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May 2024

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P28

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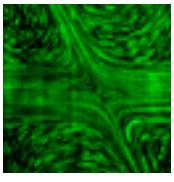

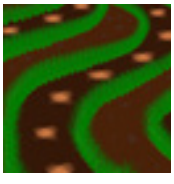

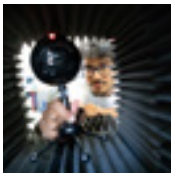

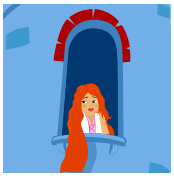

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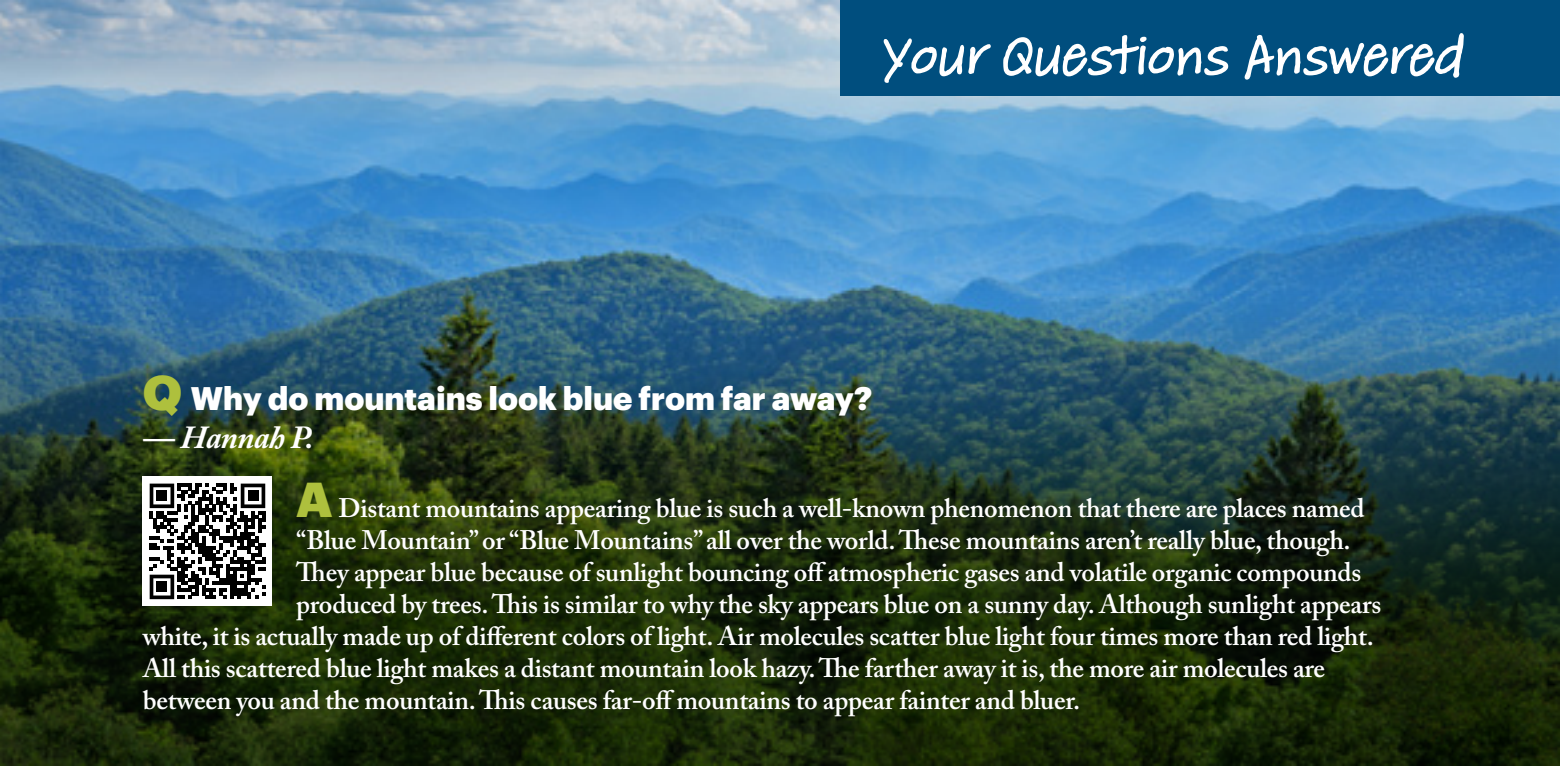

Q Why do mountains look blue from far away?

