The ability to see is something many people take for granted everyday. The human eye is a fascinating thing. Seeing is composed of many steps, yet it occurs in less than a millisecond. The eye is treasured. Without eyes, we would not be able see; we could not see the beauty that surrounds us. One small accident or bad brain signal could turn someone blind. When I was nine, I was diagnosed with an eye disorder called Amblyopia. This has affected my life in many ways, but at the same time it does not hold me back. Light enables sight. In the absence of light, there is only darkness, in which our eyes cannot see. Light is also responsible for color, as color occurs when light reflects certain hues back to our eyes.

Scientifically, vision is possible through the combination of two components: light and the eye. The eye is considered one of the body's wonders. Light rays reflect off an object or image and enter the eye through the cornea, the transparent outer layer of the eyeball. This layer bends the light rays as they enter the pupil, the hole into eyeball that is protected by the cornea. The iris, the colorful part of the eye, controls the pupil by contracting to regulate the amount of light entering the pupil. There is a lens located behind the pupil that the light passes through next. This lens refracts rays more before they hit the retina. The retina is a thin layer of tissue in the back of the eye that consists of millions of little light-sensing nerves called rods and cones. Rods and cones are named after their shape. Cones are located in the back of the retina in a part of the tissue called the macula. Rods are located outside of the macula. They are used to detect motion and help the eye see in dim light. All the nerves in the macula send impulses to the brain through the optic nerve, and the image is received. When the brain first receives an image, it receives it upside down. The brain then proceeds to flip it around, showing the viewer the correct image right side up.

The sense of sight takes place in the occipital lobe, located at the back on the brain.[1] Within this lobe, there are two visual cortexes. The Primary Visual Cortex, also known as V1 or striate cortex, is specialized for developing information about moving object and recognizing patterns. The V1 has a sort of map of visual information that is created by the retina. Everything in the field of vision is mapped, including blind spots. This detailed map is then decoded by the primary visual cortex to become an image in the brain. A large bulk of the V1 is profiled into tiny portions of the visual field; this is a phenomenon called cortical magnification and it enables us to see in small detail and allows our brains to analyze what we are seeing.

There are multiple parts that make up the next visual cortex, each with its own function and purpose. These include the extrastriate visual cortical areas, such as V2, V3, V4, and V5/MT. Each visual area has a separate job to help the eye see. The second major area of the visual cortex is called V2 or prestriate cortex and it is the first region enclosed in the visual association area. V2 gets strong signals from V1 and vise versa. The prestriate cortex then takes these connections and sends them out to V3, V4, and V5. The third visual complex, or the V3, is located directly in front of V2. This complex is full of neurons that respond to varying mixtures of visual stimulation such as color-sensing neurons. The fourth visual area, V4, is one of the visual areas located in the extrastriate visual cortex. It is the third cortical area in the ventral stream and it takes in strong signals from the primary visual cortex and sends the signals to the posterior inferotemporal area, or PIT. V4 is tuned for things like orientation and color and focuses on decoding objects' features and intermediate complexity. The last visual area is V5 or Visual area middle temporal (MT). V5 plays a major role in perceiving movement. MT has a

[1] Shepherd, Gordon M. "The Major Senses: Sight, Hearing, Taste, Smell, and Touch - The Dana Guide." *Dana Foundation*. The Dana Foundation, Nov. 2007. Web. 30 Nov. 2013.

large proportion of neurons that are tuned in to sensing speed and direction of moving visual stimulation.[2]

Light is responsible for vision in that, without light, we would not be able to see anything because everything would be dark. Visible light is electromagnetic radiation that is visible to the human eye. Light travels in wavelengths that range from 400 nanometers to 700 nanometers. Humans can only see a certain range of wavelength, and all others are unseen by the naked eye. This range of electromagnetic waves is called the visible spectrum. The average naked eye will respond to wavelengths from 390 to 700 nanometers. However, this spectrum doesn't include all the colors that the eye and brain can see. The only colors that are included in these wavelengths are the pure colors, red, blue, and yellow. Of course, since we cannot see many frequencies of wavelength, many colors exist that we cannot see. There are some animals that have the capability to see these wavelengths, such as the parrot, because they have more color cones in their macula than humans do. A parrot's eye is, unlike a human's, the largest organ in their body. For instance, the Blue Fronted Amazon Parrot is capable of seeing florescent colors because their eyes can take in wavelengths that are ultraviolet light. These parrots also have feathers that reflect these florescent colors. To humans, Blue Fronted Parrots appear green with blue feathers on their face, but appear vibrant and colorful to other parrots that perceive them. They use this skill to see each other when they are in the Amazon forest while the parrots are camouflaged from other animals.[3]

Colors exist within the large library that is human vision. Many scientists consider it fact that there are three separate parts in the process of color perception. The first is the medium, or considering color as pigment or color as light. Next is the sender, or how the color is transmitted to the eye. Last is the receiver, which in this case would be the eye. Color occurs when light reflects certain hues off an object back to the human eye. This color theory suggests that black is not a color because the color black occurs when all colors on the visual spectrum are absorbed by an object, leaving nothing to reflect back to the eye. However, white is considered a color. White occurs when all colors from the visual spectrum are reflected off an object back to the eye. Other colors, such as blue or red, occur when an abject absorbs all but one color or a mixture of colors, reflecting that one color or mixture of colors back to the human eye.

