

[MUSIC PLAYING]

MOLLY BLOOM: Hello, it's Molly Bloom here. And you're listening to *Brains On* from American Public Media. We are serious about being curious. And speaking of curious, have you ever heard that saying, curiosity killed the cat? We're not really fans of that phrase because it makes curiosity sound like something bad.

We should all be curious. It's how we learn new things. I think the saying should go, curiosity made the cat ask lots of questions. And now the cat knows a ton of stuff and is everyone's favorite animal to talk to at parties-- or something like that. So in that spirit, onto the questions. We got this one recently from Josh in Nyon, Switzerland

JOSH: Why do some animals like wolves have eyes that glow in the dark?

MOLLY BLOOM: It's a great question. Wolves do indeed have eyes that appear to glow in the dark. Human eyes? Nope, ours don't glow. But lots of other animals have these glowing eyes, like dogs, deer, cows, ferrets, horses, and yes, cats.

Inspired by Josh's question, we are presenting an encore of an episode that answered this same query. Producer Sanden Totten joined co-host Sophia Gordon and me to explain.

**SANDEN
TOTTEN:** Hey, Sophia. Hey, Molly.

MOLLY BLOOM: Sanden, what do you have there? Is it-- it's a box.

**SANDEN
TOTTEN:** Not just any box, Molly. It's one filled with a surprise guest. It's your cat, Winslow! Come on out, buddy!

[CAT MEOWS]

Whoa! Look at her go.

**SOPHIA
GORDON:** She did not like being in that box.

MOLLY BLOOM: She's scratching up the studio walls.

**SANDEN
TOTTEN:** Um, surprise, Molly? Let-- let's let Winslow gather her thoughts in the corner for a bit while I explain the magic of cat's eyes.

[CAT MEOWS]

Now, cats can't see in complete darkness. After all, eyes need light to work. But their eyes are much more sensitive to light than ours. So even if there's just a little sliver of light from, say, the moon, cats can do just fine.

**SOPHIA
GORDON:** Why is that?

**SANDEN
TOTTEN:** Well, it's because they have a lot more rods in their eyes than we do.

MOLLY BLOOM: Rods are cells in the eye that help us see. We also have cells called cones that work in a similar way.

SANDEN Exactly. One big difference between rods and cones is that rods are really good at detecting light, cones aren't. A
TOTTEN: typical human eye has about 120 million rods. Cats have seven times more rods in their eyes than we do, so it's a lot.

SOPHIA So that means their eyes are a lot more sensitive to light.
GORDON:

MOLLY BLOOM: And that would explain why even with a little light, they can see a lot better. They can basically make out more of an image with less of a signal.

SANDEN Precisely. But since a cat's eye is crammed full of all these rods, there's not as much space for as many cones.
TOTTEN:

MOLLY BLOOM: And cones are the thing that are really great at detecting color and fine details. Rods don't do that very well.

SANDEN I spoke with Kristopher Lappin, he studies animals at Cal Poly Pomona. And he says because of that, cats can't
TOTTEN: see color as well as we can. And they don't have the best day vision either.

KRISTOPHER It's a classic tradeoff. Almost everything in biology involves a tradeoff. They can detect light. They can form
LAPPIN: images and detect movements in much lower light. But during the day, because they have so many rods at the expense of cones, they actually don't have as good resolution of vision in bright daylight as humans do.

SANDEN Isn't that right, Winslow? You have blurry day vision. Your eyes are blurry right now, so blurry.
TOTTEN:

[CAT HISSES]

MOLLY BLOOM: I would back away from Winslow if I were you.

SANDEN Nah, she loves it. Let's move on. Cats have another secret tool that helps them see in very low light, something
TOTTEN: humans are totally missing.

SOPHIA What's that?
GORDON:

SANDEN It's called the tapetum lucidum. Lots of night-loving, nocturnal animals have these, but we totally don't. It's a
TOTTEN: layer of reflective material in the back of the eye, just behind the retina. Here's how eye expert Aaron Seitz at the University of California, Riverside describes it.

