Interpreting Visual fields

Original Article Contributed by: Renn Lovett, BSN, RN
Faculty Editor: Brian Jerkins, MD

Visual field assessment is a critical component in the ophthalmic examination. Many conditions can affect visual field testing such as glaucoma, strokes, tumors, and retinal detachment to name a few. Visual field testing can be performed in numerous ways, including confrontation method, kinetic perimetry, static perimetry, Amsler grid, or tangent screen. One mainstay technique is standard automated perimetry (SAP), most measured by Humphrey visual field perimeter. Unlike Goldmann kinetic perimetry, which is manual and uses a moving target, Humphrey uses fixed points of light shown at different intensities to determine a threshold of visual loss.

Interpreting visual field testing can be a difficult skill to master and takes continual practice. When interpreting a standard "Central 24-2 Threshold Test," the baseline visual field test analyzing the central 24 degrees of vision, the results are divided into 3 sections: patient and test details, displays of sensitivities across the visual field as graphical plots, and summary measures of test performance.

A visual field test is often difficult for a patient to perform, so patient and test details must be analyzed to measure reliability of the test results. Ensure that the patient's name, demographics, and time match the results you intend to analyze. Information to help judge the reliability of the test includes rate of fixation loss, false positive errors, false negative errors, and the time necessary to complete the testing. The test will routinely test the patient's physiological blind spot to assess for gaze fixation. If the patient can see the spot, it's recorded as a fixation loss. Reliable tests generally have below 20% fixation loss. A false positive occurs when the patient presses the button when there was no stimulus, sometimes referred as "trigger happy." A false negative occurs when the patient fails to see a stimulus which was brighter than one they saw earlier in the same test. This can also occur due to attention lapses or fatigue. Reliable tests have below 33% false positives and false negatives.

There are generally 6 different plots displaying sensitivities per single field analysis. A numerical plot gives the threshold for all 54 points checked, and the corresponding grayscale plot to the right graphically displays regions of visual field loss with decreased sensitivity in darker tones. Higher numbers indicate higher sensitivity to light at that location, whereas low numbers indicate decreased sensitivity. The sensitivities are not compared to any normative database, therefore take caution as it may be misleading based on where the machine makes the cutoff between different shades of gray. The numerical total deviation plot compares the patient's visual sensitivity to an average normal age-matched individual. Positive values indicate the patient can see higher sensitivity than the average individual of that age while negative values indicate decreased sensitivity from the normal. The numerical pattern deviation plot measures discrepancies in a patient's visual field by correcting for generalized decreases in sensitivity. Instead of comparing to a normalized database, the analysis finds the patient's 7th most sensitive (85th percentile) non-edge point and assigns a value of zero, to which all subsequent values are compared [1]. The bottom most plots are probability plots corresponding to the total deviation and pattern deviation plots above. They demonstrate statistical significance of abnormal results at a 5%, 2%, 1%, or 0.5% probability of results displayed in the numerical plots above, allowing for a visual representation of statistically significant visual field deficits. Of all these plots, the pattern deviation probability plot is the best for determining widespread or diffuse field loss from localized loss [2].

The summary measures of test performance are shown on the bottom right side and include glaucoma hemifield test (GHT), visual field index (VFI), mean deviation (MD), and pattern standard deviation (PSD). GHT splits the results into mirroring superior and inferior zones across the horizontal meridian comparing the differences in zones with normal population controls. Outcomes include within normal limits, outside normal limits, borderline, general reduction of sensitivity, and abnormally high sensitivity. VFI reports the patients visual field status as a percent of normal population age-matched visual field. MD is the average of all the deviations across the entire field compared to normative age-matched controls. Positive MD signifies the patient was able to see dimmer stimuli than controls while negative MD signifies the patient requires brighter light than controls. A reliable test usually ranges from +2 dB to -30 dB MD. PSD compares differences between adjacent points with higher values representing more focal loss and lower values representing either no loss or severe, diffuse loss. Subsequent p values corresponding with abnormal results express the probability of the result occurring by chance, meaning lower p values correspond with greater clinical significance and less likelihood of the result happening by chance alone [3].

There are many details involved in the interpretation of visual field testing. Establishing an approach is important to maximize diagnostic power. As a rule of thumb: confirm it's the right patient by reviewing name, date, and date of birth; confirm which eye has been tested; look at the reliability indices; review the visual field patterns, especially the pattern deviation probability plot; look at the GHT, VFI, MD, and PSD; and compare the results to previous visual fields in that same eye [4]. Below are common patterns of visual field loss and glaucomatous visual field defects.

