

Chapter 4

Sunrise and Sunset –Where is the Color Really?



Where does color come from? - Just minutes earlier the sky had been a deeper blue. Before that, gray and even earlier it was almost impossible to discern the dark sky from the faint silhouette of a landscape. The mountains were still black, but he had tremendous faith that with a bit more patience, the greens would slowly present themselves amidst the now dark area at the bottom of the field of vision. - Where do these colors come from? - Where does any color come from?

Look around the room you are sitting in as you read this book. Notice all of the images around you. Perhaps there is a brightly colored pillow, a wooden floor, or rug with many colors. Depending on the time of day, your location, the time of year, and even the weather outside, you will be reading this book and looking around the room under a specific set of conditions. While many of us have had some experience indicating that under certain conditions the appearance of colors will change, it is possible to investigate this more deeply and see just where the colors actually appear.

Exercise #4

Part 1

This is best experienced in the following manner. Before going to sleep, set your alarm to get up at least one hour before the sun rises. This is should be done in a rural setting, in the absence of artificial lighting such as street lamps or the bright glow of a large parking lot or cityscape. You need to be outside, in an area where you will be able to see a fair distance when the sun rises. Though it can be a challenge, try to get outside without using any artificial light. It should also be noted that this exercise is best done during a new moon or when the moon is still waxing (moving toward a full moon); this will ensure complete darkness upon rising when you first get up. You want to experience as dark a scene as possible. I first experienced this type of darkness in the Adirondack Mountains, a place far from any city and free of city lights. It is worth the extra effort to create these conditions. To read on in this chapter without having done the exercise will still be informative, however, from my experience, to actually see what will be described is profound – perhaps one of the most profound experiences of my adult life.

When you are outside, simply observe the scene before you (if you can see anything) and note images – both seen and unseen. If you pay careful attention, you will see scenes coming into appearance slowly and in a number of different steps. Also, pay careful attention to the colors. What colors do you see when you first go out? Do these colors change in time or remain constant? Are there some colors that appear only when the sun is quite high on the horizon? Do the colors change over the course of the sunrise, the day, or even the weather of the day?

If you are able to get out on a perfectly dark morning, you will find that you see nothing (*no-thing*). This is a difficult experience to have today as most of us live in an area where complete darkness is rare. There are usually streetlamps, passing cars, porch lamps, the soft glow of a neighboring city in the sky, or the brightness of the moon to contend with. If the sky is perfectly clear, there will also be some brightness from stars. However, if you keep an eye out for it, near complete darkness is possible. In complete darkness there are no images.

The first time I did this exercise, it changed my entire day. I was so impressed with what was experienced, that at the end of the day I went back to the same place and watched it all happen again as the sun set, as the colors of the day came to a close. I would also encourage this expanded experience, but it is not as critical as the first part of the exercise.

Part 2

Another possible exercise is to sit silently in a dark room with other people present, without moving. In this case, all sense of the “others” disappears, unless someone moves or a sense other than vision is engaged. It is fortunate if you have this experience in complete darkness. Usually, there is some place in the room where a door isn’t tightly closed, or a small gap appears between the wall of the room and the sill of the frame of the building. In each of these cases, a bright spot will appear in that direction as well as opposite the opening.

If you do indeed go into a dark room, bring a small diffuse flashlight or a single candle and match. If with others, sit together very quietly in the darkness and note any visual impressions that can be experienced. If the room is properly prepared, even after some time no images are seen, unless you light a match and make more visual observations. Once a match has been lit, light a candle. And, then, a few more candles. Add them one at a time, with sufficient period for observation between each addition. Compare the image quality in the room under darkness and then with a lit match and/or candle. After observing many different levels of brightness in the room, you can compare the colors with those when the room is fully illuminated with the electric light

bulbs. Again, look especially at the colors and note any experience of changes in depth perception.

Commentary on Exercise #4

We will look carefully at how these phenomena unfold – those under the ideal conditions of a dark predawn and moving through sunrise, and also those found under a perfectly dark room until it is brightly lit. An assumption is made that the reader has healthy eyes that function in a manner that is within the range of fully functioning human visual possibilities. If some aspect of the observer's vision is unusual, the experience can still be completed, though with differing results. Fully functioning eyes are a prerequisite for seeing the full range of color. Any limitations in the physiological capacity of the eye, such as colorblindness, will change the observer's experience. Thus, we now have our first condition for seeing color: fully functioning human eyes.

