Why Do Animals See Color Differently?

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Transcript:

Andrew:
I'm Andrew Norton, and this is Completely Optional Knowledge. Today's question comes from Rick Schwartz, better known as Zookeeper Rick. He is an ambassador for the San Diego Zoo. If you're a regular listener to the show, Rick's voice should sound pretty familiar. Rick, last time we had you on the show we talked about animal farts.

Rick:
It's true.

Andrew:
It ended up being our most popular episode to date. I don't know what that tells us.

Rick:
Well, I would like to take credit for that, but I think it might have to do something with the topic and not with the person talking about it.

Andrew:
Thanks again for elevating the discourse of this podcast, Rick.

Rick:

I do what I can.

Andrew:
Last time you were on the show you were answering a question for us, but this time you have a question, right?

Rick:
Yeah. My question is why do different animals see color differently?

Andrew:
You hear about different types of animals seeing different spectrums and maybe seeing crazy, different colors. It seems like us humans are mild mannered in the kinds of colors that we can see. Right?

Rick:
Right. My understanding from my zoology courses is of course that there's a broad light spectrum. I'm curious to know why is it some animals can see those other sections of the spectrum I guess. I'm just curious as to why that is.

Andrew:
Huh. You said you know a little bit about it, but I was a little bit worried when you said you had a question. I'm like, "Is this one of those quizzes where you know the answer to it and you're just trying to check if you do our research here?"

Rick:
Exactly. That's exactly it. Yes. I'm ready to grade you and judge you.

Andrew:
I'm Andrew Norton, and this is completely Optional Knowledge, brought to you by Greenpeace, the show where we take questions that make you go, "Huh?", and we try and make you be like, "Oh." Completely Optional Knowledge is presented by Greenpeace. Help support the show and show your support by signing up for news and updates at Greenpeace.org/USA/Knowledge. Jay Neitz is a professor of ophthalmology at the University of Washington. This dude knows a thing or two about vision and color in animals.

Jay:
I started graduate school studying color vision in 1980. I think of nothing but color vision for the last 35 year.

Andrew:
We have this big question to deal with here, which is why do animals see color differently? First, how can you tell what colors animals can see?

Jay:

That's a really great question. I've tested color vision in lots of different animals. Animals just don't do very good when you say, "What number do you see here?" Instead what we do is we put the thing that's a different color, we just make it into a blob, and we put it in a particular place on the screen. We just ask the animal to find it. It's a nice big touch screen. They just touch it with their nose.

Andrew:
What kinds of things can different animals see? I told the person who asked this question that I feel like humans are pretty boring when it comes to the colors and the color spectrum that we can see. Is that right?

Jay:
Well, this is a very common kind of misconception. I think humans are pretty exciting actually. A television has three different primary colors that are produced.

Andrew:
Which is red, green, and blue. Right? RGB, is that it?

Jay:
Exactly. It turns out that the reason that there are three primary colors in your television, or computer, or smart phone is because we have three different kinds of cone photo-receptors in our eye. One of the things that then determines how good our color vision is is how many different receptors that organism has. Every time somebody says, "Oh. You know something about color vision in animals? How about the mantis shrimp? It has 12 different color receptors. It must have this fantastic color vision."

Andrew:
Right. I imagine it's like watching Jurassic park on VHS and then switching over to the 4K Blu-ray version. Right?

Jay:
Thankfully, someone actually did an experiment on a mantis shrimp to measure their color vision. It turns out they have terrible color vision.

Andrew:
They have terrible color vision. What do you mean by that?

Jay:
Our color vision is actually not in our eye. Our color vision is in our brain. We have a really huge brain, and the mantis shrimp has a really, really tiny brain.

Andrew:
I see. It's like they can see a lot, but it's lost on them. It's like having a full production of Shakespeare for a one year old.

Jay:
Exactly. It doesn't have this movie inside of it's head that it's sitting and going, "Wow. Look at the beautiful sunset."

Andrew:
It's not going to the Museum Of Modern Art and looking at the Picassos and such.