AARON SEITZ: This is basically a mirror in the back of the eye. And so if you ever shine a flashlight at a cat's eye at night and you see something shining back, that's what's happening, is that the light goes to the back of the retina-- so the part of the eye that actually does our vision-- and then it bounces off the surface and goes forward again.

SANDEN The fact that the tapetum lucidum reflects light back means the rods in the eyes have a second chance to absorb
TOTTEN: any light they may have missed during the first pass.

SOPHIA That explains why sometimes you see animals at night and their eyes are glowing.
GORDON:

SANDEN Yeah. You see it in dogs. You see it in rodents, raccoons, possums, even Winslow here. Watch. I'll just turn on this flashlight I brought, shine it right in her face.

[CAT HISSES]

Ow! She scratched me.

MOLLY BLOOM: You kind of deserve that one.

SOPHIA Yeah, most animals don't like it when you shine lights right in their eyes. I mean, I wouldn't like it either.
GORDON:

SANDEN [SIGHS] I just thought-- I just thought she'd want to help with the science lesson. Why am I so bad with cats? I
TOTTEN: just want to love them, and pet them, and occasionally force them to participate in live podcast demonstrations. Is that so wrong? I mean, come on.

MOLLY BLOOM: Just let Winslow cool off. Cats like it much better when you're just chill.

SANDEN Yeah, yeah, OK, OK.
TOTTEN:

MOLLY BLOOM: So anything else you want to share about cats and their amazing eyes?

SANDEN Yeah. Another thing they've got going for them is their pupils.
TOTTEN:

SOPHIA Pupils, I know what those are. They are the dark circles right in the middle of the eyes.
GORDON:

SANDEN Yeah, and if you look, ours are round. But have you ever noticed anything interesting about a cat's pupils?
TOTTEN:

SOPHIA They're the shape of a football.
GORDON:

SANDEN Yeah, they're kind of like a football standing on its end right before you're about to kick it into the end zone.
TOTTEN: These are called vertical pupils because they go from the top to the bottom. And this shape lets them adjust their pupils fast, so they can open them very wide at night and let in lots of light, kind of like opening your shades really high so all the light from outside comes in.

But during the day, they can narrow their pupils into tiny slits. That way, all those light-sensitive rods they have in their eyes won't get blown out by too much stimulation. It also makes cat's eyes really pretty. I mean, just look at Winslow's pretty green eyes.

She's so handsome. She could be a cat model, her face on billboards or the cover of cat fancy magazine, her own cat fashion line. [GASPS] You guys, she just jumped on my lap.

MOLLY BLOOM: See? Just be chill. Cats like it when you let them come to you.

SOPHIA And they usually don't like being stuck in the box and dragged to a recording studio, just so you know.

GORDON:

SANDEN OK. You guys, Winslow and I are totally bonding right now. So I'm just going to peace out of this interview and get
TOTTEN: some quality time with my new bestie here. But it's been good chatting. Bye.

MOLLY BLOOM: Bye, Sanden.

SOPHIA Bye, Sanden. Bye, Winslow.

GORDON:

NARRATOR: No actual cats were used in the making of the skit. Do not attempt to put a cat in a box, unleash it in a studio, make fun of its vision, and then stick a flashlight in its face.

[WORDLESS SINGING]

MOLLY BLOOM: Cats aren't the only animals with some cool eyes.

SOPHIA Human eyes are capable of greatness. But in some ways, animals have us beat.

GORDON:

COACH: All right, team, huddle up! We've got a tough one today. It's us, the Hillsboro humans, against the Akron animals. Some of those animals may be stronger, faster and have sharper teeth than we do, but we have the best eyes. The eyes have it. Uh-- [CLEARS THROAT]

Anyway, we humans have them beat when it comes to vision. Think about our eyes, what incredible organs. We have the pupils, a hole in the middle of our eyes that lets light in. And it can change size.

HARRIS: That's the iris, right?

COACH: Correct, Harris. The iris, that's what makes the pupil bigger or smaller to take in more or less light.

[SOUNDS OF AGREEMENT]

Yeah, that's what I'm talking about.

MARTINEZ: What about the lens, Coach?