— Hannah P.

A Distant mountains appearing blue is such a well-known phenomenon that there are places named "Blue Mountain" or "Blue Mountains" all over the world. These mountains aren't really blue, though. They appear blue because of sunlight bouncing off atmospheric gases and volatile organic compounds produced by trees. This is similar to why the sky appears blue on a sunny day. Although sunlight appears white, it is actually made up of different colors of light. Air molecules scatter blue light four times more than red light. All this scattered blue light makes a distant mountain look hazy. The farther away it is, the more air molecules are between you and the mountain. This causes far-off mountains to appear fainter and bluer.

Q Why does freezing bread keep it from going stale?

— Izzie B.

A The flour in bread contains granules of tightly packed chains of starch molecules. The heat and water added during baking separates these molecules and makes the granules swell, giving fresh bread its fluffy texture. When the bread cools, though, the water can no longer keep the starch molecules apart. Without this padding, the starch molecules rearrange into a crystalline structure, making the bread dry and tough. The surrounding temperature affects how quickly this happens. Starch molecules crystallize fastest at temperatures close to those found in your refrigerator. Keeping bread below freezing, though, slows this process down.

Q If the planet is a sphere, how come those that live at the bottom of the globe aren't upside down?

— Pierrette F.

A If you live in the Northern Hemisphere, people in the Southern Hemisphere are upside down relative to you. But you are also upside down relative to them. There is no true "up" or "down" in space — a map or globe with the South Pole at the top is just as correct as one with the North Pole at the top. You could assign any place on Earth as the "top" or "bottom" of the planet, even where you are right now. So if all of us could be said to be "on top" or "on the bottom" of Earth, why don't any of us fall off? Because Earth's immense gravity pulls everything on its surface toward its center, keeping you and everything else from flying off into space.

Do you have a science question you want answered? Reach out to us on Instagram (@SN.explores), or email us at explores@sciencenews.org.

Sarah Zielinski
Editor, *Science News Explores*

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MARGARETWIKTOR/SHUTTERSTOCK

PHYSICS

How a stack of fruit tumbles

Studying stacked fruit can teach us about avalanches and rockslides

If you take more than 10 percent of the fruit in a stacked produce display — watch out. Sloped produce displays in grocery stores can cause chaos when they collapse. But figuring out how much fruit can be removed before a lot more comes tumbling down has proven surprisingly tricky.

Such collapsing fruit displays provide a way to study the forces behind even more important events, says Eduardo Rojas. He's thinking about avalanches and landslides. A physicist, Rojas works at the University of Antofagasta in Chile.

Those Earth tumbles are more complicated than a crumbling stack of fruit. In a fruit display, the objects are arranged in an orderly form, like that in a crystal. And the apples or pears are roughly the same size and shape. That's unlike the soil that slides down a mountainside, for instance. So it's easier to examine how removing one piece of fruit impacts the overall structure.

Using computer simulations, Rojas was part of a team that modeled fruit stacked at many angles.

About 10 percent of the fruit in a given display can be picked out before triggering a collapse, the team found. Say 29 shoppers grabbed an apple from a stack of 300. The next shopper might want to put on a hard hat before plucking one for themselves. The researchers shared their results in *Physical Review E*.