Jay:
Exactly. Across animals there are animals that only have one kind of cone photo-receptor. Those animals don't have any color vision at all. A good example of that are hamsters. Hamsters only have a single kind of cone photo-receptors. Another one, interestingly, is dolphins. Actually all marine mammals only have a single kind of cone photo-receptor. You basically see in black and white. Why some animals only see in black and white is something that we don't understand. The next kind of animal are animals that have two different kinds of cones, like dogs, and cats, and cows, horses, and this is what is common among almost all mammals.

Andrew:
For mammals we're doing pretty good. We've got three.

Jay:
For mammals, yes.

Andrew:
What would that look like with just the two? You said the one photo-receptor means basically black and white, which makes sense. You only pick up one hue, so you can't compare. What would it look like with two?

Jay:
People that are red/green color blind, they're missing one of their cone photo-receptor types.

Andrew:
I see.

Jay:
Humans that are red/green color blind and most other mammals have something in common. What happens is that animals that have just two receptors, they can see black and white and two colors that I like to call blue and yellow. I mean, my brain can't really be in a dog's head.

Andrew:
Right. We talked about hwy animals physically see the world differently, because they have different receptors and their brains process these receptors differently, but there's still a why as to what purpose does this serve.

Jay:
Part of the reason that other mammals only have two and primates have three is that our visual system is just more highly evolved. In a few hundred million years all the other mammals will all have trichromatic color vision and we'll have tetrachromatic color vision. Part of it just depends a little bit on the history of the evolution of a particular organism I think.

Andrew:
We got these different color receptors that let animals see different colors, but some animals can actually see different parts of the light spectrum that us humans can't see. Right? Infrared or ultraviolet.

Jay:
Sure. There's quite a few animals that can see in the ultraviolet. Many times the male bird is more colorful than the female, but people have said, "It's interesting. Here are these birds, and they don't follow that pattern. The male and the female look pretty much exactly the same." Then they went with their ultraviolet camera and it turns out that the male has this super ultraviolet reflective foliage that the females don't have.

It turns out that oftentimes flowers have all sorts of patterns that are communicating with bees that the reflectance is all in the ultraviolet. Maybe the way that it works out is that the flower doesn't want to be communicating this information about where it's nectar is to all different organisms. It really wants to communicate just with the bee.

Andrew:
Nature's sending secret messages that we're not privy to, because we can't see the certain spectrum, which is pretty cool.

Jay:
Yeah. It's fantastic.

Rick:
Well, there you go. Truly fascinating.

Andrew:
It reminds me of that invisible ink when you were a kid and you rubbed the lemon juice on a piece of paper of something and that was the only time you can see the message.

Rick:
Exactly. Exactly.

Andrew:
Have you seen that movie, They Live, by John Carpenter, the 1980's movie?

Rick:
I can't say that I have. No.

Andrew:
It's this dude. He find these glasses, and he puts on these glasses, and he sees these hidden messages everywhere. He sees this alien race living in the Earth, but he can only see them with these glasses. I feel like it's kind of like that. These bees, they have this certain way of seeing the world that other animals don't. They look at these flowers and they're like, "Oh. That's a good flower to go to," whereas we just look at these flowers and we don't see this infrared pattern that bees see. Right?

Rick:
Right. Exactly. Yeah. Yeah. Why in the world would a mantis shrimp evolve to have that many receptors, but not have a processor to understand it all and do something with that information it's receiving?

Andrew:
Either way, this gives me an idea for our next episode. You, me, in the field. We take a full tank of mantis shrimp, throw it in the back of the car. We go around town and just try and blow their minds with their crazy color vision. We'll go to the planetarium. We'll go see a 3D Star Wars movie, and we'll sort of poll them afterwards. It'll be scientific. We'll gauge their reaction.

Rick:
Here's the follow up to all of it. Do mantis shrimp fart?

Andrew:
What color are their farts maybe?

Rick:
There you go. Maybe they can see that, but they don't know it. I don't know.

Andrew:
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