VISUAL FIELDS: THE PATH LESS TAKEN
By Mile Brujic, O.D.

Visual fields are an important test of the visual system. They allow us to determine the health of the ocular system including the eye, visual pathways and visual cortex. We will explore visual fields as an important tool for eye care practitioners in assessing the health of the visual system. We will examine visual fields by first understanding them and how they are measured and then discuss when they are warranted and what the printouts mean.

What Are Visual Fields?

Visual fields may be defined as “The space or range within which objects are visible to the immobile eye at a given time.” Visual fields are usually described in degrees from the point of fixation. In an individual with normal sight, visual fields extend 90 degrees temporally, 60 degrees nasally, 60 degrees superiorly and 70 degrees inferiorly.

Different areas in a person’s visual field have very different levels of sensitivity. The center of fixation, or the spot at which the patient is looking, is most sensitive. As you travel away from the fixation point, the sensitivity decreases. This is easily demonstrated by covering one eye and viewing a target with your uncovered eye. The point that you are viewing is much easier to see than things that are located in your periphery. This phenomenon is often referred to as a hill of vision.

Many of the measurements we take in the office are monocular, yet visual fields are also always measured one eye at a time. This is done so that visual field defects in one eye are easily exposed upon testing.

Clinical Significance

Visual fields are used in the diagnosis and treatment of many ocular diseases. Let’s examine some of the more common uses of visual fields.

Glaucoma

Visual fields are an integral component in the diagnosis and treatment of glaucoma. Glaucoma is a progressive optic neuropathy that is affected by increased intraocular pressure. Initially this disease affects a patient’s peripheral visual field, and when left untreated will continue to decrease the patient’s usable field of vision (Figure 1).

Visual fields are one of the initial tests used to assist clinicians in diagnosing the disease and are also important to perform when treating patients with glaucoma. If a visual field defect is identified, the test will most often need to be repeated in order to determine whether the defect is, in fact truly there, or whether a patient has contributed to...
unreliable test results. In the Ocular Hypertension Treatment Study, a visual field defect had to be present on three consecutive visual fields before it was considered a true defect from glaucoma, and not variability in the patient’s response.\

Neurological Conditions

Visual fields also may give us insight into the health of the neurological system. In order to fully appreciate the power of visual fields, it is important to have a good working knowledge of the visual system, including the visual pathways (Figure 2).

The visual system begins with the eyeball, which often is referred to as the globe. Protruding posterior from the globe is the optic nerve. From each eye, an optic nerve goes back and crosses at the optic chiasm. The pituitary gland is located inferior to the optic chiasm. Many types of pituitary tumors that apply pressure to the chiasm will be evident upon visual field testing. These types of tumors will usually initially affect the superior temporal visual fields of both eyes, but often affect it asymmetrically.

Posterior to the optic chiasm are the optic tracts. The optic tracts carry information corresponding to the opposite side of the visual field for the same eye. So for example, the left optic tract carries information about the right visual field of both the right and the left eye, and the right optic tract carries information about the left visual field of both the right and the left eye. These visual pathways are made up of millions of smaller neurons. Neurons are single nerve cells that conduct information along their cell bodies.

Continuing more posterior in the visual pathway is the area where these neurons end and communicate with other neurons. This area is called the lateral geniculate body. Lateral geniculate bodies are located on both the right and the left side of the brain.

From there, the neurons that are on the receiving end of the communication make up the optic radiations. The optic radiations are located on the inner side of the temporal lobes and end up in the occipital lobe, which is commonly referred to as the visual cortex. Any compromise to the visual pathway may result in visual field changes. As such, we should be attuned to any irregularities that may be present during visual field testing.

Several things can impair the different sections of the visual pathways. Some of these conditions are things such as tumors and strokes.

Depending on where the compromise is, the visual field will show different defects. If the insult is located at the level of the optic nerve, the defect will usually be seen in only one eye. If the insult occurs at the level of the optic chiasm, the visual field defects will usually occur in both eyes. If the insult is located posterior to the optic chiasm, the visual field defects will usually be seen on the same side of the midline for each eye. As an example, a person with an insult in the optic radiation on the left side may have a visual field defect on the right side of the visual field printouts of both eyes.

