaucoma, neurological loss
- (+) value: high in “trigger happy” patients, in other words, the patient is over clicking the response button

## PATTERN STANDARD DEVIATION (PSD)

- Reflects irregularities in the field caused by localized loss
    - Normal PSD is small and close to 0
    - Higher PSD indicates greater localized loss up until approximately -12dB; at which case the field defect becomes too global and therefore the localized value goes back up towards 0
    - Risk factor associated with OHTS study

## GLAUCOMA HEMIFIELD TEST (GHT)

- Compares Pattern Deviation probability scores in five zones in the upper hemifield with corresponding mirror image zones in the lower hemifield
- Each hemisphere is divided into 5 sectors
- Clusters of points are evaluated against a normative database and based on RNFL anatomy
- Printout:
    - **Outside normal limits** – when at least zone pairs differs by an amount seen in less than 1% of the age-based normative database
    - **Borderline** – at least one zone pair differs by an amount found in fewer than 3% but more than 1% of normal subjects
    - **‘General reduction in sensitivity or ‘abnormally high sensitivity’** – test points are either so high or so low that the levels tested were seen in fewer than half a percent of normal subjects
    - **Within normal limits** – all other results

# TYPES OF FIELD DEFECTS IN GLAUCOMA

The following sections describe the most common visual field defects seen in cases of glaucoma (Figure 14.6).

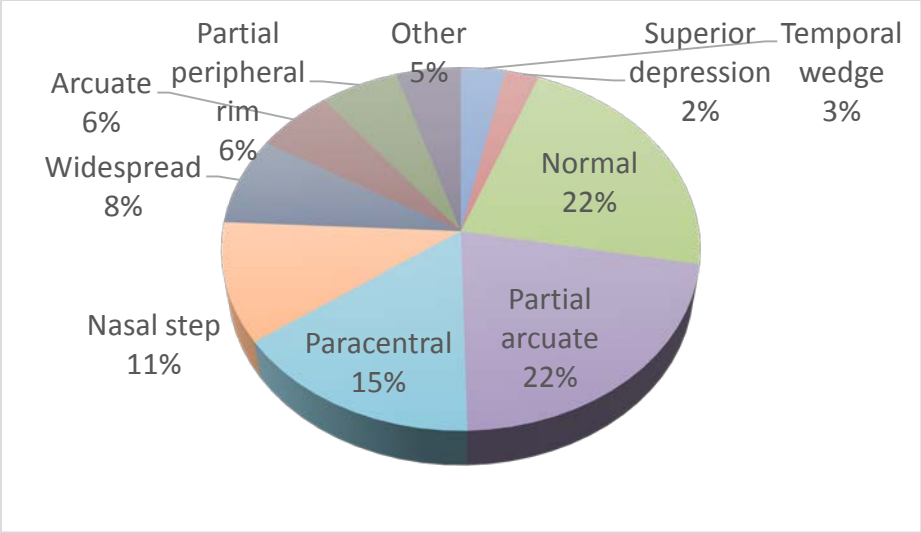


***Figure 14.6:*** *Types of visual field defects seen in glaucoma*

## NASAL STEP

- Visual field loss limited to nasal horizontal meridian
- At least one abnormal point outside 15º meridian

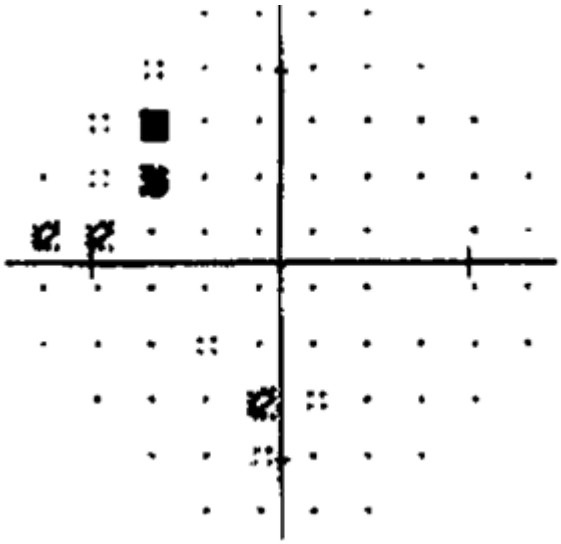

***Figure 14.7:*** *Nasal step defect*

## PARACENTRAL

- Relatively small visual field abnormality in nerve fiber bundle
- Does not affect blind spot or nasal meridian
- Does not involve points outside 15º

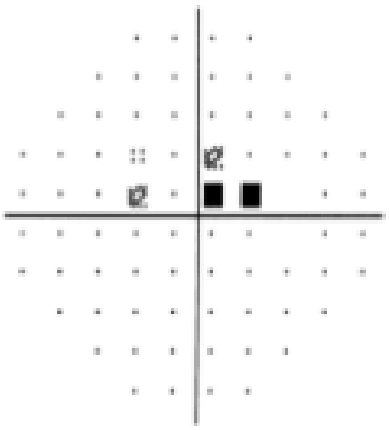

***Figure 14.8:*** *Paracentral defect*

## PARTIAL ARCUATE

- VF loss in RNFL
- Incompletely extends from blind spot towards nasal meridian
- Must include one location in temporal field