Under complete darkness, no images are seen. If you wave your hand in front of your eyes and can't see it, then you know you have achieved total darkness. It is interesting to sit quietly in darkness. This strong habit of thinking of "out there" and "in here" begins to fall away when vision is absent. This also results in a loss of depth perception. Pay careful attention to this last point, especially in comparison to what happens when the first glimpse of light is present in the room.

When the first glimpse of light appears either outside in the early morning or in the darkened room, the first colors that appear are black and white or shades of gray. Look carefully if you missed this the first time. I recall a number of occasions where even some of the medium tone colors were simply varying shades of brightness and darkness. In other words, the images were black and white. Also note that all of the images are simply images at this point; a sense of depth is not apparent if the level of illumination is sufficiently low. All of the "objects" in the scene may not even be visible. Thus, the following questions arise. How can the colors of the images be different than the "real" colors? How is it possible that under these conditions of brightness the scene appears flat rather than three-dimensional? Are colors simply given or are they dependent on a set of conditions? Is any given scene two or three dimensional in nature? We will take up the first question first and determine the dependent qualities that affect the color that appears.

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In the exercises discussed above, we saw that the color of an image is dependent upon the ***brightness of illumination***. In the case of the sunrise, the color of a far off mountainside may initially appear black, then, as the level of illumination increases, gray, and then, as the surroundings became even more bright, slowly change to green, (if there is vegetation) or an earth tone (if there is no vegetation). It is important to be clear that the faint or bright sun is the brightest image on the scene, and what is changing is the brightness of this image. There are other conditions affecting the apparent brightness of the image of the sun. One of these is the ***condition of the atmosphere*** of the earth. During the sunrise and sunset phase of the earth, the bright image of the sun is seen through a thicker layer of air than when the sun is higher in the sky at noon. This thicker layer of air through which the bright image of the sun illuminates the surrounding atmosphere increases the effects of water vapor and particulate on the colors that are seen. A good landscape painter knows this is the case and will often seek out these times of day, and avoid the intense brightness of noon, in which colors may appear to be washed out. A few years ago, in the summer, a great forest fire took place in Quebec and, due to the pattern of the wind, some of the particulate matter drifted down-wind into the sky above New Hampshire where I happened to be teaching. It was interesting to see that even in midday the sky had a pink hue to it. I also recall seeing a reflected image of the sun on a black automobile. The sun's image on the car was not the unusual bright white but instead a wonderful salmon color.

The color of the sky can also vary with atmospheric conditions including the ***variations associated with a change in altitude***. At higher elevations, the air is less dense and the atmosphere is able to hold less water vapor, particulates and the major gases nitrogen and oxygen.

The ***constitution of our atmosphere***, the gases surrounding the earth, also play a role in the colors we see. This was shown by NASA with the gathering of many images from the Mars missions over the past few years. The color of the sun's image on Mars at sunrise/sunset and noon can be quite different from the colors we see here on earth. At noon, the image of the sun on Mars is more reddish in color and there are reports that, at sunrise and sunset, the color of the sun's image can sometimes shift toward blue! So what color is the image of the sun really? It depends on where you are looking at it from.

The ***seasonal and geographical variability of the angle of the sun's image***, even at noon, can also play a role in the colors that are seen. Just think of what

the colors appear to be at noon in Tuscany, Italy, or Nairobi, Kenya, in comparison to Barrow, Alaska. The former will appear a bit washed out, while in Barrow the colors depend more on the time of year. In the summer, the colors will appear bright, while in the winter there aren't too many colors at all under the stars and occasional moonlight. When I teach classes on Visual Physics, I get to this point and like to ask the students: "So what color is a red Ferrari really?" There are even more conditions that affect the color of the red Ferrari, so, before we attempt to answer the question, we shall continue on.