COACH: You bet, Martinez. Without the lens, it's blur city. It sits right behind the pupil. It focuses the light, bouncing off all the objects around you on your retina. And here's the amazing thing, the light makes an image on your retina. It's like a tiny movie projector.

MARTINEZ: But that movie is upside down and backwards. Right, Coach?

COACH: That's it, Martinez. You got it. So how do we see the world right side up? It's the cells on your retina.

HARRIS: Ooh, ooh, ooh! The rods and cones!

COACH: Yes, the rods and cones. They detect the image being projected on the retina. And they change that picture into a message your brain can understand. A nerve carries the message to your brain. Your brain reads the message, flips the image, and correct it, and ta-da! It knows exactly what it's looking at.

TEAM: Yes, yes! Rods and cones, rods and cones, rods and cones.

COACH: And our visual acuity, those are all the details that we can see with our eyes, our eyes are really good at that. And we can see far. What we can see at 100 feet is what a dog sees at 20 feet. Take that!

[CHEERING]

MARTINEZ: All right!

BOB: Uh, um, Coach?

COACH: [SIGHS] What is it, Bob?

BOB: Well, I-- [CLEARS THROAT] I-- I do believe they have an eagle on their team. And their visual acuity is even better than ours.

COACH: [STAMMERS] Well, Bob, that's just one player. And I'm sure you know that our eyes are trichromatic, which means we have three kinds of cones-- red, green, and blue, which is pretty good for mammals. Most mammals are only dichromatic, meaning they only have two kinds of cones-- green and blue. So we can see more colors than most mammals.

SHAPIRO: Uh, OK.

BOB: Um-- but the eagle, and reptiles, and fish, and butterflies are tetrachromatic. That means they can see colors that we can't see or even imagine.

COACH: Well, I'd say, good for them. But I think we've still got this.

SHAPIRO: Coach?

COACH: What is it, Shapiro?

SHAPIRO: Don't a lot of these animals see way better in the dark than we do, like dogs, cats, horses?

COACH: Well--

SHAPIRO: Yeah, and then there's the polarization vision.

COACH: [SIGHS] What in the--

SHAPIRO: We don't have that either. Insects, and octopuses, and squids have it.

MARTINEZ: Yeah! That's where they can actually see polarized light, which we can't see at all. The light they see changes based on what angle they're at.

SHAPIRO: It helps them see glossy surfaces like leaves or water.

MARTINEZ: Yeah! It helps them see better underwater.

SHAPIRO: And octopuses and cephalopods can actually change the polarization of their skin.

COACH: Well, that's all very interesting. But--

MARTINEZ: You guys, I-- I heard they have a rabbit on their team.

COACH: A rabbit? Please.

MARTINEZ: Rabbits have amazing peripheral vision. With eyes on the sides of their heads, rabbits can basically see behind themselves without even turning!

COACH: Guys, guys, guys, calm down. We have way better 3D vision. And remember, we have binocular vision, so we can see depth. That means we can catch a ball way better.

[CHATTERING]

MARTINEZ: Sounds pretty good to me.

COACH: [BLOWS WHISTLE] OK, so they may have some things we don't. But we've got heart. And that can't lose!

BOB: Well, actually, they have hearts, too. And the octopus has three of them.

[CHATTERING]

COACH: [COUGHS] [CLEARS THROAT] [SIGHS] Well, let's just do our best. Bring it in, on 3, 1, 2, 3!

TEAM: Humans!

COACH: I can't hear you!

SHAPIRO: Well, yeah, that's because your ears do the hearing.

[CHATTERING]

BOB: Ow! I-- I think I got something in my eye.

COACH: [SIGHS] Come on, Bob.

[MUSIC PLAYING]

MOLLY BLOOM: Sophia, are you ready?

SOPHIA Yes.

GORDON:

MOLLY BLOOM: It's time for the mystery sound.

[MUSIC PLAYING]

CHILD: (WHISPERING) Mystery sound.

MOLLY BLOOM: Here it is.

[MOTOR VIBRATING RHYTHMICALLY]

Any guesses?

SOPHIA Something sleeping or breathing.

GORDON:

MOLLY BLOOM: OK, that is an excellent guess. And we will be back with the answer in just a little bit.