How Are Visual Fields Measured?

Although there are many ways to measure visual field function, we will concentrate our efforts from this point forward on automated perimetry because of its widespread use in
eye care offices. There are many different brands of perimeters. Most have many similar features. During automated perimetry testing, the patient’s non-tested eye is covered while the uncovered eye views a small fixation target located centrally in the visual field instrument. While the patient continues to view the fixation target, visual stimuli are presented throughout his or her visual field. The stimuli do different things depending on the type of test being performed. There are two basic types of testing strategies: screening and threshold.

A screening visual field test is a basic test that allows the clinician to detect large visual field defects. During the screening visual field, patients are shown stimuli at levels that should easily be seen by someone in their age category. If they are not seen, the automated field analyzer will identify that area of the visual field as being abnormal.

During threshold visual field testing, stimuli are shown to the patient, and the intensity level of the stimuli presented is constantly altered, based on whether or not the patient has seen the previous stimuli. If the patient taking the test sees the stimulus in a certain spot, the next time the light is shown in that spot it is made slightly dimmer until the patient’s sensitivity at that spot is determined. If the patient does not see the stimulus in a certain spot, the next time the light is shown in that spot it is shown at a slightly brighter intensity. The level where the patient can then see the light determines his or her sensitivity at that spot.

Understanding the hill of vision helps us to understand sensitivities in different areas of the visual field. The sensitivity is typically greatest at the point of fixation (central vision) and decreases as we move toward the periphery. Thus, light that is presented to the patient more peripherally will usually be of greater intensity than those presented more centrally.

Of critical importance during the visual field testing process is to make sure that the patient is always looking straight ahead at the fixation target. If the patient moves his or her fixation, the visual field will also move and create an unreliable visual field measurement.

**What Do the Printouts Mean?**

The visual field printouts contain a lot of information. (Figure 3 demonstrates a typical visual field for a patient and will be a good reference as you read through the remainder of the article.) Patient information, including which eye is being tested, is usually located at the top of the printout. The type of test, along with the length of time that it took to complete the test, also is located at the top of the printout.

Fixation losses, also located at the top of the visual field printout, describe how many times patients move their eye during the test. The instrument tests if the patient is fixating and gives a ratio of how many times the patient lost fixation to the amount of times the visual field analyzer tested fixation.

The instrument checks a patient’s fixation in a very interesting way. Patients who perform the test correctly will have a blind spot that is mapped out and easily visible on the gray scale located on the top right portion of the printout. When checking fixation, the analyzer will show a small spot of light in the area of the visual field that corresponds to the patient’s blind spot. If the patient is fixating on the target, he or she will not see
the spot of light when it is shown in the blind spot. If they can see it, they must have moved their eye. Thus, the analyzer records every time a stimuli is shown in the blind spot and seen by the patient as a fixation loss.\textsuperscript{11}

Two other important measures of reliability are false positives and false negatives. False positives represent the patient responding to stimuli levels that the field analyzer would not predict the patient would see. This creates the appearance of a patient whose visual field sensitivity is very high. Unfortunately, these patients’ visual fields show low reliability, and oftentimes these patients are termed “trigger happy” because they will respond even when they don’t necessarily see a stimuli.

False negatives, on the other hand, describe those patients who do not respond to certain stimuli that the analyzer would predict they would see based on previous responses. This is a patient who is hesitant to respond to stimuli unless they are certain that they saw it and will oftentimes have a generalized depression in their sensitivity\textsuperscript{12}.

\textbf{Visual Field Appearance}

The visual field results are analyzed and classified in three ways: 1) the gray scale, 2) total deviation, 3) pattern deviation. We will discuss each of these in detail and understand the value and meaning for each of these measures.

\textit{The Gray Scale}

This is located at the top right of the visual field printout. This scale represents the visual field and allows the clinician to quickly view the results. This gives a general understanding of the gross visual field findings. Those areas in the visual field that represent defects are designated as darker areas while those areas that are seen well by the patient are represented by lighter areas. As you can see in figure 3, the blind spot is clearly seen as a darker, vertically elongated oval in the temporal portion of the visual field.