Next, Rojas and his team hope to study angled stacks with objects of different sizes. And they want to include ones arranged in a more random way, like rock piles that could lead to dangerous rockslides.
— *Darren Incorvaia*

Grocery stores stack apples, oranges, and other types of fruit at an angle. Such displays can tumble down once a small share of the produce is removed, new research suggests.

KONDOR83/ISTOCK

ANIMALS

Bonobos cooperate across social groups

Their generosity could help us learn how human society evolved

People cooperate and share resources with others. Often, they extend this generosity even to people they may not know or where they get no obvious reward. Such interactions have been considered unique to humans. But some bonobos appear to share this same social behavior, new research finds. The research may help explain how large human societies evolved.

Bonobos (*Pan paniscus*) live in social groups where members may not be close relatives. They also tend to be tolerant of outsiders. It's not unusual for them to groom and share food with members of outside groups. They have even been known to adopt others' offspring. But the full picture of their cooperative behavior had been unclear.

Liran Samuni and Martin Surbeck wanted to dig deeper into this behavior. Samuni is a behavioral ecologist at the German Primate Center in Göttingen. Surbeck is a behavioral ecologist at Harvard University in Cambridge, Mass. They chose to work in the Congo's Kokolopori Bonobo Reserve. For two years, they recorded the interactions of two groups of these primates.

The team documented which bonobos groomed or shared food with others, and when. The animals didn't always get along. Conflict and competition would sometimes crop up between social groups. The researchers recorded instances when the bonobos formed alliances to attack another member.

Encounters between the two bonobo groups happened a lot. They interacted nearly 100 times. The groups spent one-fifth of their time in each other's company during the two years they were studied. Some meetings lasted only an hour. Others went on for a week or more.

During these meetups, the researchers saw lots of cooperation. They documented more than 3,700 instances of grooming. One in every 10 instances involved bonobos from different social groups. And when alliances formed to attack another, about one-sixth (15 percent) were between bonobos from different social groups.

In addition, 6 percent of food sharing instances were between the groups. Clearly, Samuni says, "This is not a one-off kind of thing."

The bonobos' cooperation also wasn't random. Those that cooperated in their own group were more likely to interact with like-minded members of the other group. And immediate payback wasn't the motivating factor, the researchers say. Only one in every seven bonobos that shared food with the other group saw this favor returned.

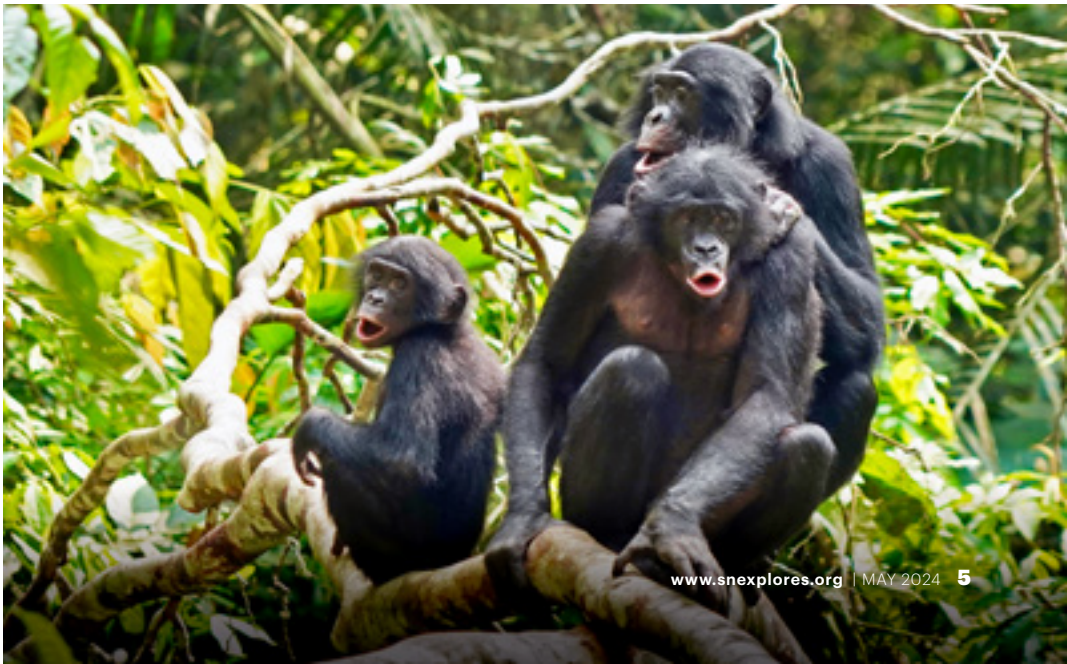
Samuni and Surbeck described their findings in *Science*.

