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Vertebrate Morphology
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Assignment 3

The eyes are a fascinating organ that has been studied for decades. Its small size and function make scientist wonder what goes on inside this tiny organ to give humans one of their vital functions. Light rays enter the eye through the cornea, which bends the rays to pass through the pupil. The light rays come to a sharp focusing point on the retina that captures the rays and impulses through millions of tiny nerve endings that send impulses through over a million nerve fibers to the optic nerve. Through this process, we are able to see and embrace the world around us. The workings of the eye do raise questions as to how/why humans see in color and where this function came from. Scientists believe that morphology and evolution play a role in modern day human eyesight.

How do the eyes see in color? Most people can tell you that the wavelengths of reflected light determine what color you see, but how did humans evolve to see color? According to Emory Health Sciences, many genetic mutations in visual pigments, spread over millions of years, were required for humans to evolve from a primitive mammal with a dim, shadowy view of the world into a greater ape able to see all the colors in a rainbow. Scientist Shozo Yokoyama and various collaborators over the years have been studying ancestral molecules to analyze adaptive evolution of vision in humans and other vertebrates. This analyzes involved estimating and synthesizing ancestral proteins and pigments of a species, then conducting experiments on them. They found that bits and pieces of the opsin genes change and vision adapts as the environment of a species changes. Ninety million years ago, our ancestors were nocturnal and had UV-sensitive and red-sensitive color, giving them a bi-chromatic view. Thirty million years ago we evolved four classes of opsin genes, giving them the ability to see full-color spectrum of visible light. Through research, these scientists identified

5,040 possible pathways for the amino acid changes essential to bringing about the genetic changes. According to Yokoyama, “only when several of the changes combine in a particular order that the evolutionary pathway can be completed”. Through evolutionary morphology, we are able to see the genetic changes develop over time to give humans their definitive vision.

So now that we know physically how our eyes evolved we want to know why. Some studies confirm that human color vision appears to be optimized for picking fruit at arm’s reach. However, other evidence proposes the act of spotting fruit from a distance is more of an important aspect of vision in primates (Bompas, 2013). For primates, differentiating fruit from their leaves is an important factor as to why humans evolved to see color (Bompas, 2013). In many cases, red is the color of ripe fruit, which many animals can easily detect. It is also hypothesized that being able to detect red fruits against a green background is the reason that trichromatic color vision evolved in primates. Regan et al, and Sumner & Mollon modeled the task of finding a fruit or young leaves in foliage for the functions that the L and M cones might take. It turns out that the optimal pair are very close to what we possess, which supports the argument that the act of finding fruit amongst leaves is one of the driving forces in the evolution of the LM color channel. Cones are highly diverse in structure and can be divided into many spectrally distinct classes within a given species, says Bowmaker. With this information, we can infer that there are many reasons as to why we evolved to see in color, but the main reason is the detection of fruit amongst a green background. Through the survival of our ancestors, the recognition of fruit was the key to survival and therefore changed our lives forever.

Being able to see in colors is one of the most beautiful things the human species can do, but 3 million people per year are affected by this strange occurrence called color blindness. According to David Turbert, color blindness is when you are unable to see colors in a normal way and cannot distinguish between certain colors. The difference between greens and red is the most common form. The cone cells in our eyes detect color and are concentrated near the center of our vision. When one of more or the color cone cells are absent, not working, or

detect a different color than normal is when color blindness is present. Within color blindness, there are different stages, like when some people can see colors normally in good light but not in dim light. Even though color blindness is most commonly formed from birth, it is as well inherited from our parents. Inherited color blindness is on the X chromosome and because males only have one they are more prone to this condition. This is called X-linked inheritance and the mother carries the mutated gene on one of her X chromosomes that will 50% pass on to her children (Turbert, 2018). Through its genetic transformation, we have yet to find a cure, but studies have been done to cure color blindness in adult monkeys and hopefully to humans in the near future.

The eyes can do so much for such a tiny organ. With our vision, we are able to perform millions of tasks and improve our community. It is interesting that through evolution and species survival that modern humans have their distinctive eyesight. Millions of years ago our species need for survival evolved our cones to differentiate colors against different backgrounds. It's interesting to think about how other animals are still color blind, but their need for survival is not at a threat, therefore, no need for change. This leads to the fact that millions of humans are colorblind and themselves cannot detect certain colors from others. Humans take for granted their eyesight and color vision on a daily basis. The question is will we ever evolve to no longer see color? I guess we will never know.

Bibliography

"A Clear, Molecular View of How Human Color Vision Evolved." *ScienceDaily*, ScienceDaily, 18 Dec. 2014, www.sciencedaily.com/releases/2014/12/141218210100.htm.

Bompas, Aline, et al. "Spotting Fruit versus Picking Fruit as the Selective Advantage of Human Colour Vision." *i-Perception* , 2013, www.ncbi.nlm.nih.gov/pmc/articles/PMC3677335/pdf/i-perception-4-84.pdf.

Bowmaker , James. "Evolution of Color Vision in Vertebrates ." *Https://Www.nature.com/Articles/eye1998143.Pdf*, 1998.

"Facts About Color Blindness." *National Eye Institute*, U.S. Department of Health and Human Services, 1 Feb. 2015, nei.nih.gov/health/color_blindness/facts_about.

Lhg-Admin. "How the Human Eye Works | Cornea Layers/Role | Light Rays." *NKCF.org*, NKCF.org, 25 Mar. 2019, www.nkcf.org/about-keratoconus/how-the-human-eye-works/.

Turbert , David. "What Is Color Blindness?" *American Academy of Ophthalmology*, 17 Nov. 2018, www.aao.org/eye-health/diseases/what-is-color-blindness.