Just to the left of the gray scale are the numbers that are represented by the gray scale. These numbers describe the sensitivity of the patient’s visual field. The patient’s sensitivity is measured in decibels. The higher the numbers, the more sensitive the patient is in those areas. As is shown, a normal patient is most sensitive centrally, and the sensitivity decreases as we progress into the periphery in any direction.

\textit{Total Deviation}

Total deviation is located at the bottom left portion of the visual field printout. Total deviation describes how a patient’s visual field differs from those values expected for others in their same age class. A zero means that the patient’s sensitivity is exactly as expected at that location. A negative number indicates that the patient’s sensitivity is less than expected at that spot. A positive number indicates that the patient performed better than expected in that portion of the visual field.

Just below the visual field representation for total deviation is the statistical analysis of this information. The darker areas seen in this analysis are more likely to be true defects. Areas represented by a single dot are portions of the visual field that do not differ from expected values for the patient.\textsuperscript{13}
Pattern Deviation

Pattern deviation is the total deviation adjusted for a general overall decrease in a patient’s visual field, and more accurately represents the visual field loss due to the visual pathway. Ocular issues such as cataracts or dry eyes may significantly affect the total deviation, but as long as the neural function is still intact, the pattern deviation will still show a normal pattern.14

Summary

Visual fields provide us with significant insights into our patients’ visual systems. They allow us to explore the health of the ocular system, including the eye, visual pathways and visual cortex. By understanding the anatomy and the visual field printouts, you will be able to better care for your patients and have a greater appreciation for the power of this valuable test.

Footnotes

1) http://dictionary.reference.com/browse/Visual%20field
Figure 1
Figure 2

The Visual Fields: A Textbook and atlas of clinical perimetry, David O. Harrington, 1971
Figure 3
“Visual Fields: The Path Less Taken”

To receive one hour of continuing education credit, you must be an AOA Associate member and must answer seven of the ten questions successfully. This exam is comprised of multiple choice questions designed to quiz your level of understanding regarding the material covered in the continuing education article, “Visual Fields: The Path Less Taken”.

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Select the option that best answers the question.

1. Visual fields in a healthy individual typically extend _____ degrees nasally from the person’s point of fixation.
   a. 60
   b. 70
   c. 80
   d. 90

2. Glaucoma is a disease __________________________ with visual fields.
   a. Diagnosed
   b. Followed during treatment
   c. Both of the above
   d. Neither of the above
3. In the Ocular Hypertension Treatment Study, a visual field defect had to be repeated ____ times before it was considered a true defect.
   a. 1
   b. 2
   c. 3
   d. 4

4. Pituitary tumors will typically manifest a visual field defect:
   a. Located on the right side of the visual field for each eye
   b. Located on the left side of the visual field for each eye
   c. Located in the nasal portion of the visual field for each eye
   d. Located in the temporal portion of the visual field for each eye

5. If there is an insult that affects the visual field posterior to the optic chiasm, it will affect the visual field by:
   a. Showing visual field defects in the nasal portion of the visual field for each eye
   b. Showing visual field defects in the temporal portion of the visual field for each eye
   c. Showing visual field defects on the same side (right or left) of the visual field for each eye

6. The “hill of vision” is a concept that describes visual sensitivity being:
   a. Greatest at the point of fixation and decreases peripherally
   b. Greatest in the periphery and decreases closer to the point of fixation
   c. Equal at the point of fixation and in the periphery

7. A patient with high false negatives will:
   a. Be hesitant to click unless they are certain that they see the stimuli
   b. Will usually measure a lower sensitivity than expected
   c. All of the above
   d. None of the above

8. In a typical grey scale, a higher level of sensitivity will correspond with:
   a. A lighter color
   b. A darker color

9. A positive number on the total deviation plot represents:
   a. Higher than normal sensitivity
   b. Lower than normal sensitivity
   c. The expected level of sensitivity

10. Things that can affect the total deviation but will not necessarily effect the pattern deviation include:
    a. Cataracts
    b. Dry eyes
    c. Both of the above
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