Lecture 32 - Testing Color Vision

OVERVIEW OF COLOR VISION TESTING

Q. Why are optometrists interested in testing color vision?

- Occupational physical examinations
- Diagnose hereditary color anomalies
- Diagnose and monitor diseases

When testing color vision, we usually want to know:

- Is the patient's color discrimination normal or abnormal?
- What type of anomaly does the person have; that is, is the patient a protan, deutan, tritan or something else?
- How severe is the color anomaly? For example, is the person a dichromat or anomalous trichromat?
- Is it an acquired or hereditary defect?

Different approaches to color vision testing:

- Simple screening tests (red cap tests—See notes for the previous lecture.)
- Book tests: the HRR test and psuedoisochromatic plates (PIP)
- Arrangement tests
- Anomaloscopes
- Special occupational color vision tests such as the Farnsworth Lantern (FALANT)

BOOK TESTS

Pseudo-isochromatic plates (PIP) are popular because they are easy to use and are relatively inexpensive. The test uses a number of plates that consist of a colored figure (such as a number) printed on a background of another color or colors. A person with normal color perception will be able see the figure, but the person with anomalous color vision will not be able to discriminate the figure from the background, because the figure and background are made of colors that lie on a color confusion line. This arrangement confuses a patient with a color anomaly because it uses colors that appear to be isochromatic (same color), but they really are not (pseudo-isochromatic).

Most PIP tests provide only a limited assessment of color discrimination. They usually are

- simple pass/fail screeners for red-green anomalies only.
- They do not test for tritanopes.
- If a patient fails, most tests do not differentiate between protans versus deutans.
- They do not grade the degree of color anomaly.

One of the most well known PIP-type color tests is the **Ishihara test**. Several versions of the Ishihara test have been published. Several other PIP-type color vision tests are available. For more information, refer to Borish, Chapter 9, p. 316-318.

The **HRR test** is the one you purchased, and is one of the best color vision tests available. It looks similar to the PIP tests, but is designed on a slightly different principle. Instead of using a colored background, the HRR background is neutral gray. It uses the fact that dichromats or anomalous trichromats see colors as less saturated than normal. They therefore have difficulty discriminating certain colors from neutral gray; in particular, the colors that lie on the color confusion line that goes through white. Examples of HRR test plates are shown in Schwartz Fig. 6-11, 12.

Q. Can you name some advantages of the HRR test over most PIP tests?

A. Can differentially diagnose all three major types of anomalies (protan, deutan, tritan) and the degree of severity. It's fast and easy to use, especially with its organization of screening and diagnostic series.

ARRANGEMENT TESTS

In arrangement tests, the patient must sort colored samples in a particular order. The two most well-known arrangement tests are the **Farnsworth Munsell Hundred-Hue test** and the **D-15 test**, which comes in both a saturated and desaturated version.

Farnsworth Munsell Hundred-Hue Test

This system tests the quality of a person's color discrimination (superior, average, low) and can diagnose the general type of color anomaly (protan, deutan, tritan) if it is present. It can also grade the severity of the defect numerically. The test consists of 85 colored caps, each with a different hue. The patient's task is to select the hue that looks most similar to a reference caps and place it next to the reference caps. He must then select, from among the remaining caps, the next hue in the color sequence until all the caps have been arranged in continuous hue steps. The Hundred-Hue test is time consuming and expensive, so it is not commonly used in most optometry practices.

