Binocular Visual Field

Done by:
Opto. Ihsan Madhat Hmaid
Optometry Department

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VISUAL FIELD

As a synonym to field of view.

The **visual field** is the "spatial array of visual sensations available to observation in introspectionist psychological experiments" .

**Field of view** "refers to the physical objects and light sources in the external world that impinge the retina“

The term is often used in optometry and ophthalmology

**A visual field test** is used to determine- the visual field is affected by diseases that cause local scotoma or a more extensive loss of vision or a reduction in sensitivity (threshold).

**A scotoma** is an area of reduced (relative) or total (absolute) loss of vision, which is surrounding by a seeing area vision.
NORMAL VISUAL FIELD

The normal human visual field extends to approximately 60 degrees nasally (toward the nose, or inward) from the vertical meridian in each eye, to 100 degrees temporally (away from the nose, or outwards) from the vertical meridian, and approximately 60 degrees above and 75 below the horizontal meridian.

Optic Nerve represented 10-15 degree nasally to center of the test.

Visual field loss

Occur due to disease or disorders of the eye, optic nerve, or brain.
Normal and abnormal vision
Normal visual field
Right and Left visual field
HOW TO MEASURE??

- confrontation test.
- amesler grid.
- Kinetic perimetry, where points of light are moved inwards until the observer sees them, or
- Static perimetry, where points of light are flashed onto a white screen and the observer is asked to press a button if he or she sees it.

1. Threshold, is used for detailed assessment of the hill of vision.
2. Suprathreshold, testing to check that a subject can see stimuli that would be seen by a normal person of the same age.

There are two ways to examine the visual field:
- Monocular visual field test.
- Binocular visual field test.
Visual fields

The visual field requirements for a Group 1 licence are ‘A minimum horizontal field of vision of 120° and no significant defect within 20° of fixation’.

Additional clarification of a significant defect is given: The DVLA (Driver Vechicle and Licensing Agency), accepts the following central loss (Esterman protocol):

- Scattered single missed points.
- A single cluster of up to three contiguous points.
This is a change from the situation a decade ago when no missed points were accepted within the central ±20°. The change originates from a legal challenge by an individual missing three contiguous points. He successfully argued that his scotoma was no bigger than the blind spot of a monocular driver, who was, of course, allowed to hold a licence.

**Significant central loss is defined as:**

- A cluster of four or more contiguous points that is either wholly or partly within the central 20° area.
- Loss consisting of both a single cluster of three contiguous missed points up to and including 20° from fixation and any additional separate missed point(s) within the central 20° area.
- Central loss of any size that is an extension of a hemianopia or quadrantanopia.
• The functional scoring system developed by Esterman is the current gold-standard for testing binocular visual fields and is used by many national driving authorities. National visual field requirements for fitness to drive differ significantly between countries.

• There is a *European-wide* minimum requirement of 120° along the horizontal but *Germany* is the only other country to require the central visual field to be examined.
Simulated effect of visual field loss on a real driving scene for pt. A from group 1
A typical scene when driving showing the functionally-important areas of the visual field
Binocular Testing

- An additional refinement for occupational use is binocular testing, which is of very little value in diagnosis and monitoring. It was promoted by Esterman (1982) for assessing the disability resulting from the totaling of visual field loss.
- That could be a complex distribution of heteronymous defects where only the components overlapping in the two eyes contribute to disability in everyday life. Esterman proposed a particular grid of static testing points using the Goldman apparatus which he regarded as giving appropriate weight to the more and less significant regions of the visual field.
- For example, there is a higher density of points in the lower field because loss of field below the horizontal meridian is more likely to affect mobility in a person who is spending most of their time on two legs. The test provides a number of points on the grid which missed all the stimuli are shown at maximum brightness.
- On examination the patient has five location with sensitivity value below 10 dB with central area degree.
It's not necessarily the case that these are the appropriate weightings for occupational decisions or for driving and aviation safety. Nonetheless, the *Esterman binocular visual field* test (now carried out as a built-in paradigm using the Humphrey automated perimeter) has become the gold standard for the United Kingdom Department of Transport in assessing fitness to drive.

It has the advantages that it is quick and universally available, and, although it might be possible to design a test with theoretically more appropriate weightings for visual requirements of driving, there is very little scientific evidence on which to base the judgments. Binocular visual field testing is problematic because, particularly with the viewing distance of 50 centimeters, it is necessary for the subject to make a vergence effort to fix on the target, which can lead to inconsistencies in performance.
EVFT output:
(A) and results from the binocular simulation.
(B) implemented by the PROGRESSOR for Windows software (Institute of Ophthalmology, London) are shown for another sample patient. The lower panels show the results from the binocular simulation as Humphrey type grey scale with and without superimposed symbols denoting point by point EVFT type defects (<10 dB). This patient demonstrates "No defects" using the EVFT (A). This patient also demonstrates "No defects" using the binocular simulation (B) despite the presence of areas of visual field damage in each monocular field.
• Also the "**fixation monitoring**" paradigm depends upon testing within the physiological blind spot, which is no longer a possibility. The Esterman binocular test should never be viewed in isolation but always in the context of the results of threshold testing in each eye.

