Color Vision Exam

What is this software?

I wrote the Color Vision Exam software to allow people to determine if they have a color vision abnormality or color vision deficiency.

How does it work?

The software presents the examinee a series of isochromatic plates. These are pictures of numbers where the background color and the numeral color have been carefully chosen to highlight potential abnormalities and deficiencies in the examinee's color vision perception. The examinee is shown in sequence 35 different isochromatic plates. At the end of the exam the results are tabulated and shown. The test takes approximately 3 minutes to complete depending on the speed of the person being tested.

How accurate is the exam?

This is highly dependent on the accuracy of your computer monitor. Most higher-end computer monitors will be accurate enough for the results to be meaningful. A CRT monitor that has been calibrated with a hardware measurement device will be the most accurate. Inexpensive LCD monitors, laptop displays, projectors, and alternate output devices like TV displays are not accurate enough to administer this exam and give meaningful results.

What color vision abnormalities and deficiencies can be detected?

This exam can detect anomalous trichomats, who have a weakened or shifted response in either the long wavelength (red) or medium wavelength (green) receptors in the eye. (These conditions I refer to as a color vision abnormality.) It can also detect dichromats who have an absence of either the long (red), medium (green), or short (blue) wavelength receptors. (These conditions I refer to as color vision deficiencies.) Theoretically it can also detect the very rare monochromats, who would give abnormal responses to most or all of the isochromatic plates.

What are the limitations of the software?

The software cannot detect extremely subtle color vision abnormalities (very slightly shifted receptor response) reliably. The degree of sensitivity required to detect a very slight deficiency like this is below the threshold of the computer monitor's color accuracy. The software also cannot quantify the degree of anyone's color vision abnormality. i.e. the software may detect that some type of abnormality is present but will not be able to tell you if your abnormality is better or worse than someone else's detected abnormality. All it can tell you is that your color vision perception falls outside established norms for most people.

How do I take the test?

Download the software to your computer. You probably have already done this and have extracted the .zip archive. The archive contains only two files, the Color Vision Exam.exe program and this Read Me.pdf file.

System Requirements

1. You must have a computer running Windows 2000 or Windows XP.
2. You must have the Microsoft .NET Framework 2.0 installed. (Go to http://windowsupdate.microsoft.com to download and install it if you don't have it.)
3. You need a hardware-device-calibrated CRT monitor to ensure meaningful results. Higher-end, good quality LCD monitors will work, but may be less accurate than a CRT monitor, even when calibrated. Do not use an inexpensive LCD monitor, laptop display, projector, or television to take the exam.

Taking the Exam

1. Run the program by double-clicking on Color Vision Exam.exe.
2. When the program comes up, click the **Start Exam** button in the upper left corner to start the exam. Instructions will be presented that explain how to take the exam. They are repeated here:

- You will be shown 35 different isochromatic plates that each contain a 2-digit number.
- When you are shown the plate, type the number that you see into the text box at the bottom and click on the **I See This Number** button.
- If you cannot see any number in the image, click on the **I Cannot See A Number** button.
- The number of isochromatic plates remaining in the exam is shown in the upper left corner.

- There will be some plates that are shown that everyone should be able to see, regardless of any color vision abnormality or deficiency. These are called "Control – Everybody" plates.
- There are some plates that are shown that do not have a number in them (i.e. nobody can see a number). These are called "Control – Nobody" plates. Both types of control plates are necessary to ensure that the person taking the exam is not attempting to cloud the results with guessed answers.
- The other plates in the exam are chosen such that the background color and the number's color are difficult or impossible to differentiate for people with certain types of color vision abnormalities or deficiencies.
- You may see some plates that appear to have two different 2-digit numbers superimposed over each other. If you see this, choose whichever number appears to stand out more. If it is difficult to tell which number stands out more, choose your best estimate.

How do I interpret the results?

The results will be shown to you after the 35 plates have been shown and answered. The results are tabulated based on what type of plate was shown, and whether the answers you gave were consistent with someone who has normal color vision or consistent with someone who has a color vision abnormality or deficiency.