Similar things have been seen among captive bonobos. This suggests that their generosity to outsiders is innate. Cooperating with relatives is one way of ensuring that one's own genes survive. Helping outsiders is a more indirect way of doing the same thing.

The new study hints that cooperating with outsiders doesn't rely on cultural factors and social norms. These influences are considered critical to such cooperation in humans, Samuni says.

"We are showing quite a simple system," she says. "And we still see it emerging, and in a way that is quite similar [to that in us]."

— *Jake Buehler*



L. SAMUNI/KOKOLOPORI BONOBO RESEARCH PROJECT

Scientists working in the Congo's Kokolopori Bonobo Reserve found that some bonobos extended their generosity without any clear or immediate reward.

SPACE

Hidden shapes at Mars' equator hint at an icy past

The planet may once have been tipped on its side

Rock that lies dozens of meters (yards) below Mars' surface may be riddled with huge polygon patterns.

Polygons are geometric shapes with flat sides. Such patterns appear on Earth, too, near the poles. There, sharp temperature drops can cause icy ground to cool, shrink and crack. Those cracks then fill — with ice or sand or both — to form wedges that pry the ground apart. In time, the widening cracks carve out polygon patterns.

A similar process may have created the shapes found on Mars. The Chinese rover Zhurong used radar to peer underground in a region called Utopia Planitia. There, it spied polygons that seemed to be roughly 70 meters (230 feet) across. They're bordered by wedges that could be up to 30 meters (100 feet) wide.

The structures are about 10 times as large as those typically found on Earth. So they may have formed differently than our planet's ice-wedge polygons, says Richard Soare. A planetary scientist at Dawson College in Montreal, Canada, he wasn't part of the Mars study.

But if the Red Planet's polygons did form similarly to those on Earth, they could be signs of a very active past.

Today, Utopia Planitia is a dry, sandy plain near the equator. To form polygons, the region must have been wetter, says Ross Mitchell. He's a geoscientist at the Chinese Academy of Sciences in Beijing. His team described the polygons in *Nature Astronomy*.

Changes in the tilt of Mars' axis could explain such a shift in climate.

Computer models hint that the axis around which Mars spins was once much more tilted than it is now. At times, the planet may have basically lay halfway on its side. If so, what's now the poles would have gotten more direct sunlight. Land near today's equator would have frozen.

"We think of every planet other than Earth as dead," Mitchell says. But if Mars' axis does swing around often, he says, the Red Planet's climate could have changed far more than we thought.

— *Elise Cutts*

On Mars, the Chinese rover Zhurong found intriguing polygon patterns buried dozens of meters (yards) below its landing site.