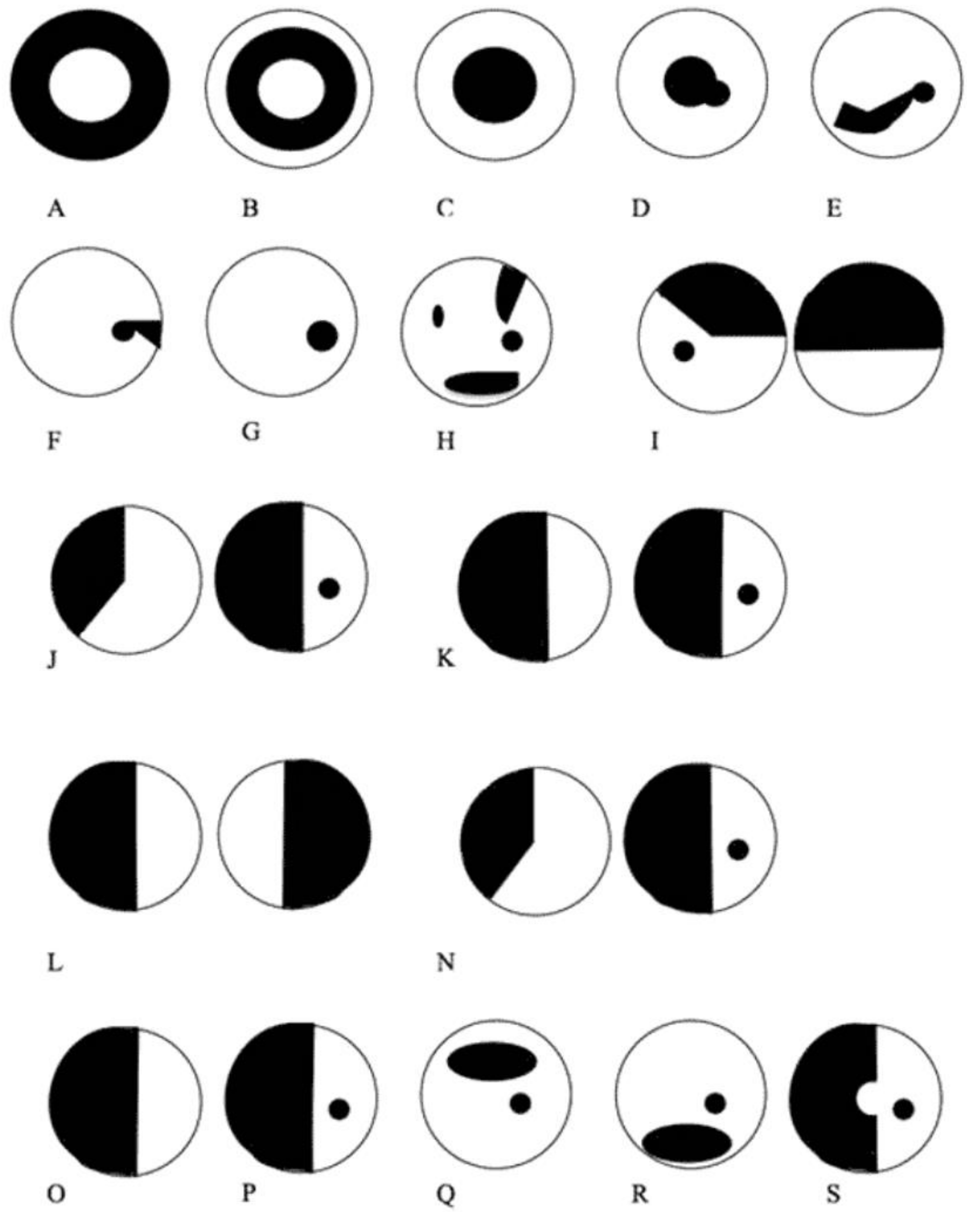

Figure 1: Common visual field defects [2]. **A**: Constriction of the visual field, **B**: Ring scotoma, **C**: Central scotoma, **D**: Cecocentral scotoma, **E**: Arcuate scotoma, **F**: Temporal wedge, **G**: Blind spot enlargement, **H**: Multiple scattered defects, **I**: Hemifields respecting the horizontal meridian, **J**: Hemifields respecting the vertical meridian, **K**: Homonymous, **L**: Bitemporal, **N**: Incongruous bilateral defects, **O**: Congruous bilateral defects, **P**: "Pie in the sky", **Q**: "Pie on the floor", **R**: "Punched out" defects**.** Image courtesy of Carroll et al; *From One Medical Student to Another. EyeRounds.org. August 21, 2013; available from http://EyeRounds.org/tutorials/VF-testing/*