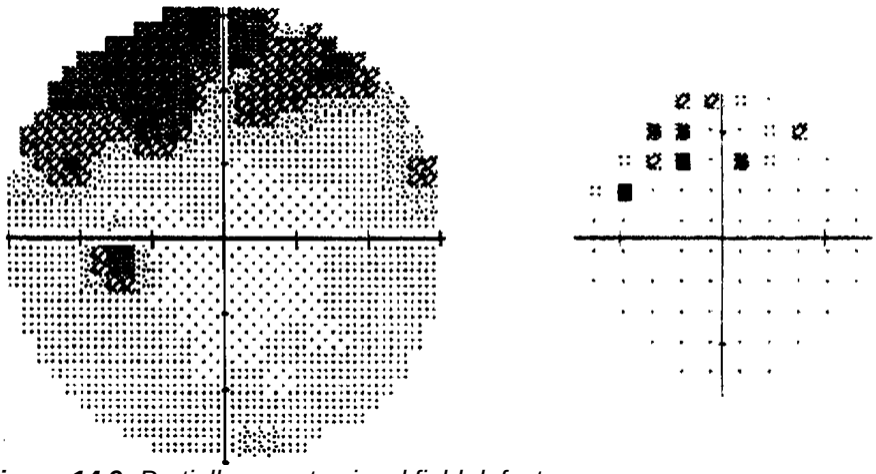

***Figure 14.9:*** *Partially arcuate visual field defect*

## ARCUATE

- VF loss in RNFL
- Extends across adjacent points
- Goes from blind spot to at least one point outside 15 adjacent to nasal meridian

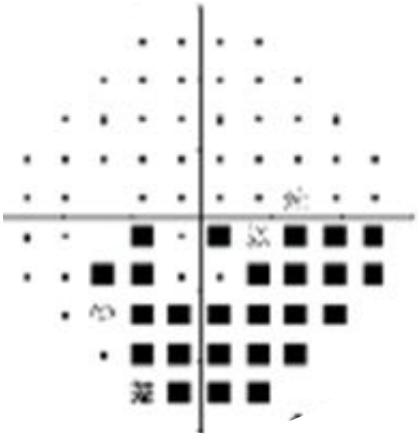

***Figure 14.10:*** *Arcuate visual field defect*

## ALTITUDINAL

- Severe visual field loss in entire superior or inferior hemifield
- Respects horizontal midline

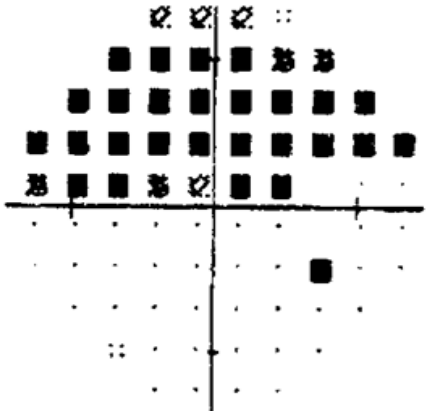

***Figure 14.11:*** *Altitudinal visual field defects*

## DIFFUSE LOSS

- General loss in entire field of vision
    - May be caused by cataract, uncorrected refractive error, poor patient cooperation, for example
- End stage glaucoma
- Or early loss MD < 5 dB
- One of the presentations of neurological defects

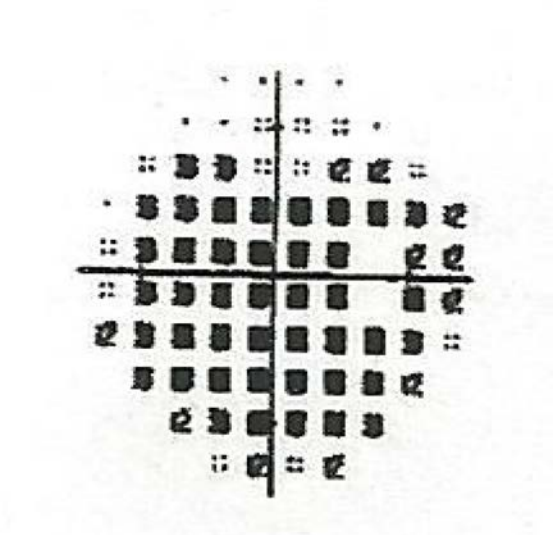

***Figure 14.12:*** *Diffuse visual field loss*

## DETERMINING IF THE VISUAL FIELD IS ABNORMAL

There are three criteria that need to be repeatable when assessing for the abnormality of a visual field measurement. The criteria are as follows:

### 1: CLUSTERS

- Three touching points on same side of horizontal meridian
- All three points must be identified as significant (P<5%)
- One of the three must be P<1%