SOPHIA OK.

GORDON:

[UPBEAT MUSIC]

We're currently working on an episode all about ants. And we want to know this. What would you do if you were the size of an ant? Where would you go? What would the world look like?

Send your answer by email to Hello@BrainsOn.org. We'll include some of the answers in our episode. You can, of course, also send us your questions, mystery sounds, and drawings any time to that same email address. It's Hello@BrainsOn.org.

Now's the time in the show where we thank the amazing kids who keep the show going with their energy and ideas. Here's the most recent group to be added to the Brains' Honor Roll.

[LISTING HONOR ROLL]

ROBOTIC VOICE: (SINGING) Brains honor roll. Bye-bye.

MOLLY BLOOM: We're back with an encore presentation of our episode all about cats. We started with their eyes. And now, we're going to learn more about what's going on behind them.

Anyone who has cats knows that cats do things that may seem a little odd to us humans. That inspired Bella to recently send in this request.

BELLA: Hi, my name is Bella from Pleasanton, California. And I like to hear a show about cat behavior.

MOLLY BLOOM: Over the years, we've seen lots of questions about cats. So we set out to understand our feline companions a little bit better. I asked Sophia about her cute and slightly crazy cats. Sophia, how many cats do you have?

SOPHIA I have two cats.

GORDON:

MOLLY BLOOM: And what are their names?

SOPHIA Sam and George.

GORDON:

MOLLY BLOOM: Do you think that your cats can understand you when you talk to them?

SOPHIA Yes.

GORDON:

MOLLY BLOOM: Why do you think that?

SOPHIA Because whenever we call my cat Sam, when we call his name, he comes running towards us.

GORDON:

MOLLY BLOOM: And do you think that they are trying to say anything to you with the things that they do?

SOPHIA Maybe when they are hungry.

GORDON:

MOLLY BLOOM: What do they do when they're hungry?

SOPHIA They meow.

GORDON:

MOLLY BLOOM: What does it sound like?

SOPHIA [MEOWS]

GORDON:

[LAUGHTER]

MOLLY BLOOM: Is it like a specific meow they do when they're hungry?

SOPHIA It's like, [MEOWS]. I can't do it.

GORDON:

MOLLY BLOOM: And do they meow other times? Or is it just when they're hungry?

SOPHIA They meow a lot.

GORDON:

MOLLY BLOOM: How many different meows would you say they have?

SOPHIA Probably five.

GORDON:

MOLLY BLOOM: Give me some examples of-- so there's the hungry meow.

SOPHIA And then there's the "everyone's sleeping and I'm at the bottom of the stairs, wondering where I should go"

GORDON: meow. And then there is the "you're opening the door, so we're going to run towards you" meow. [CHUCKLES]

And then there is the "you're opening the fridge" meow. And then there is the "I want to go outside" meow.

MOLLY BLOOM: That's a lot of meows. And it seems like you understand them pretty well.

SOPHIA Yes. [LAUGHS]

GORDON:

MOLLY BLOOM: Well, cats are quirky creatures. And there is a lot to talk about.

SOPHIA
GORDON: We spoke with cat behavior expert Mikel Delgado. She told us what to look for in their eyes and about the other messages cats are sending us.

MIKEL
DELGADO: Cats do communicate through their eyes. So you can look and see, for example, whether or not they're trying to get more information. So if their eyes are open very big or you notice that their pupils are dilated, that's a sign that they are trying to take in more information about their environment, so a cat who's in a very playful mode, where they're thinking about hunting or maybe you're playing with them with a toy.

But a cat who's afraid would also probably have their pupils dilated as well, which is a normal fear response that we also have, which is when we're kind of in fight or flight mode, our pupils dilate. A cat who's blinking would be showing a sign that they're relaxed and that they don't need constant information. So they might be tired, but they might also just be very comfortable and feel safe enough that they can close their eyes regularly.

MOLLY BLOOM: When cats are purring, what does that mean?

MIKEL
DELGADO: Purring typically signifies a cat who is content and relaxed, although not always. So I always encourage people when they want to know what does the tail mean or what does the mean, is to look at the entire cat and what's going on. So if your cat is purring and they're on your lap and their eyes are closed, that's probably a sign of contentment.

