SASTA OLIPHANT SCIENCE AWARDS

SOUTH AUSTRALIAN SCIENCE TEACHERS ASSOCIATION

Prize Winner

Science Writing

Year 9-10

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The World in Colour: How We See it!

Clara Hocking

"Mummy?" Isabelle stuck her head into the office. "I was wondering about something."

"Not now – *please* Issy." Mrs. Allen sighed, glancing at her nine-year-old. She could guess roughly what was coming – and she didn't have the time or energy to answer.

But her daughter was undeterred. "I was wondering; how do people see in colour?"

"I'll explain it later, darling." Her mum turned back to her computer. She had an entire term's worth of science lesson plans to create – and they had to be perfect. It was her role to make sure the lessons were faultless, and to deliver them with excellence.

She *had* to. Her new job relied on it.

But her daughter had other ideas. "No, Mum. Tell me *now.*"

Mrs. Allen could tell from the soft *thump* that accompanied the words that her daughter had deposited herself on the floor of the office – and the whine in her voice was well and truly there.

So she sighed, turned her chair, and faced her daughter. "Well, what do you want to know?"

Her daughter's eyes lit up. "*Everything*."

She typed a couple of words into her laptop, and a diagram of the eye flashed up.

"Okay, then. Visible light, which is traveling in waves, enters the eye through the cornea, a clear covering at the front of the eye, and passes through the lens – both of these direct, or refract, the light to hit the retina, an area at the back of the eye."

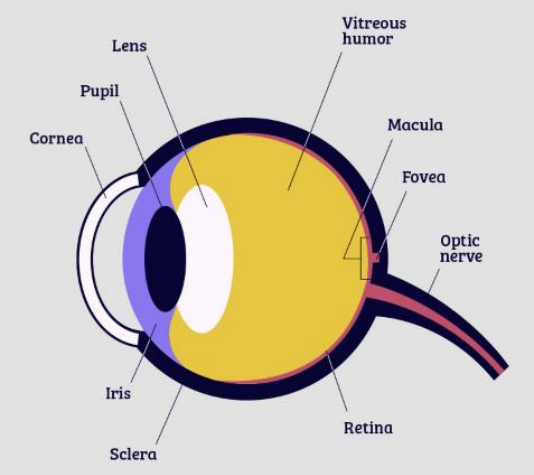

Figure 1 - National Eye Institute, 2022. About the Eye [image]. [Online]

“But how are different colours seen? Not like everything’s white, like light!” Issy cut in.

“Remember though, Issy, how white light is made up of different colours?”

Her daughter nodded. “Oh, yeah! Light is made up of teeny-tiny particles called photons, but also behaves as a wave. Each colour of the spectrum has a different wavelength.” She pointed to a poster on the wall, naming some of them. “Red has the longest one, which is why it is refracted the least. Purple, the shortest wavelength, is refracted the most, when white light is dispersed through a glass pyramid.” (Macmillan Education, 2011)

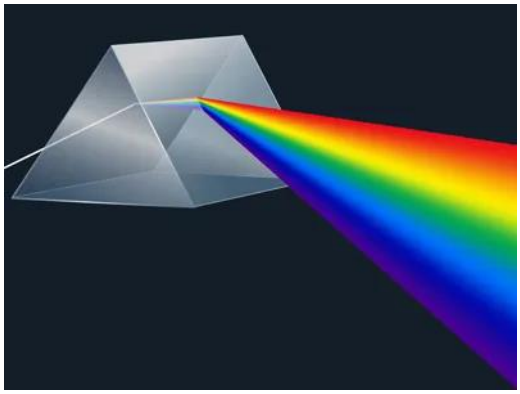

Figure 2 - National Aeronautics and Space Administration, 2024. Chapter 6: Electromagnetics; Visible Spectrum [image]. [Online]

“That’s right! It’s because of the slight difference in the speed in which they travel – red is slightly faster than violet, so it is bent more when passing through the pyramid. And different surfaces absorb and reflect different wavelengths differently. Like this apple,” Mrs. Allen picked up an uneaten snack from her desk.

“It *absorbs* all wavelengths except red, which it *reflects* – which is why we see it as red. The reflected wavelength is what enters and is detected in our eyes. Different surfaces absorb and reflect different amounts of the colours of light. This means that, even though no object actually possesses a colour, humans can see *millions* of different colours!” (Mukamal, 2017)

Issy’s brow furrowed. “But… how does our eye know which colour is which?”

“It isn’t the *eye* that names and makes sense of the colours – although there are cells in it that take in different colours of light.”

“*What?* Cells can do that?” Her daughter’s eyes were wide, and Mrs. Allen couldn’t help smiling to herself.

“Yep. There are two types of light-detecting cells, or photoreceptors, found in the retina –” she pointed to the diagram on her laptop “– called rods and cones. Rods mainly detect the shape of an object, and help us see in black and white, so we won’t worry about those too much. But *cones* can detect coloured light.”

She typed a few more words, and a website and diagram flashed up, with extra information, which Mrs. Allen read aloud, paraphrasing slightly.

