Case Study 04: Roses Are Red, Violets Are Blue…Or Are They? DUE: 21 Apr 25

Photo by Unchalee Srirugsar : https://www.pexels.com/photo/pink-green-blue-multi-petaled-flowers-70330/

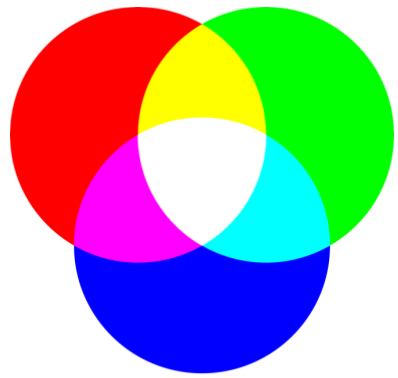
Introduction

Roses are red, violets are blue, and daisies? Apparently those can be any color you want! Can you see all of the vibrant colors in the photo on the left? If you can, you probably take your color vision for granted and it's perfectly normal to you to perceive literally millions of different colors.

But do you see the same thing I do? Do those bright pink flowers look the same to me as they do to you? On the one hand, the answer is yes; the physics is the same and the flower petals reflect certain wavelengths of light no matter who happens to be observing. But on the other hand, if you are colorblind, the world looks a *lot* different.

Let's examine how objects appear to be certain colors, and why. Let's also take a look at the standard tests opticians use to diagnose colorblindness and notice the difference between different types of colorblindness. Finally, what about your dog? Do dogs see color? Do they see the same colors as we do? What does the world look like if you're a dog?

Additive and Subtractive Primary Colors



What's the difference? First off, let's recall that we know that white light is comprised of all colors. Additive primary colors will combine to give you white light. As you can see on the right, red, green, and blue light overlap to make white. This is definitely *not* what you would expect if you were mixing paint, right? But paint is not light, and the additive primary colors of light are RED, GREEN, and BLUE.

Visit this color simulator: RGB Color Interactive. You can mix colors together, and view a photograph (or upload your own picture!) using RGB light sources. Play around a little.

1. What happens when you overlap the red and blue spotlights? Is it consistent with our example here on the page? What about combining red and green or blue and green?

Overlap all three light sources so you get a white circle where all three spotlights intersect. Now subtract the red light by dragging the red slider to 0%.

2. What color remains when you subtract? White – red = what? That's our first subtractive primary color!

Do the same thing twice again: Starting with white light, subtract one color. You did red, now do blue. Then do green. You've just identified the three subtractive primary colors!

3. What are these colors called? They can be described in many ways, but what are the standard names we use for these three colors? White – red = ? White – green = ? White – blue = ?
4. Are the daisies in the photo above predominantly additive or subtractive primary colors?

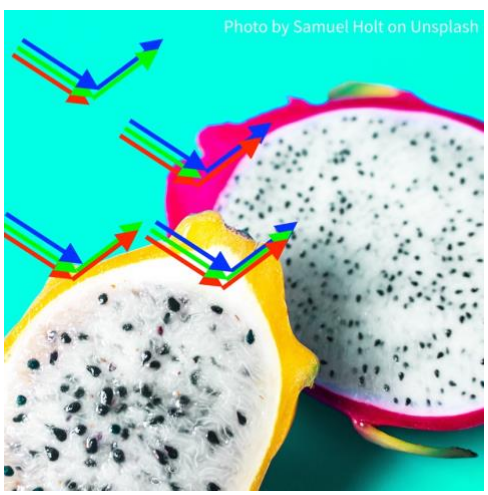


Photo by Samuel Holt on Unsplash

The Color You See

When you see an object—*any* object—it's because light has reflected off the surface of that object and that reflected light enters your eye. Any random object typically reflects more than one color (wavelength) light, as you can see in the photo on the left. As indicated by the arrows, the objects are illuminated by white light.

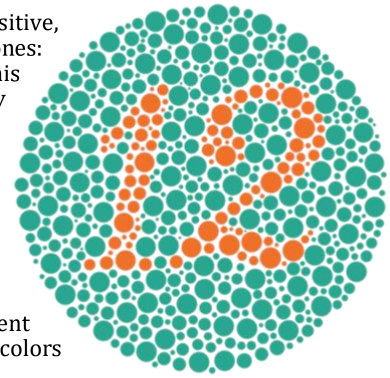
5. For example, the background color of the photo is a bright blue-green color, or cyan. Your eye sees the reflected green and blue light, but the red light that strikes the background is absorbed, or subtracted. Complete the table below:

Object	Red	Green	Blue	Color
Background	Absorbed	Reflected	Reflected	Cyan
Upper Fruit				
Lower Fruit				
Fruit Interior (Flesh, not Seeds)				

Objects do not necessarily reflect all colors in the same proportions. For example, an object might reflect virtually all red, but only about 50% of the green and 50% of the blue light.

6. Try this in the simulation by adjusting the sliders to 100% red, and 50% each for green and blue. What color do you get? Describe what you see.
7. What's your favorite color? Adjust the sliders until you find your favorite shade. What are the percentages of red, green, and blue light? If I described my favorite color as bright medium teal, what would the RGB percentages be?
8. Switch to the photo of the sunflower, overlapping the images until you get the full-color white-light effect. Focus your attention on the green leaves, then turn the green light slider all the way down to 0%. What color do the leaves appear to be now? Why?

But What If You Can't See Color?