There's still a lot we don't understand about purring really, why cats purr. But some of the theories are that it helps mom cat bond with her babies. So the purring helps elicit caretaking behavior in the mom.

But we also know that cats will purr when they're very frightened or even when they're very injured. So it could be a self-comforting behavior as well. Some believe that purring is actually at a similar frequency to that which would heal tissue. That hasn't been studied in as much detail. But there's some thoughts that maybe the cat is trying to take care of themselves by purring.

SOPHIA
GORDON: I was also wondering, why do cats tails puff up when they see another animal?

MIKEL
DELGADO: Yeah so that is called piloerection. And a lot of cats, they'll puff up all over. Some cats just puff their tail. And that's an attempt to look bigger. So the piloerection gives the impression that you shouldn't fight with that cat because that cat is big and possibly scary.

MOLLY BLOOM: And Sophia, do you feel like your cats communicate with you?

SOPHIA
GORDON: Well, whenever we call my cat Sam's name, he always meows back at us and runs towards us.

MIKEL
DELGADO: Oh, that's great. So he knows his name basically.

SOPHIA
GORDON: Yeah. And a follow-up question to that, do cats actually know their names? Or do they come to sounds or words?

MIKEL That's a really good question. I think you could train your cat to come to a particular sound, being their name. I
DELGADO: think a lot of cats respond to our tone of voice. So if you always use the same tone of voice when you call George, so he learns that that tone of voice means you're going to give him attention.

MOLLY BLOOM: Yeah, my husband and I had an experiment once, where he thought the cats knew their name, which was Cosmo. So he would go, Cosmo, and the cat would come. But then I started going, sofa, in the same voice, and the cat still came to me.

MIKEL Yeah, I've done that with my own cats, too, in the same result. So I think it really is tone of voice because we tend
DELGADO: to exclusively use it for them.

[MUSIC PLAYING]

DAN First, you love dogs.
DONALDSON:

[DOG BARKS]

Now, from the people who brought you dogs, it's cats.

[CAT MEOWS]

SUSAN SHARP: Cats!

DAN Do you ever wish your dog was smaller, better at cleaning itself, and buried its poop so you didn't have to look at
DONALDSON: it? Well, then you're going to love cats. Hi, I'm Dan Donaldson.

SUSAN SHARP: And I'm Susan Sharp. We're here to tell you about a breakthrough in pet technology. It's a new furry creature that never needs a walk and is perfectly sized for on-the-lap cuddles. Cats!

DAN Cats come with amazing state-of-the-art technology like whiskers.
DONALDSON:

SUSAN SHARP: These aren't just hairs, Dan. They're like kitty radar. They're attached to very sensitive nerves and allow cats to detect the location, size, and texture of something just by brushing past it.

DAN They're like fingers on a face, Susan.
DONALDSON:

SUSAN SHARP: That's gross, Dan. It's cats!

DAN Has this never happened to you? You're trying to pick up your big old dog and it wiggles and wiggles until you
DONALDSON: drop it on its head.

[DOG WHINES]

SUSAN SHARP: That's no problem with cats. They're built-in righting reflex uses their signature flexible spine and lack of a functional collar bone to make sure they can swing around in mid-air to almost always land on their feet.

[CAT MEOWS]

CROWD: Wow!

DAN What about when you get home and that mutt jumps up and slobbers all over your new shirt?

DONALDSON:

[DOG BARKS]

SUSAN SHARP: Gross! That won't happen with cats. Simply come home and they'll just sit in the corner, silently judging you.

[CAT MEOWS]

It's actually quite soothing.

DAN [LAUGHS] Amazing, Susan. Cats sound great. I'll take 10.

DONALDSON:

SUSAN SHARP: And I'll take 20.

DAN If you want to know more about the fantastic feline features of the amazing cat, stay tuned after this quick break.

DONALDSON:

MOLLY BLOOM: All right. The suspense is over, time to go back to the mystery sound. Let's hear it again.

[MOTOR VIBRATING RHYTHMICALLY]

Any guesses?

