Names ____________________

Lab 2 –Perimetry

BASIC PRINCIPLES OF VISUAL FIELD TESTING

Psychophysical threshold and sensitivity

Visual fields testing, a *psychophysical* procedure, is the mainstay of glaucoma diagnosis and is at the heart of neuro-optometry. In glaucoma, early diagnosis is the key to preventing blindness, and visual fields analysis is often the most sensitive test for detecting early damage. Damage to the retinal nerve fibers can cause loss of vision in any part of the visual field; therefore a test for glaucoma must test vision many points across the visual field. In perimetry, we usually measure the threshold for detection of a small spot of light against a uniform background. The dimmest spot that can be detected is compared to age-matched norms to evaluate visual performance. Where the eye can detect a dim light (low threshold), sensitivity is high and vision is good. If the eye requires a bright light for detection (high threshold), sensitivity is low and vision is poor. Note that the terms, “threshold” and “sensitivity” have an inverse relationship (Figure 1).

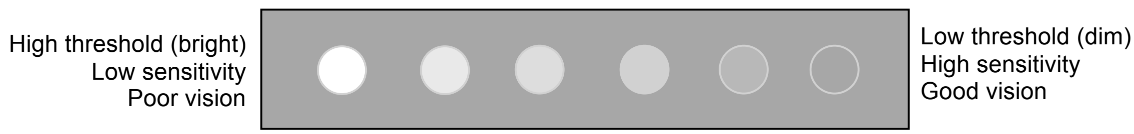

Figure 1. Relationship between threshold and sensitivity in a detection task.

The “hill of vision”

The eye’s sensitivity varies depending on the retinal location and is often described as a “hill of vision” (Figure 2). The goal of visual field testing is to measure the “height” of the hill at discrete locations. You must determine the dimmest light that the patient can detect at each location. In Figure 2, higher values indicate greater sensitivity (better vision) or that a dimmer light was detected (lower threshold). Lower values mean poorer sensitivity (poor vision) or a higher threshold (brighter light required for detection).

You can measure the hill’s height at one particular location in the visual field by shining a light on that location and adjusting its brightness until it can no longer be seen (A; **static perimetry**). Or you can start with a fixed brightness and move it across the visual field to find the location where it first becomes visible (B; **dynamic perimetry**).

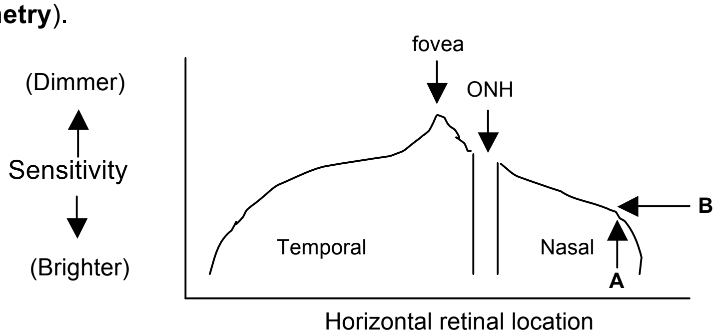

Figure 2. The “hill of vision.”

The Decibel labels

The Humphrey Vision Field Analyzer tests sensitivity by varying the brightness of a test spot (static perimetry). Photometric units (such as nits or apostilbs) may be used to specify the brightness of the target, but visual field plots are normally labeled in decibels (dB).

Discussion question: What is meant by the decibels? Aren’t decibels used to measure hearing?

The maximum brightness setting is 10,000 apostilbs, and it should be easily visible for a normal healthy eye anywhere in the visual field. Usually you will need to dim the light to a much lower level to measure the threshold, and this is accomplished by using neutral density (ND) filters. ND filters are labeled in log units of optical density. A 1.0 ND filter reduces light by a factor of 10; a 2.0 filter reduces light by a factor of 100, etc. This is illustrated in Figure 3. A decibel is one-tenth of a log unit; the higher the decibel value, the denser the ND filter and dimmer the light. Therefore, a higher decibel value indicates that the threshold is lower and the sensitivity is higher; that is, vision is better.