Perhaps the following scenario or something similar has happened to you. I once went to a picture framing supply store to purchase background matting for a black and white engraving I was framing. It was early afternoon on a summer's day in Saratoga Springs, New York. Given that the engraving was over 100 years old, I wanted to choose an off-white color. I went into the store, purchased a wonderful creamy color and went to leave. As I was placing my purchase into my car, the matting now appeared to be a pale yellow color. Thinking it was simply the bright sunlight, I took the matting home, only to find that in my house it still appeared to be a pale yellow. In short, the matting color appeared horrifically wrong. How could I have misjudged the color so completely? Back I went to the store, where I explained my apparent error to the salesclerk, who was fine with me changing the matting for the color I wanted. While I was filing the old colored matting in the stack, I continued to work selecting a new color. In a few minutes I had found the perfect cream-colored matting, and, just as I was about to take it up to the counter for exchange, I noted a small crease on a corner. This was the same matting that had just been returned to the stack! How could I make the same error twice?

I looked up at the ceiling and there was my answer: the store was illuminated with fluorescent lighting. The apparent color of an image under fluorescent lighting can be very different than the appearance of the same object's image under bright afternoon sun or the low-voltage incandescent fixtures that were in my home. ***Different types of artificial lighting*** can produce different colored images of the same object. This is well known by interior designers, architects, and lighting designers. Many of us may also have had such an experience when trying to find our car in a parking lot illuminated at night. Under such conditions, perhaps you have commented on the unhealthy appearance of a friend, only to have them reply that under these conditions you aren't looking so good yourself!

Interior designers and artists are very aware that the color of a surface's image will appear different depending on the colors that surround it. This phenomenon of ***simultaneous contrast*** is very important in interior design as well as painting. The change in the appearance of seat fabric simply by adding a complementary colored pillow is a useful tool if used correctly. Clothing designers work with this

phenomenon all the time, some more successfully than others.

Related to the experience of simultaneous contrast is the phenomenon of **successive contrast**. The colors you see are greatly influenced by the colors you have just finished seeing. While shorter in duration, this technique can also be used to give a color mood in time. Stage lighting is one application where this phenomenon can be used to an advantage.

It is important also to explore the phenomenon of shadows. Stage lighting, for example, as well as a bright sunny day, beg this exploration. Is a shadow a thing? What is a shadow? If your Red Ferrari is parked half inside a garage, is the real color the color it appears outside the garage or inside where it is shady? What we call shadow is simply the effect of indirect lighting. The apparent color of the image of a surface is brighter when there is a direct line of sight between the bright image of the sun or lamp and the surface. In a shadow, on the other hand, a visually opaque or translucent surface lies between the bright image of the sun/lamp and the surface under investigation.

Finally, the color of an object's image can be influenced by the **pigment of the material** comprising the object itself. This is often the only variable we associate color with. We think of the object having this or that color, no questions asked. Still further, all we have to do is go into a paint store, ask for a specific color by name or number, and the sales person will ask: do you want that in gloss, semi gloss, satin eggshell or flat? **Surface texture** also affects the color we see.

All of the qualities listed above can affect the color of the images we see. This can happen in a very living dynamic way, as when the colors change in a beautifully rhythmic manner. This first became apparent to me while walking up a dirt road in a small hollow in the mountains. The sky was filled with scattered clouds that moved quickly across the otherwise clear blue sky. The wind was blowing in strong gusts from west to east and felt pleasant on a warm day. The "shadows" cast on the ground by the clouds moved quickly up the mountain as the combination of semi open fields, scattered trees, wind, and the geometrical elements all combined into one living dynamic motion. In an instant, as I focused on any one particular location on the ground, the "shadows" disappeared and were replaced by a pulsating pattern of colors that shifted and transformed through various hues, tones and contrasts. Even the boundary of the colors, the key to seeing forms, constantly shifted and danced in a fantastic display of living dynamic color. All this occurred while the objects expressing the colored images on the ground remained essentially motionless. The colors moved but the physical forms were motionless. Look for this fantastic symphony of color under

a tree on a bright sunny day in late spring or early summer when the wind is blustery, the skies are partly cloudy, and you are willing to look with a new perspective.

So with over 10 variables listed above, and the quality of color sometimes static sometimes quickly changing before your eyes, I still ask the question: what color is a red Ferrari really? (Hint: Be sure not to park it in a parking lot with those bright yellow sodium vapor lamps! You may not recognize it.)