### 2: GLAUCOMA HEMIFIELD TEST

- Must be outside normal limits

### 3: PATTERN DEVIATION GLOBAL INDEX

- PSD P<5% on two consecutive fields

## STEPS TO ANALYSE THE VISUAL FIELD TEST

1. **Do the right test**

2. **Determine the reliability**

3. **Fixation Losses**
    a. Causes:
        i. Stimulus is presented in blind spot and patient responds
        ii. Gaze tracker shows large deviations from fixation
        iii. May be due to testing artifact or blind spot not located correctly
            1. Importance of gaze tracker
4. **False Negatives**
    a. Patient fails to respond to a super threshold stimulus
    b. Usually high in cases of true field loss
    c. Will be high with visual inattention
    d. Fatigue

5. **False Positives**
    a. TRIGGER HAPPY
    b. **Best index indicating reliability of a field**
    c. > 5-15% can reflect unreliable field

6. **Review Probability Plots (see review above)**

7. **Review Indices (GHT) – see review above**

8. **Pattern of loss**

9. **Repeat**

10. **Confirm the diagnosis**

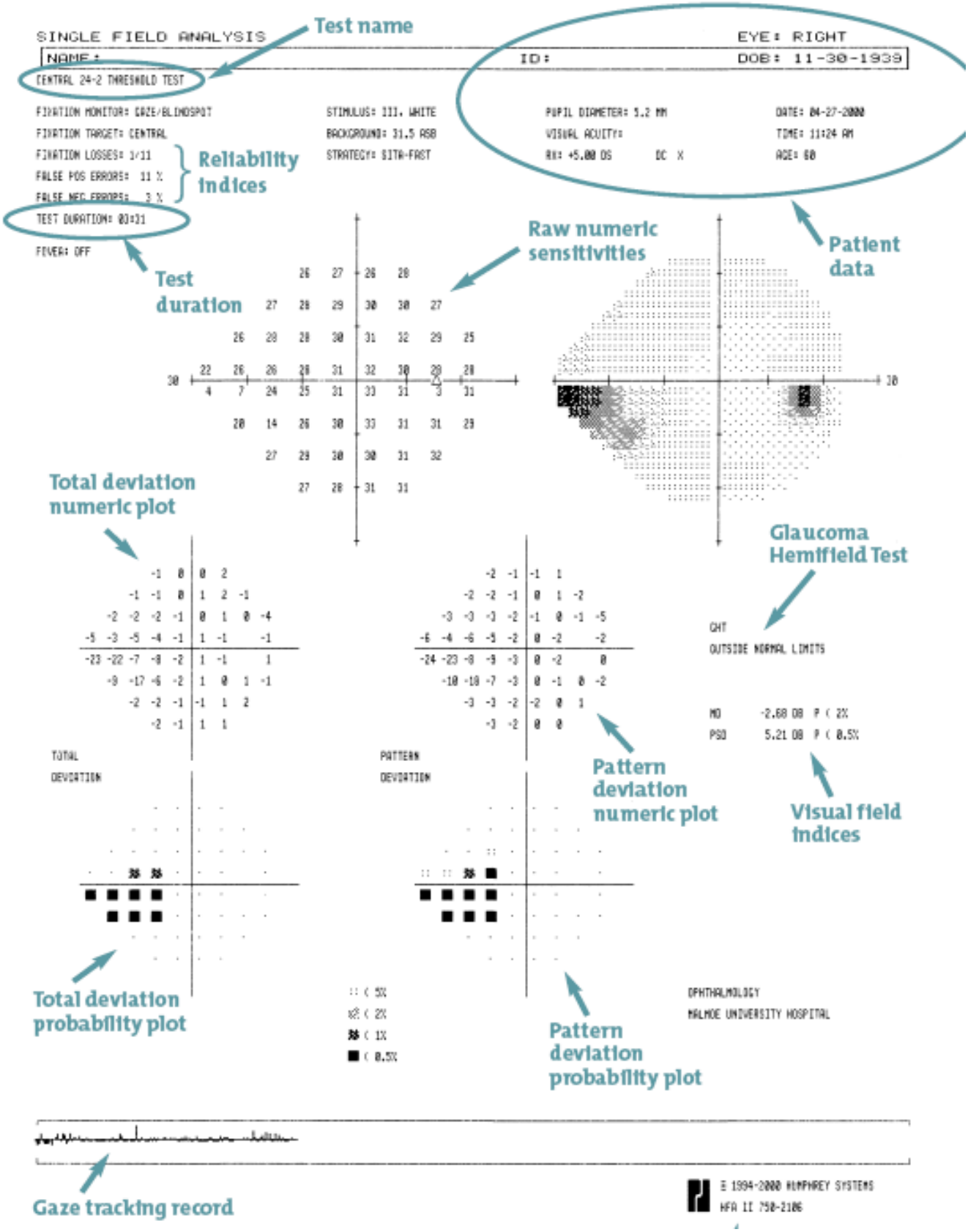


***Figure 14.13:*** *Summary of key features of visual field analysis printout*