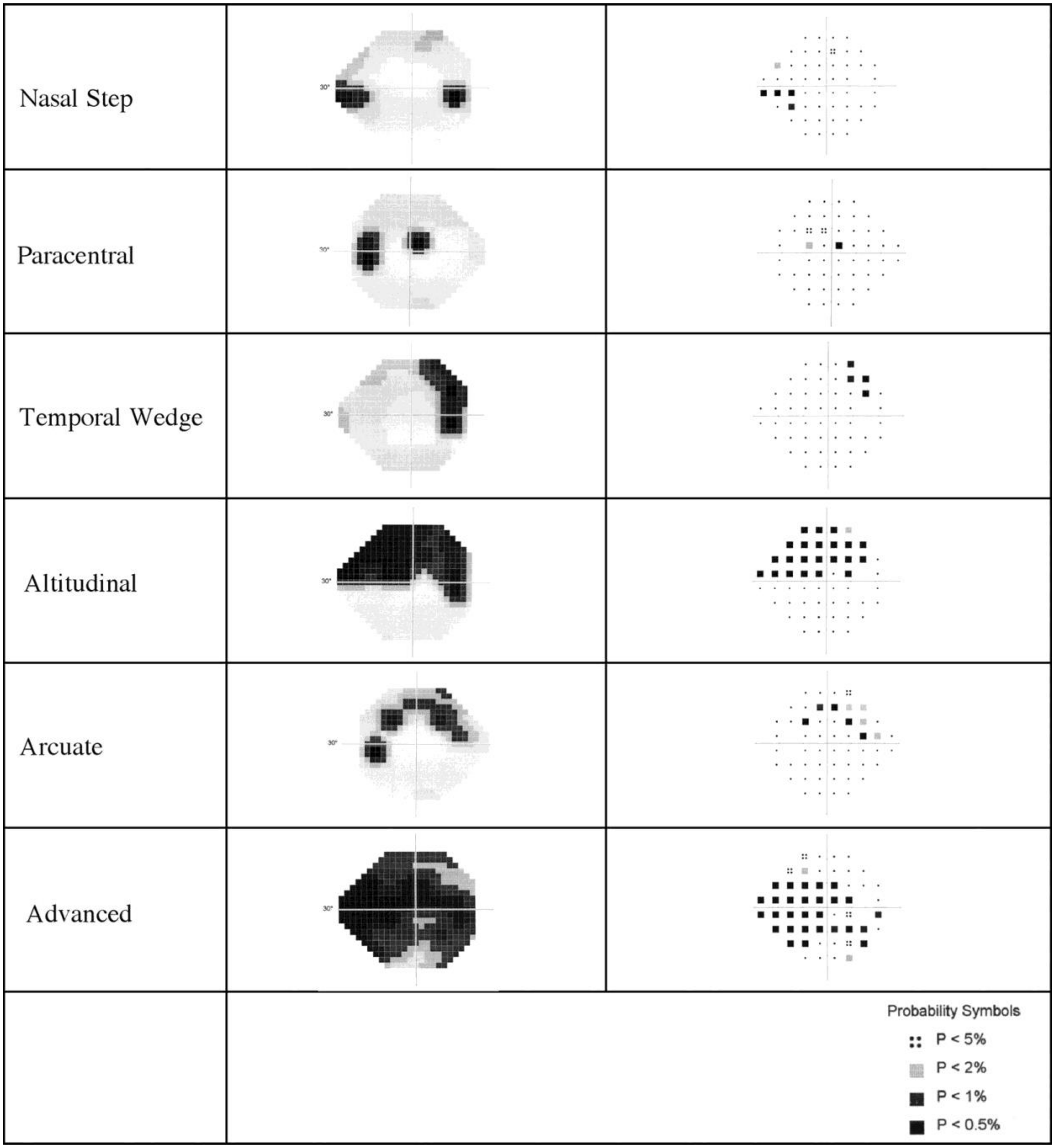

Figure 2: Patterns of glaucomatous visual field defects [4]. Image courtesy of Pamela et al; *Using Unsupervised Learning with Variational Bayesian Mixture of Factor Analysis to Identify Patterns of Glaucomatous Visual Field Defects*

References:

1. Sample PA, Dannheim F, Artes P, Dietzsch J, Henson D, Johnson CA, Ng M, Schiefer U, Wall M. Imaging and Perimetry Society Standards and Guidelines. *Optom Vis Sci* 2011;88:4-7. [PMID: 21099442]
2. Carroll JN, Johnson CA. Visual Field Testing: From One Medical Student to Another. EyeRounds.org. August 21, 2013; available from http://EyeRounds.org/tutorials/VF-testing/
3. Ramulu P. Standard Automated Perimetry. 2012. [Cited 2021 Aug 16]; Available from http://eyewiki.aao.org/Standard_Automated_Perimetry
4. Pamela A. Sample, Kwokleung Chan, Catherine Boden, Te-Won Lee, Eytan Z. Blumenthal, Robert N. Weinreb, Antje Bernd, John Pascual, Jiucang Hao, Terrence Sejnowski, Michael H. Goldbaum; Using Unsupervised Learning with Variational Bayesian Mixture of Factor Analysis to Identify Patterns of Glaucomatous Visual Field Defects. *Invest. Ophthalmol. Vis. Sci.* 2004;45(8):2596-2605. doi: https://doi.org/10.1167/iovs.03-0343.