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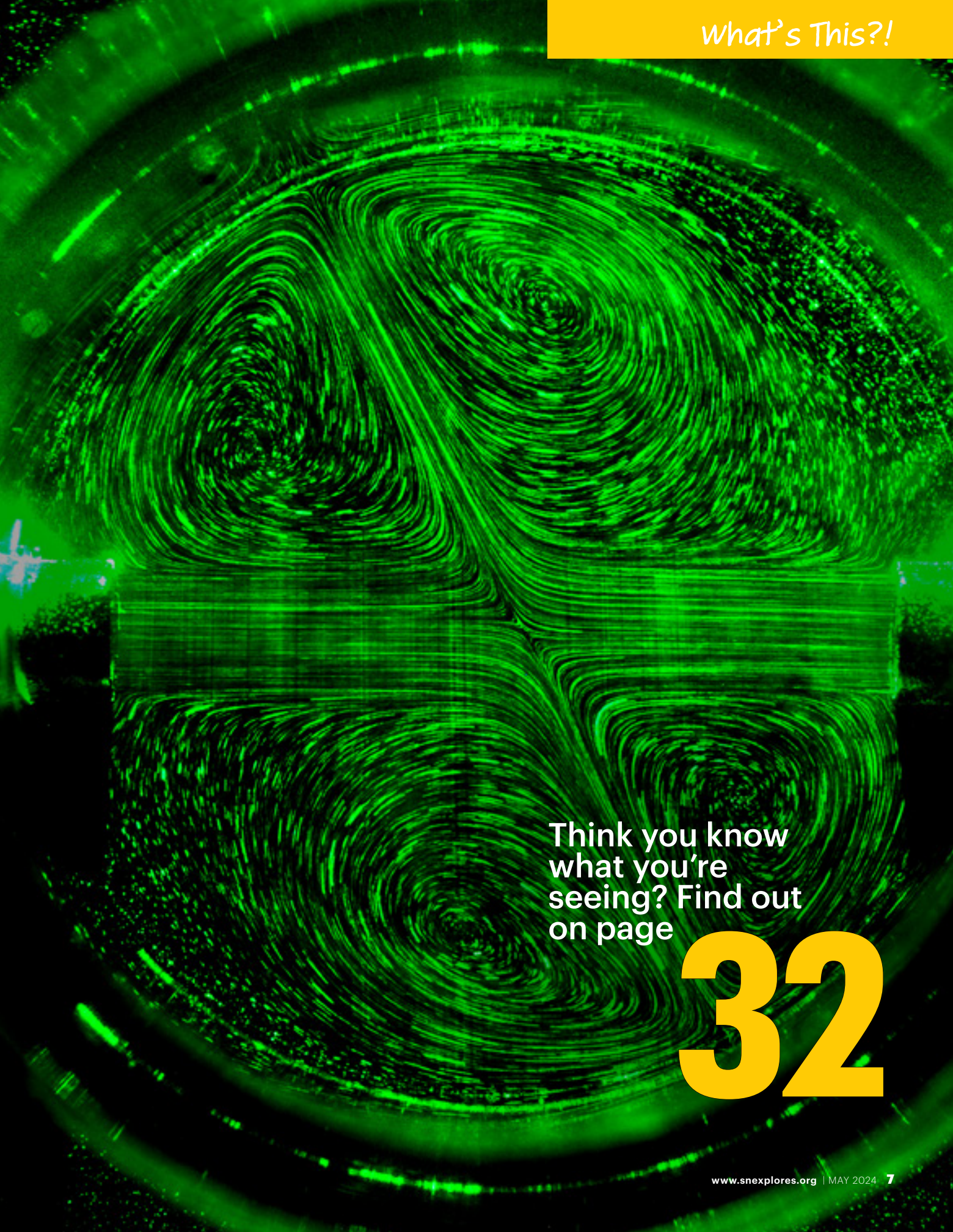