Depth perception is the visual ability to see the world in three dimensions and to sense the distance to an object. Being able to tell whether an object is near or close to you is called depth sensation. This sense helps animals move accurately and respond to surroundings consistently. Depth sensation is possible through depth cues. These cues are called Binocular cues and Monocular cues. Monocular cues are represented in two dimensions using only one eye. Therefore, you cannot have depth perception using only one eye. These cues include receiving visual information of size, visual angles,[4] and parallax.[5] Binocular cues are based on reception by both eyes and taking in information in the third dimension. Cues include stereopsis,[6] disparity,[7] eye convergence,[8] and yielding depth using binocular vision through parallax.

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[2] "Visual Cortex." *Wikipedia*. Ed. Azan Ashai. Wikimedia Foundation, 17 Nov. 2013. Web. 04 Dec. 2013.

[3] The Nature Crest Bird Shop. "Health Tips - Those Beautiful Eyes." *Health Tips - Those Beautiful Eyes*. Yahoo!, 2013. Web. 19 Nov. 2013.

[4] The angle formed at the eye by rays from the extremities of an object viewed.

[5] Parallax is the displacement of an object due to what angle it is viewed at compared to its background.

[6] The perception of depth produced by the reception in the brain of visual stimuli from both eyes in combination

[7] The difference in image location of an object seen by the left and right eye.

[8] When one's eyes don't turn inward properly while you're focusing on a nearby object.

Amblyopia, also known as "lazy eye," is a disorder in which the brain, in a sense, "gives up" on fully developing the sight in one eye and focuses on the other. Although one eye has little sight, it appears completely normal. This causes loss of the eye's ability to see details. One who has a lazy eye does not immediately lose all ability to see in one eye, but there is a possibility that they will lose all sight in that eye later in life. Amblyopia mostly occurs in young children during the time that their sight is developing; research shows at only 2% to 3% of the US and UK population suffers from this disorder.[9] Visual stimulation either poorly or unsuccessfully transmits through to optic nerve to the brain for an ongoing period of time, causing the brain to virtually ignore the eye. Symptoms include blurred vision, double vision, poor depth perception, eyes not working together, and/or a squint (either upwards, downwards, outwards, or inwards). This disorder is sometimes caused by the brain predicting cross-eye and trying to avoid it.

When I was diagnosed with Amblyopia at age nine, it explained why I was the only one of my friends with a "good eye," as I called the eye I could see perfectly out of. Although my left eye appears completely normal, it can read no smaller than font size 22 by itself. My vision is 20/20 in my right eye, but 20/100 in my left. My ophthalmologist tried treating me in many different ways including pupil dilation eye drop appointments, glasses, and eye patches, but none of these treatments worked. I have a vivid memory of having to wear an eye patch to school one day. I would normally only wear one at home when I watched television or worked on homework. Embarrassed, I hid in my big wooden locker for a long time because I was scared the other kids would make fun of me. A few years later, I returned to the ophthalmologist. He told me not to waste my money on 3D movies in the theaters, for the 3D affect wouldn't work on my eyes. To this day I fear that I don't truly know what depth perception really looks like because I grew up focusing with one eye instead of two. I can tell the distance between objects, but vision is probably much more dramatic to those with two fully working eyes.

One of the most debated issues concerning the science of color is the answer to the question "are black and white colors?" There are three theories that could explain the answer to this question. The first theory is the idea of color as light, the second theory is the idea of color is pigment, and the third theory is the idea of color as perception, as stated earlier.

Some scientists and philosophers raise a question: are black and white colors when generated by light? Natural light appears colorless or white to the human eye. Sunlight is created by all colors in the visual spectrum. The visual spectrum is the range of electromagnetic wavelengths that the human eye can see. Although sunlight looks colorless in most occasions, when atmospheric conditions bend and refract the light ray, it can result in a streak of color across the sky. This is called a rainbow, and it proves that white, as light, is a color. However, black is the absence of light. When there is no light, everything is dark—black. Black is not a color when generated by light because you can't generate black with light, only without light.

Other scientists, philosophers, and artists argued for the idea of color as pigment. This idea is based on physically making colors with pigments or paints. For example, as you mix the three primary colors, you can make a shade of black. Of course, it won't be jet black, but it will still be black. Since there is no way to mix colors and have an outcome of white, white is not considered a color in this scenario. It is believed that, in the case of pigments, white is the absence of color.

Vision, light, and color. All three topics are easily looked over everyday by human beings, yet each topic is so intimately diverse and complicated. The sense of sight is a true gem

[9] "Amblyopia." *Wikipedia*. Ed. Chris Howard. Wikimedia Foundation, 18 Nov. 2013. Web. 19 Nov. 2013.

in itself; it lets us observe and experience life on such a personal level. Even with my eye disorder, I still cherish sight dearly, as everyone who can maintain this sense should. Light is connected to both topics, for it is responsible for both sight and the possibility of visual color.

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