“The cones in a human eye “contain photo pigments or colour-detecting molecules” that recognise different colours of light. Human cones usually consist of “three types of photo pigments – red, green, and blue”.” (Mukamal, 2017)

“And “each type of cone is sensitive to different wavelengths of visible light”.” Issy finished reading off the screen. (Mukamal, 2017)

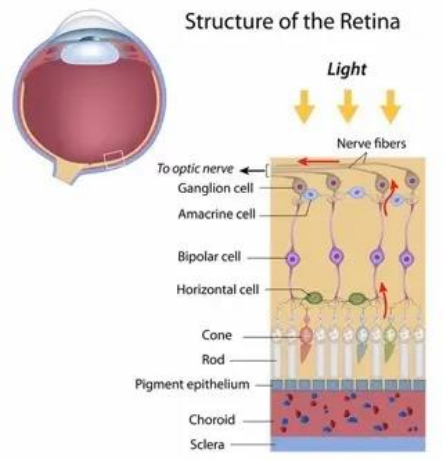

Figure 3 - Mukamal, R., 2018. How Humans see in Colour [image]. [Online]

Her mum elaborated. “One type of cone is sensitive to red, the longest wavelength, another is sensitive to blue, the shortest, and the third type is sensitive to green, which has a ‘medium’ wavelength. Depending on what combination of the wavelengths of light enter your eye, the one or more of the cones are activated, as this diagram shows. Their sensitivity can overlap with different wavelengths, which is why there are so many colours that the human eye can see.” (Cleveland Clinic, 2024)

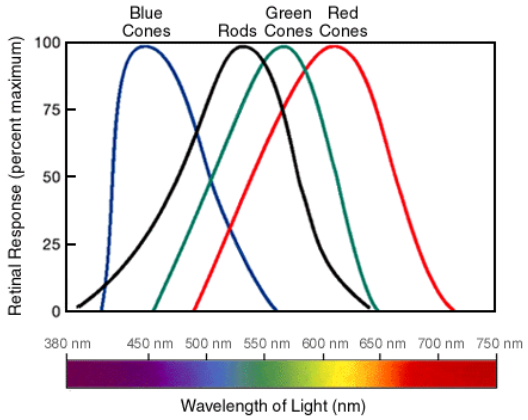

Figure 4 - Arizona State University, 2010. Rods and Cones [image]. [Online]

“So, Mum, why *are* the cells called cones?”

“Because of their shape. They look like cones, while rods look like long, rod-like tubes. There are *millions* of these cells inside your eye, but most of the cones are found in a place in your retina called your macula.” (Cleveland Clinic, 2024)

Issy frowned. “So… is that all?”

“No. As I said, the *eye* doesn’t interpret images. The brain does.”

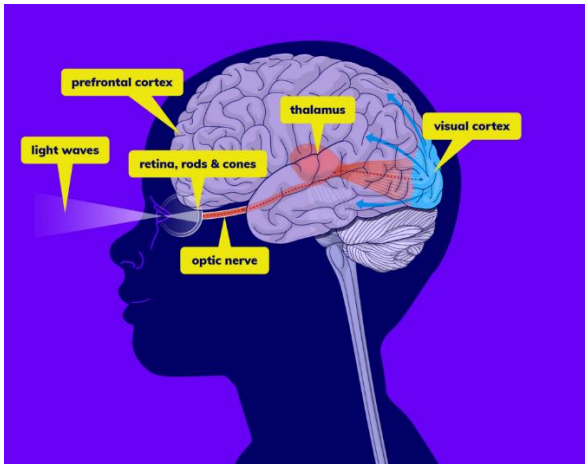

Figure 5 - American Museum of Natural History, n.d. Seeing Colour (image). [Online]

“As soon as the rods and cones detect light, the ganglion cells that the rods and cones are connected to will transmit a nerve message to the brain along the optic nerve, which is connected to the thalamus,” she pointed to a poster on the wall: a diagram of the brain.

“The thalamus is sometimes called the “sorting station” of the brain because it processes, or sorts through all the different signals from the retina, “combining and repackaging some of them into new information”. Then, the information is sent to the Visual Cortex, which contains a bunch of different cells, which all react to different pieces of information – movement, colour, shape, and a bunch of other things. The Visual Cortex combines these signals into an image – which is then sent onto various parts of the brain, including the Prefrontal Cortex. This is an area of the brain responsible for combining the image with other information the brain’s received from the other senses, as well as memories – all of which works together to let our brain make sense of what it is seeing.” (American Museum of Natural History, n.d.)

Issy nodded. “So, all this is the same for animals, right?”

“Nope! Different animals see things in *completely* different ways. Take the dog, for example. They can see really well in low light, but have dichromatic vision; in terms of colours, they can only see greys, blues and yellows.” (Belmont Eye Centre, 2020)

Her mum laughed, as her daughter’s eyes widened. “It’s because dogs have way more rods and a lot less cones than humans do in their retina – as well as only having two types of cone cells, instead of three.”

“Which types?”

“Blue and red cone cells. Dogs don’t have any green-sensitive cone cells, but their eyes can pick up far more detail when it’s dark than human eyes can – mostly because they have more rod cells. They also have a larger lens, which impacts how much they can see.” (Colie, 2024)

Issy nodded – then yawned. She was beginning to get bored.

Mrs. Allen smiled. “So, how much of what I just told you do you remember?”

Issy sat up a bit straighter. “Light is made of different wavelengths, which are absorbed by cells in our eyes, called rods and cones. Unlike dogs, we have three types of cones, which absorb different wavelengths; it depends on what is reflected by the object our eye is looking at. When cone cells are activated, ganglion cells transmit a nerve message along the optic nerve to the brain, where different parts of the brain work together to make sense of the image. And that’s how we see the world in colour!”

She walked out of the room, as Mrs. Allen re-opened her work. Time to make some lesson plans.

“*Human sight.*” She read aloud one of the term’s topics, glancing back at the door her daughter had exited through. “Huh.”

Word count (excluding the Bibliography): 1368 words.

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