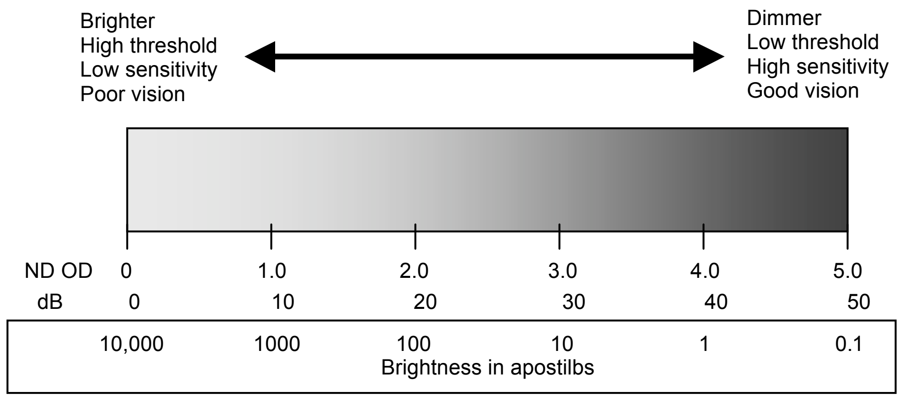

Figure 3. Scoring visual sensitivity using decibels in the Humphrey Vision Field Analyzer.

Q. If the sensitivity at one point in the visual field is reduced 5dB below normal (-5dB deviation; vision is worse than normal), how much brighter must the light be made relative to normal?

Brighter by 5dB = brighter by a factor of $10^{.5}$. Calculating, $10^{.5}$ = 3.16. So it must be over 3x brighter.

Q. Assuming that the normal threshold, for the question above, would have been 30 db. What would the brightness be in apostilbs for a -5dB deviation?

That means if must be 25dB dimmer than full brightness (10,000 apo). That is dimmer by a factor of $10^{2.5}$ = 316.23. So the brightness must be 10,000 divided by 316.23 = 31.63 apostilbs.

PERIMETRY

Experiment 1 - Extent of the normal visual field

In the first experiment, you will use the dynamic technique to determine the perimeter (or outer edge) of the visual field for a particular stimulus. The instrument you will use is a classic arc perimeter, with a 5-mm diameter white target. Slowly move the target from outside the visible range, inward until the subject first sees it. Record the mean of several measurements in the temporal, nasal, superior and inferior meridians.

Work in pairs (one group of 3) and collect data on each right eye, then enter the results in the table below and on the Excel spreadsheet on the lab computer. Dr. Salmon will compute the mean and standard deviation for the class and see how it compares with expected norms.

Subject	Superior	Nasal	Inferior	Temporal

Experiment 2 - What limits the nasal field?

Nothing obstructs the temporal visual field, so it is obviously limited by the edge of the retina. Why are the superior, inferior and nasal fields narrower than the temporal field? Let us consider the nasal field. What limits the extent of the nasal visual field? There are two possible hypotheses:

1. The nasal field may be limited by the nose.
2. The nasal field may be narrower because the temporal retina ends sooner than the nasal.

Design an experiment to determine which hypothesis is correct. Write a brief (less than one page) summary of your A) experimental procedure, B) results and C) conclusion.

Experiment 2 - The nasal visual field

Introduction.
The nasal visual field extends about 60° peripherally, while the temporal field goes out to 90°. Most people assume that the reason for the restriction is because the nose blocks the field of view. However, it is possible that the reason is that the temporal retina is shorter. The purpose of this experiment was to determine which factor limits the nasal field, the nose or the retina.

Methods
1. Using an arc perimeter, measure the extent of the OD nasal visual field in primary gaze.
2. Rotate the head leftward so the nose is pointed about 30 degrees left of the straight-ahead fixation spot. This gets the nose out of the way.
3. While the subject fixates straight ahead, re-measure the nasal visual field. If just the nose (and not the retina) limits the visual field, then the measured field should be significantly expanded.

Results
Most students find that the extend of the visual field, with the nose "removed" is about the same, or only slightly expanded, relative to the field measured in primary gaze. For example the data might show:

Condition	Extent of nasal field
Primary gaze	55°
Nose "removed"	58°

Discussion
This shows that both the retina and nose (in primary gaze) limit the extent of the visual field to about the same extent. That is, the extent of the temporal retina is well matched to the extent of visual field that it was designed to see, and even without a nose to block the view, the nasal field would still be much shorter than the temporal field.