

Lab 9 - Testing Color Vision

INTRODUCTION

Clinical color vision testing is important for detecting both ...

- hereditary color anomalies (occupational concerns) and
- acquired color anomalies that may be a sign of ocular disease.

Table 1. Prevalence of hereditary color anomalies

| Anomaly type | Prevalence in males (%) |
|---------------|-------------------------|
| Protanopia | 1 |
| Deuteranopia | 1 |
| Protanomaly | 1 |
| Deuteranomaly | 5 |
| Tritans | < 0.005 |

We want to know if ...

- the patient's color vision normal or abnormal?
- What type of anomaly does he have? (protan, deutan, tritan or other)
- How severe is the color anomaly?
- Is it an acquired or hereditary defect?

The simplest color vision tests answer the first question only, and usually for red-green anomalies only. Other tests provide more information.

GENERAL PRINCIPLES FOR PROPER COLOR TESTING

- Read the instructions
- Use the proper light source
- Test monocularly

LAB ASSIGNMENT

Practice each of the following color vision tests on a partner, preferable a male partner. Record results and write your diagnosis on the page. For the 100-Hue test, enter your results on the lab computer and save it on the desktop with your names in the file name.

PSEUDO-ISOCROMATIC PLATES

Pseudo-isochromatic plates (PIP) are popular because they are easy to use and relatively inexpensive. The most commonly used plates, such as those manufactured by Richmond Products, are *simple pass/fail screeners for red-green anomalies only*. **Most do not ...**

- Test for tritanopes.
- Differentiate between protans and deutans.
- Do not grade the severity of a color anomaly.

1. Pseudo-isochromatic Plates for Testing Color Perception (Richmond Products)

This test is designed as a pass-fail screener for red-green defects only. It does not classify the type of red-green defect and does not test for tritans (blue-yellow defect). It also does not quantify the severity of the anomaly. The recommended illuminant is the **MacBeth lamp**. Test procedure:

- Ask the patient to read the number on each page. The first page is a demo and not scored.
- Record the number of errors on the next 14 pages.
- Fail is ≥ 5 errors. It indicates a red-green anomaly (deutan or protan).

2. Ishihara's Tests for Color-Blindness (24-plate edition, 1982)

This tests for red-green defects only (no blue-yellow). It can distinguish between protan and deutans and can diagnose the defect as either strong or mild. The recommended illuminant is normal daylight, but not direct sunlight. Test procedure:

- The standard screening uses pages 1-15 with #1 a demonstration page. Ask the patient to read the number and record each incorrect response. Note that for pages #14 and 15, the normal person should see nothing, but the person with a color deficiency should see numbers.
- FAIL is ≥ 6 errors. It indicates a red-green anomaly (deutan or protan).
- Use plates 16 and 17 to diagnose the type of red-green defect (protan or deutan).
- Plates 18-24 may be used if the patient cannot read numbers. Refer to the instruction booklet.
- The book also explains an abbreviated screening procedure that uses only some of the pages.

3. AO HRR Pseudoisochromatic Plates (From Richmond Products)

This is one of the best color vision tests. It can diagnose all three color anomalies and grade their severity. The recommended illuminant is the MacBeth lamp (Standard Illuminant C). Testing procedure:

- Pages 1-4 Demo. The patient should say 1) how many symbols are present, 2) identify it/them, and 3) say correctly where it/they are located.
- Pages 5-10 Screening. The patient must correctly answer the same three questions for each plate. Failure to correctly answer any one is a failure for that page. Record each page passed with a check mark. If he passes all six plates, he has normal color vision and the test is done. If he misses any plate, retest. If he still misses either Page 5 or 6, then proceed to Pages 21-24 to test for a blue-yellow defect. If he still misses any page between #7-10, proceed to Pages 11-20 and test for a red-green anomaly.
- To diagnose a red-green anomaly use Pages 11-20. Record each correct response with a check.
- Count the number of check in each column. The column (protan or deutan) with the greater number is that kind of defect.
- Follow a similar procedure for blue-yellow defects in plates 21-24.

FARNSWORTH MUNSELL HUNDRED HUE TEST

This color discrimination test and can diagnose the type anomaly (protan, deutan, tritan) and grade the severity. Each of 85 color samples, separated into four boxes, are designed for equal perceptual hue increments. The recommended illuminant is the MacBeth lamp (Standard Illuminant C). Test procedure:

- Select one box and randomize the disks.
- Ask the patient to arrange them in color order, starting with the reference sample.
- When the patient is finished, close the box, turn it over, and record the numbers, in order, on the Excel spreadsheet designed for this test.

To interpret the results, view the graph and note the region that has the greatest errors (largest departure from the center). Reference lines help identify the type of defect. Also note the score and interpret it according to Table 2.

Table 2. 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 |

D-15 AND DESTURATED D-15 TEST

This is like a mini-Hundred-Hue test and is much easier to administer and interpret. It consists of 15 colored disks that must be arranged in hue order, starting with the reference color. The perceptual color steps between each hue are not equal, therefore it is more difficult to compute an overall color score. Computer programs are available to compute numerical scores, however we normally plot the results and make the diagnosis based on the graph. This fast, simple test can detect and diagnose all the major types of color anomalies and can give you an estimate of the degree of severity. The desturated test is used to detect more subtle color anomalies.

Results that exceed the normal standards (below) constitute a failure. If the patient fails, he should be retested. Color anomalies can be classified as protan, deutan or tritan by comparing the slope of the cross-over with the reference lines on the record sheet. Diagnose pass/fail according to Table 3.

Table 3. 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 |

FARNSWORTH LANTERN TEST

This test is sometimes required for military or other occupational physical exams. Most clinics don't have the test, but we are fortunate to have one here. It is a simple pass/fail screener for protanopia or dueteranopia. Test procedure:

- Lighting – normal room lighting
- Test distance = 8 feet
- This is the only test that is normally done binocularly.
- Present each of the 9 lights in random order, allowing about 2 seconds per exposure.
- Tell the patient to say the color of the top, then bottom light. The choices are red, green or white.
- Record the number of errors out of the first run of 9. If there are no errors, the patient passes.
- If there are any errors, repeat the test two more times.
- Three or more errors (for the two runs) is a failure.

Table 4. Farnworth Lantern test results.

| | 1GR | 2WG | 3GW | 4GG | 5RG | 6WR | 7WW | 8RW | 9RR | errors |
|---------|-----|-----|-----|-----|-----|-----|-----|-----|-----|--------|
| 1st run | | | | | | | | | | |
| 2nd | | | | | | | | | | |
| 3rd | | | | | | | | | | |

AQT-10 Color Vision Tester

This is a new test that has been designed using the anomaloscope principle. It is able to diagnose all three major types of dichromacy and anomalous trichromacy. Since it is self luminous, you don't need an external light source. Test procedure:

- Have dim illumination in the room
- Turn on the switch on the back of the instrument
- Select "New Patient" on the control pad, then "GO."
- Select "Test," then "GO."
- Select the type of test you wish to perform. For the purposes of this lab, try all three.
- Press the GO key to present the stimulus. The patient must say which dot has the different color (top, bottom, right or left). Record the patient's response; either "SEEN" OR "NOT SEEN."
- Using the right and left arrow keys, select the next step, and repeat, until all steps have been tested
- Use the up and down arrow key to change to the alternate test.
- Record the number of incorrect responses for each test, or print the results.
- The instruction brochure does not state pass/fail or diagnostic criteria, however, I would diagnose an error on any of the congenital tests as a color anomaly, which is mild, moderate or strong depending on the number of errors. For acquired tests, record the number of errors and monitor.