• The binocular results can be predicted from the monocular results on the simple assumption that the eye with the higher sensitivity will determine the threshold at any particular point in the visual field (Crabb and Viswanathan). This exercise should be undertaken at least to a first approximation to ensure that the monocular results are consistent with the binocular test.
The **Esterman test** may also fail drivers unfairly. Those patients with visual field loss in one eye and normal visual field in the other may, in some cases, not provide an acceptable binocular Esterman results. The test may show a missed point in the area of blind spot of the normal eye, where the other eye has not compensated for this. Where such a query exists, it is advisable to repeat the Esterman monocularly for the normal eye, as a normal monocular field of vision meets the DVLA driving standard.

Patients with other conditions such as those relating to retinopathy (e.g. segmental retinitis pigmentosa) may have a borderline result on Esterman testing.
The binocular Esterman visual field test is most commonly run on the Humphrey Visual Field Analyzer.

It is a supra-threshold test that presents a single, very bright stimulus (10dB) at each of 120 locations within the visual field.

The subject is required to fixate centrally and press a button when a stimulus is detected. The Esterman test has the advantage of being relatively quick compared to other ‘full field’ tests (4-5 minutes for a normal subject), and is by far the most frequently available binocular field test in ophthalmology and optometry clinics.
• The 120 points in the stimulus array are spread over a large area extending approximately $\pm 75^\circ$ horizontally, $35^\circ$ superiorly and $55^\circ$ inferiorly.

• Occasionally, an asymptomatic binocular visual field defect is picked up by the optometrist during a routine visual field screening when a patient reaches the age of 40. In a fair proportion of the cases with a negative medical history, the lesion is likely to be congenital in origin.
Binocular visual field testing programs are readily available in various automated perimeters. However, additional binocular examination is not routinely administered in the clinical setting where perimetric resources are normally directed or “consumed” by monocular testing. Binocular visual field testing in glaucoma normally only becomes necessary when a patient presents with bilateral defects commonly seen in advanced stages of the disease and assessment of visual disability is required.
This paper describes a method of simulating a binocular visual field from the results of Humphrey monocular fields. This technique requires no extra perimetric testing and allows for a quick and useful estimate of a patient’s central functional field. Purpose written computer software merges individual sensitivity values from left and right fields to generate a map of the central binocular visual field. Results are displayed as an easily interpretable grey scale with significant defects denoted by superimposed symbols.
Although it is critical to assess the function of each eye individually to determine the presence of ocular disease, our visual world is determined by the input from both eyes to the brain. Therefore, an appreciation of how a person’s vision affects quality of life (QOL) should incorporate binocular visual function, for both central and peripheral vision.
Glaucoma is a disease in which vision loss most commonly starts in the midperiphery, with central vision loss not occurring until late in the disease. An assessment of the binocular visual field in patients with glaucoma, particularly one that included the midperipheral points first lost in the disease, could be a valuable adjunct in understanding the visual limitations that glaucoma causes. Specifically, the degree of binocular visual field loss may correlate with vision-related QOL and mobility skills.
Two strategies can be used to assess the binocular visual field.

- **First**, the visual field can be determined with a binocular test, in which both eyes remain open. The concept of using a binocular visual field as a means of assessing visual disability was popularized by Esterman. The Esterman binocular visual field was designed first for manual perimetry, was later adapted to automated perimeters, and is included as an algorithm on the Humphrey Field Analyzer II (HFA II; Humphrey Systems, San Leandro, CA).
Several investigators have used the Esterman binocular visual field test, as configured for the HFA II, in trying to assess visual disability in patients with glaucoma. All these studies, whether evaluating patients primarily with early glaucoma, or those with more advanced disease, and including a study that we have recently completed have found that most of the scores on the Esterman binocular visual field test are clustered in the 80% and above range. This lack of breadth in Esterman scores makes it difficult to find strong correlations between the Esterman score and other measures of visual function. For example, in our recently completed study, the mean Esterman score was $89.7 \pm 13.4$, with a maximum score of 100, and the partial correlation coefficient between the Esterman binocular visual field score and the overall score on the National Eye Institute Visual Function Questionnaire (VFQ)-25 was 0.32.
A second strategy for assessing a person’s binocular visual field is to combine the results obtained from testing the visual field of each eye separately. If this can be accomplished in patients with glaucoma who are already undergoing monocular visual field testing to detect and monitor disease, then no additional visual field tests would be necessary to make an assessment of the binocular vision. Recently, Nelson-Quigg et al. 13 reported that using either of two binocular sensitivity-prediction models, known as best location and binocular summation, they could predict the results obtained on a binocular visual field test.
Binocular visual field
(overlapping of R.V.F and L.V.F)
Esterman visual field test output from the Humphrey visual field analyser for one of the sample patients. A circle representing the central area 20° from fixation has been superimposed. There are 24 test locations within the central area. This patient has five locations with sensitivity values below 10 dB within this area and is therefore classified as exhibiting "At least one defect (<10 dB)" using the EVFT analysis.
Excellent agreement exist between the simulated binocular results and EVFT in classifying glaucomatous patient with central binocular defect. A rapid estimate of a patient’s central binocular field and visual function capacity can be ascertained without extra perimetric examination.
When it is necessary to estimate the percentage of functional visual loss, a system is available (the Esterman grids) in which the field is divided into 100 blocks of varying size according to functional value, with each representing 1%.

The system has been adopted by the American Medical Association as a standard for rating visual field disability. Grids are available for scoring the tangent screen, perimeter, or the binocular field. In patients with severe visual loss of glaucoma, the binocular Esterman score of data generated by an automated perimeter correlated well with combined monocular visual field results.