SOPHIA I still don't know what animal it is. But I still think it's sleeping.

GORDON:

MOLLY BLOOM: All right. Well, here is Karen McComb. She is the professor of animal behavior and cognition at Sussex University in England. And she has the answer.

KAREN That was what we call a solicitation purr. That was the purr that my cat gives in the morning when he wants to be
MCCOMB: fed. So the cat would be sort of right up close to you on the bed, staring at you quite intently, and giving this very grating purr, which is difficult to ignore and gets you downstairs and feeding him before you fix the coffee for yourself.

MOLLY BLOOM: And since Karen studies animal communication, she thought to herself, hey, let's find out more about this purr and why it's so hard for me to ignore. She was able to get recordings of 10 cats who do this kind of solicitation purring.

KAREN Not every cat does this. It's quite a specialist thing, tends to be cats who have a sort of a one-on-one relationship
MCCOMB: with an owner or with two owners who pay a lot of attention to the cat.

MOLLY BLOOM: She also got recordings of these cats non-solicitation purrs, which sound like this.

[PURRING]

She took these recordings of that purr you just heard and the mystery sound purr and played them randomly for people. She had them rate how urgent the purr sounded and also how pleasant it sounded.

KAREN It turned out that even humans with no experience of cats could do this task very well and find the solicitation
MCCOMB: purrs unpleasant and urgent.

MOLLY BLOOM: Karen analyzed what made the solicitation purr different from the other purr and found there was something hidden within it.

KAREN The key part of the story is the cats were embedding within this sort of low frequency purr that we think of as
MCCOMB: something pleasant that cats do, they were putting a high frequency cry in it that was similar to the pitch of a baby cry and probably, as a result of that, being able to generate this response from humans where they immediately wanted to give care because we've got a sensitivity to those sorts of signals.

MOLLY BLOOM: And cats do some cool things with their vocal cords that lets them embed this secret high pitch in their purr.

KAREN The reason that they can do it, first of all, the purr itself, it's a very low pitch sound. It's much lower than a cat
MCCOMB: should be able to produce. It's not generating the vocalization in the normal way. The normal way would be to blow air across the vocal cords. The cat twitches the vocal cords using muscles within them.

MOLLY BLOOM: They're using their muscles to generate the purr sound and air to generate the high pitch, making two sounds at once. Next time you hear a cat purr, think about the signal it might be trying to send to you.

[UPBEAT MUSIC]

SOPHIA Cats are complicated creatures.
GORDON:

MOLLY BLOOM: Their actions and behaviors--

SOPHIA --like purring, pupil dilation, tail puffing--
GORDON:

MOLLY BLOOM: --could have different meanings. So you have to look at the whole cat and what's going on around it to figure out what that behavior means.

SOPHIA And while our eyes are really good at certain things--
GORDON:

MOLLY BLOOM: --animal eyes have some cool powers that we don't have--

SOPHIA --like seeing in the dark, seeing more colors, and even being able to see behind them.
GORDON:

MOLLY BLOOM: That's it for this episode of *Brains On!*

SOPHIA This episode was produced by Marc Sanchez, Sanden Totten, and Molly Bloom.
GORDON:

MOLLY BLOOM: Special thanks to Danielle St. Germain-Gordon, DJ Haeussler, Dan Eric Nilsson, John Gordon, Eric Wrangham, Tim Post, Joe Jovelin, Chrissy Pease, Tracy Mumford, John Cone, Becca Murray, Jen Miller, and Colin Campbell.

SOPHIA To listen to past episodes of *Brains On*, you can head to our website BrainsOn.org.
GORDON:

MOLLY BLOOM: And while you're there, you can sign up for our newsletter.

SOPHIA You can also keep track of us on Instagram and Twitter @brains_on.
GORDON:

MOLLY BLOOM: And if you're a fan of *Brains On*, consider leaving a review in iTunes.

SOPHIA It really does help other kids and parents find out about the show.
GORDON:

MOLLY BLOOM: And you can send your art ideas or questions, drawings, and mystery sounds to Hello@BrainsOn.org.

SOPHIA Thanks for listening.
GORDON:

[MUSIC PLAYING]