Table 1. Interpretation of Hundred Hue test results

Color discrimination score	Location of bulge center
Superior: 0-16	Protan: 62-70
Normal/average: 20-100	Deutan: 56-61
Low discrimination: >100	Tritan: 46-52

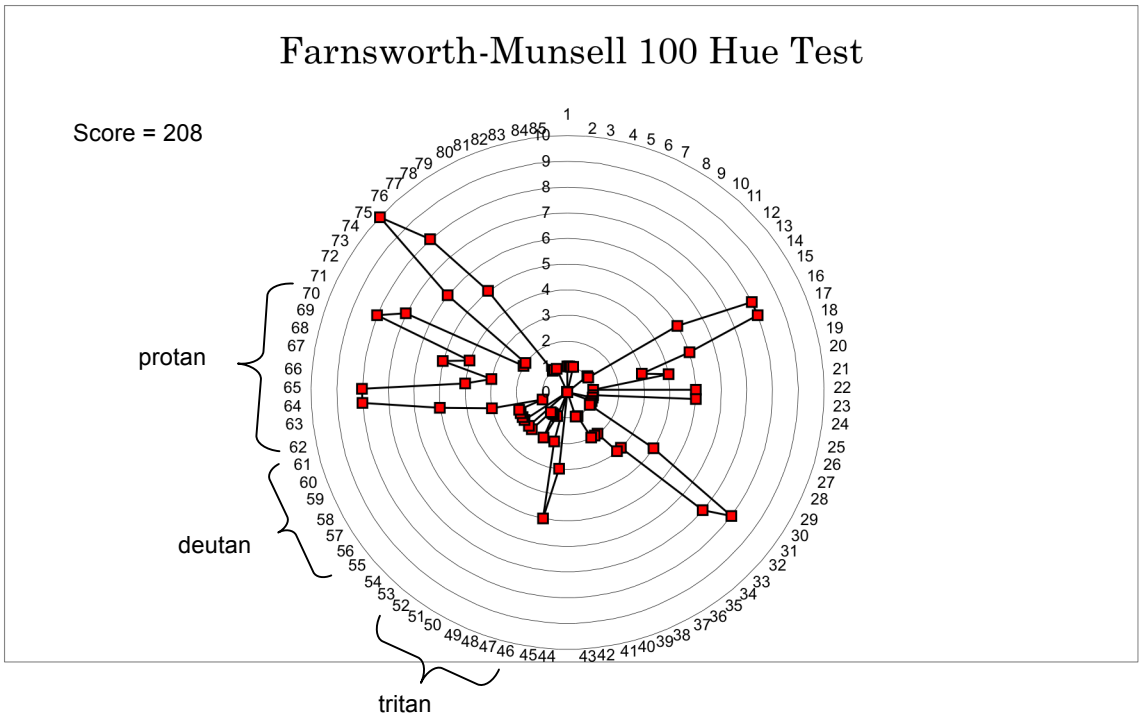

Figure 1. Example computer plot of one patient's Hundred-Hue test.

Saturated and unsaturated D-15 tests

The D-15 test is an abbreviated version of the Hundred-Hue test, so it is easy to use, fast and can diagnose all three categories of color anomaly (protan, deutan, tritan). It can also grade the severity of

the defect. This is the test that has been produced by the NSU Optometric Students Association, and one version is called the **Oklahoma Color Vision Test**. This is the test that we have in our clinics.

Like the Hundred-Hue test, the color samples (15 of them) must be arranged in hue order, starting with a reference cap. The order of the caps is recorded on a dot-to-dot style recording sheet. See Borish Figs. 9-37, 9-39, 9-45 for examples of D15 test results for patients with normal and anomalous color vision,

The dots on the recording sheet are based on the CIE chromaticity diagram (Schwartz Fig. 6-13; Borish Fig. 9-36). The reference lines on the recording sheet are color confusion lines, and they help diagnose the type of color anomaly. If the patient is a protan, deutan or tritan, lines will cross the circle with a slope that parallels the reference line for the particular anomaly.

On this test, one cross-over is considered a fail. Table 2, below, summarizes criteria from Borish Chapter 9, for interpreting other misplacements. The desaturated test is more difficult and is a more sensitive test for a color anomaly, so it should do a better job of detecting subtle changes in color vision that might accompany a disease.

Table 2. Pease's (Borish Chapter 9) Pass/fail criteria for the D-15 tests

Test result	Cross-overs	Two or greater place error	Single place error
Fail	1	1	2