Color vision is the result of cone cells located on the retina of your eye. The cells are photosensitive, meaning they respond to specific frequencies of light. A normal eye contains three kinds of cones: L, M, and S. These labels stand for long (red), medium (green), and short (blue) wavelength. This is called trichromatic vision. If you are colorblind, some of the cone cells don't respond properly when light hits them, and they don't send the proper signal to your brain (which you interpret as the full range of color).

This is typically genetic, and there are several different types of colorblindness. It's also much more common for men to be affected than women. Diagnosing colorblindness is not difficult; the Ishihara test consists of a series of figures (like the one on the right). A person with colorblindness will be unable to resolve the number at the center, but everyone should be able to resolve the 12 at the center of this test plate.

Because there are different types of colorblindness, the test contains multiple figures in different combinations of colors. When a person takes the test, the figures they cannot see reveal which colors their eyes cannot process.

9. Test your color vision! You can take the Ishihara Test here, along with several other interesting tests. Can you see all the colors in the different test patterns? Did your results surprise you? The tests are not a substitute for consulting with a medical professional! If you have concerns after taking the test, contact your physician or optometrist.

As you can see on the left, color vision defects make the world look very different. You can view many other examples here.

Do you want to see your own examples? If you have photos that you would like to test, you can use the Coblis (**Co**lor **Bl**indness **S**imulator) program, available online here. Upload your own photo and select which color vision defect you want to simulate!

10. Examine the example on the left. A person with protanopia would have the hardest time discerning the difference between what two colors of the Skittles? What color(s) could that person most reliably choose?
11. A person with tritanopia cannot see which of the additive primary colors?

Can Your Dog See Color?

Unfortunately, not very well. Dogs cannot perceive color the way humans do. Dogs only have two types of cones (instead of three like humans). Their color vision is most similar to a person with protanopia, or red-green colorblindness.

Examine the photos of the dog toys on the left. Notice that it's exactly the same grouping of the same toys, just moved from inside the house to out in the yard. Now think about playing with your pupper.

12. Which of the toys would be the easiest for your dog to see, regardless of whether you are indoors or out? Is there a specific color that your dog can see the best?
13. Is there a color toy that would be particularly difficult for your dog to see if you playing outside in a grassy yard? Why?
14. The retrieving dummies used to train duck dogs to retrieve fallen birds are almost invariably bright hunter's orange. Is this a better choice for the dog or the trainer? Why? (Hint: Check out the protanopia Skittles!)
15. Will this make you re-think your choice the next time you are buying your pet a new toy? Are the toys designed to appeal to you or to your dog?

While most land mammals (excluding primates) have dichromatic vision, other animals see color similarly to humans (reptiles have *four* types of cones!). And then there's the birds and the bees…Did you know that many species can see into the ultraviolet? There are bird and bee species that are red-insensitive, but ultraviolet-sensitive! Don't you wonder what color UV light looks to them?

Put It Together and Hand It In!

This Case Study is due on Monday, 21 April 2025, no later than 6:00PM.

To prepare your case study for evaluation, create a neat, easy-to-follow document that addresses each of the questions completely. Creating a Google doc that can be shared within your group is a great idea for allowing everyone to have access and be able to contribute to the document. Use tables to organize your numeric results!

Please take a few moments before you submit to make sure that your document is neat, complete, and professional. Proofread it for spelling and grammar (then have another person do it again!). Make sure the questions are numbered, any figures or tables are labeled, and that the document is easy to read.

To submit your case, export the document as a pdf. Blackboard does not recognize a Google doc as an allowable file format for submissions. Use the Blackboard assignment to upload your work, and submit only one document for the entire group. Each Case Study is worth 50 points, and all *participating* group members will receive the same score.

Remember that you are permitted to self-select your groups, and if you find yourself on a team that isn't your best fit, you can choose to work with different people on the subsequent cases. You are not required to work with the same team each time, but once a team is formed, it's for the duration of the Case.

Scoring Rubric

Your Case Study will be evaluated using the following scoring rubric:

QUESTION	CRITERIA	COMMENTS	POINTS POSSIBLE	POINTS EARNED
1	Questions are completely answered; responses are correct		3	
2	Question is completely answered; response is correct		3	
3	Primary subtractive colors are correctly identified		3	
4	Response is correct		3	
5	Table is correctly completed		9	
6	Description reasonably matches results		3	
7	Descriptions reasonably match results		3	
8	Description reasonably matches results; correct explanation		3	
9	Response indicates completion of task		2	
10	Response is reasonable/correct		3	
11	Response is correct		3	
12	Response is fully explained		3	
13	Response is fully explained		3	
14	Response is fully explained		3	
15	Response is fully explained		3	

Sources

Additive Primary Colors: https://www.mediacollege.com/lighting/colour/additive-primaries.html

Subtractive Primary Colors: https://www.mediacollege.com/lighting/colour/subtractive-primaries.html

RGB Color Addition Interactive Simulator: https://www.physicsclassroom.com/Physics-Interactives/Light-and-Color/RGB-Color-Addition/RGB-Color-Addition-Interactive

The Ishihara Test: https://en.wikipedia.org/wiki/Ishihara_test

Color Blindness Tests: https://www.colorblindnesstest.org/

How People With Color Blindness See The World: https://www.boredpanda.com/different-types-color-blindness-photos/

Color Blindness Simulator: https://www.color-blindness.com/coblis-color-blindness-simulator/

Are Dogs Color Blind?: https://www.petmd.com/dog/general-health/what-colors-do-dogs-see