Control – Everybody Plates

There are 5 of these plates in the exam, and everyone should be able to answer all 5 correctly. Incorrect responses to these plates may indicate a typing error during the exam or a mistake in button clicking (i.e. clicking **I Cannot See A Number** instead of clicking **I See This Number**).

Control – Nobody Plates

There are 5 of these plates in the exam, and nobody should see a number in these plates. In other words, the correct response to these plates is clicking the **I Cannot See A Number** button. Incorrect responses to these plates indicate that the examinee is guessing at many of the plates in the exam, or is "trying too hard" to see a number.

Deuteranomalous/Deuteranope Detection Plates

There are 10 of these plates in the exam. Those individuals with abnormalities in the medium wavelength color receptors (green) will have varying amounts of difficulty with these plates. Those with only slight anomalies will generally get some plates correct but

will almost always answer incorrectly to at least a few. Deuteranopic dichromats will generally incorrectly answer most or all of these plates.

Protanomalous/Protanope Detection Plates

There are 10 of these plates in the exam. Those individuals with abnormalities in the long wavelength color receptors (red) will have varying amounts of difficulty with these plates. Those with only slight anomalies will generally get some plates correct but will almost always answer incorrectly to at least a few. Protanopic dichromats will generally incorrectly answer most or all of these plates.

Tritanope Detection Plates

There are 5 of these plates in the exam. (Only 5 are used because the defect is very rare, and virtually always a dichromat.) Those very few individuals with a deficiency in the short wavelength color receptors (blue) will have difficulty with these plates. There is almost no incidence of tritanomalous abnormality (shifted or weak blue) – anyone with a defect in the short wavelength color receptors is almost always a tritanopic dichromat. These individuals will incorrectly answer virtually all of these plates.

Technical Details on the Software

References

The primary algorithm used in the program for generating the colors is given in the paper *Digital Video Colourmaps for Checking the Legibility of Displays by Dichromats*, by Françoise Viénot, Hans Brettel, and John D. Mollon.

Features of the Exam

The exam generates all plates from scratch during the exam – the plates have not been pre-generated and predetermined. This ensures that the exam is different every time and prevents memorizing plates. The 2-digit numbers inside the plate are random, the colors are randomly chosen (but matched for the abnormality that the plate is testing for), and the order of the different plates that are testing for different abnormalities is also randomized. This level of randomization enables the software to generate approximately 7,000,000 different plates for each abnormality tested.

Version Information

1.0.0.0 Initial Release

End User Software License Agreement

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How many people are affected by color vision abnormalities or color vision deficiencies?

Approximately 8 % of all men have some form of color vision abnormality or deficiency. This figure and the breakdown that follows vary somewhat with the region of the world and the testing method used to detect these color abnormal/deficient individuals. The particular types of abnormalities and deficiencies are approximately broken down as follows:

Total color vision abnormal/deficient	**8 %**
Deuteranomalous (weak or shifted green receptors)	6 %
Protanope (absence of red receptors)	1 %
Protanomalous (weak or shifted red receptors)	0.5 %
Deuteranope (absence of green receptors)	0.5 %
Tritanope (absence of blue receptors)	< 0.005 %

Because the genetic defect that causes these abnormalities/deficiencies is located on the X chromosome, the abnormalities/deficiencies are sex-linked, affecting men much more often than women. Only about 0.4 % of women have a color vision abnormality/deficiency.

I notice that the term "color blind" isn't used in your software or this Read Me. Why?

I dislike that term. I feel it's extremely inaccurate and serves to perpetuate the myth that "color blind" individuals can't see any color at all. Individuals with a color vision abnormality (deuteranomaly or protanomaly) or a color vision deficiency (deuteranope or

protanope) are not “blind” in the slightest. Their perception of colors is outside the established normal range for most people. I use the terms “color vision abnormality” and “color vision deficiency” because they accurately describe the conditions.

How can I get in touch with you or give you feedback on the software?

You may send me an e-mail at somejoe7777-colorvisionexam@yahoo.com. I can’t guarantee that I can respond to every e-mail, but I do read all of them. All feedback is welcome.

Thanks for your interest in the software,

Dan Wilson