

Dogs don't see life through rose-colored glasses, nor in black and white

September 5 2023, by Langis Michaud



Credit: AI-generated image ([disclaimer](#))

For a few months now, I've been treating six-year-old Samuel, who has the beginnings of myopia. He's very quick for his age and often asks me questions about tests I give him, and about what I see inside his eyes.

But the last question surprised me.

Samuel knows that some people, like his father, don't see colors well. But what about his little poodle, Scotch, he asked?

I'm not a veterinarian and don't want to intrude on their domain of expertise. However, as an optometrist, I can offer some insights that might help answer Samuel's question.

Cones and rods

Ambient light is composed of [particles \(photons\)](#), which line up in rays. Light rays travel and strike objects. Some rays are absorbed, while others are reflected, depending on the characteristics of their surfaces and the composition of their materials. The wavelengths of the reflected rays determine the color of the object as it is perceived by the eye.

Like everything about [human vision](#), color perception is complex. The retina, the sensitive part that lines the back of the eye, has two types of photon receptors: cones and rods. The cones, in the center of the retina (fovea), perceive [bright light](#) and are [responsible for color perception](#).

There are three types of cones. Each type contains a specific photopigment called opsin, which defines its nature. The opsin is produced under the influence of specific genes. The shortest opsin ("Cone S" for short) reacts mainly to blue light (420 nm). The longer one ("Cone L") is more sensitive to orange-red light (560 nm) and the one in between ("Cone M" for middle) [is activated in the presence of green \(530 nm\)](#).

However, each cone reacts to each of the rays entering the eye. For example, a red ball will produce a weak response from the S cone (3/10), a slightly stronger response from the M cone (5/10) and a [strong response from the L cone](#) (8/10).

The brain combines the signals emitted by each of these cones to form

the color it perceives. So, in the previous example, the perceived color would be coded 3-5-8, corresponding to what we know as red. A pink color might have the code 4-6-6, and blue, 8-6-3. Each combination of the 3-cone signals is unique, which allows us to appreciate different hues in all their variations.

That is, as long as the genetic code is intact.

The genes associated with color vision can be mutated or defective, in which case the person will be partially or completely impaired. The best known of these anomalies is color blindness (red-green deficiency or daltonism).

And what about animals?

Color vision, in humans as in animals, [has developed throughout evolution](#) and results from the needs of each species according to their environment, the prey they hunt and the threats they need to avoid.

For example, birds have a fourth opsin that allows them to see ultraviolet (UV) light. Humans cannot perceive this light because our crystalline (internal) lens [filters UV rays](#). UV rays influence birds' behavioral decisions, including foraging and [their choice of a mate](#).

So the color vision of birds is more complex, with the result that the pigeon, which can perceive a myriad of colors, wins the [award for best color vision among all species](#).

Insects also perceive UV light. This function is essential for them to spot pollen, although their color vision is very poor. Their eyes are made up of multiple lenses (ommatidia) that perceive [more movement than color](#). That's much more practical while in fast flight.

Most forest-dwelling mammals have only two opsins. That's because they lost the one associated with orange-red over the course of evolution. This explains why, unlike humans, these animals don't perceive the orange bibs of hunters.

Snakes, on the other hand, are more sensitive to red and infrared light, thanks to their infrared receptors. This is an advantage when it comes to spotting prey, as [they can distinguish their heat even at night](#).

Unsurprisingly, it's the monkey that's closest to the human, with its three opsins. It is said to be trichromatic.

Back to Scotch

The vision of dogs—such as our friend Scotch—is [quite different](#).

Unlike humans, dogs' eyes are located on the side of the skull. As a result, dogs have a wider field of vision (250 to 280 degrees), but less simultaneous vision.

So Scotch's vision of movement is well developed throughout his visual field. But his central vision is actually six times weaker than ours. This is equivalent to the vision of a very myopic person not wearing glasses. Why? Because the dog's retina contains no fovea, and therefore fewer cones.

But while dogs eyes have fewer cones, they have more rods. And as an added bonus, they have an extra layer of the retina, called the tapetum lucidum—or carpet. When combined, these ingredients mean dogs see better in dim light and at night. This layer receives light and reflects it back onto the retina for a second exposure. This explains why your dog's eyes seem to glow at night.

When it comes to colors, dogs are dichromats. They perceive only yellow-green and violet-blue. Colors are perceived paler, like pastels. And some colors don't contrast: that's why a red ball on green grass will appear to them as pale yellow on a gray background, with little contrast.

So it's possible, depending on the color of the ball, that Scotch will not see it, and as a result, will gaze up at Samuel with a lost look. As for the infrared, he perceives heat through his nose, not through his eyes.

Cats are also dichromats. Their vision is therefore similar to that of dogs, but their color palette is different—more oriented towards violet and green. Having no perception of red-green, they are essentially color-blind. They are also very short-sighted. Their clear [vision](#) is limited to a few meters in front of them.

Throughout cats' evolution, other senses came to compensate for this. Among other things, although they only perceive certain contrasts, they are [formidable at perceiving movement](#). Mice move quickly!

Every species adapts to its environment, and humans are no exception. Who knows what our [color vision](#) will be like 500 years from now, after we've been exposed to more and more electronic devices and artificial colors?

But that's a question for Samuel to answer when he's older.

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Citation: Dogs don't see life through rose-colored glasses, nor in black and white (2023,

September 5) retrieved 27 April 2024 from <https://phys.org/news/2023-09-dogs-dont-life-rose-colored-glasses.html>

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