Think you know what you're seeing? Find out on page

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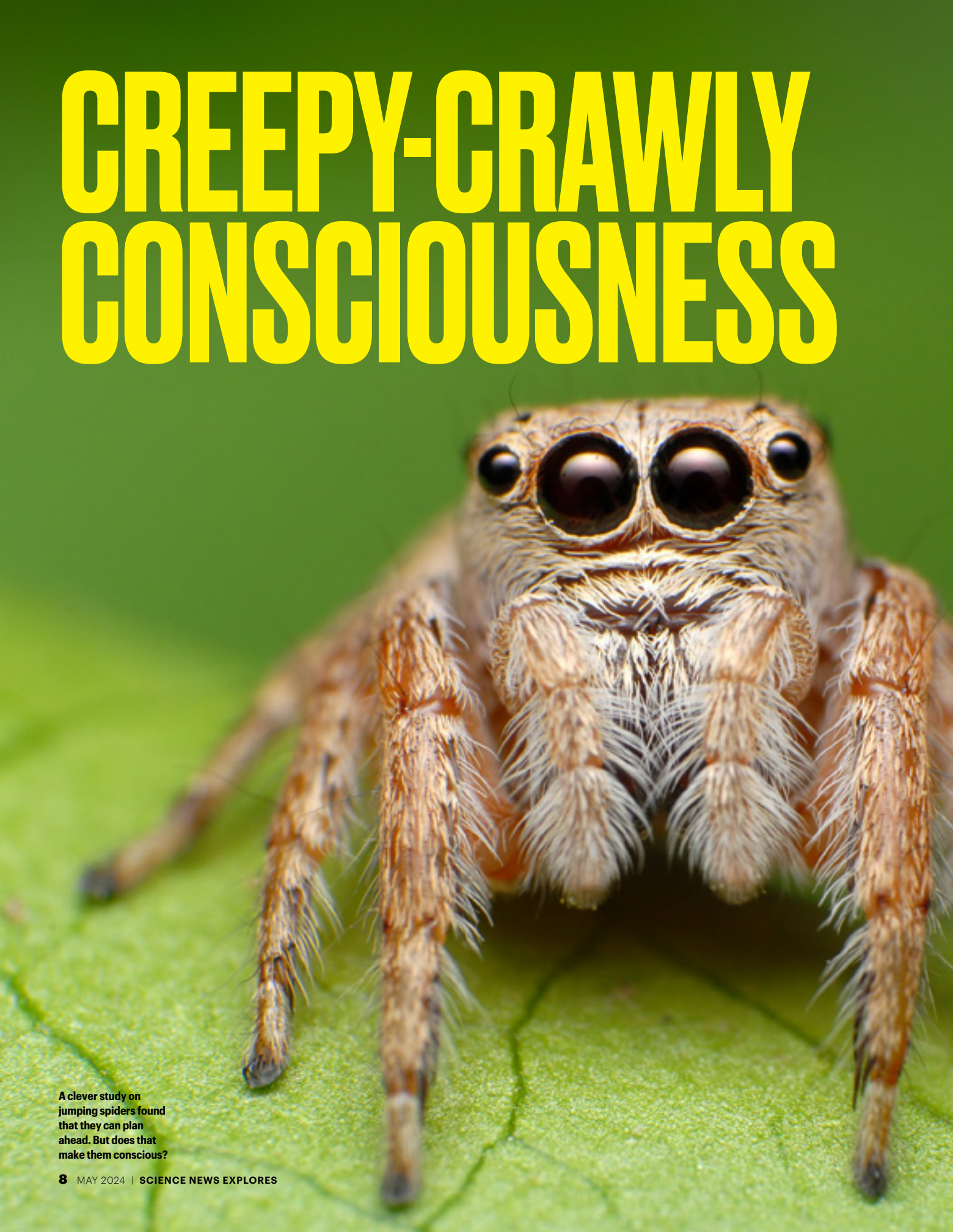
CREEPY-CRAWLY CONSCIOUSNESS



A clever study on jumping spiders found that they can plan ahead. But does that make them conscious?

By **Avery Elizabeth Hurt**

Invertebrates are pretty clever – but are they conscious?

We tend to think that animals like dogs, cats and horses experience the world somewhat like we do. But what about animals that aren't mammals? Do beetles enjoy the feeling of a warm sun on their backs? Do ants fear being stepped on? Do spiders get excited when they catch prey in their webs?

RUNDSTEDT B. ROVILLOS/MOMENT/GETTY IMAGES

Beetles, ants, spiders and other animals that don't have backbones are called invertebrates. About 97 percent of all animals are invertebrates. Insects, scorpions and worms are examples. So are lobsters, crabs, shrimp, squid and octopuses. Invertebrates are different from humans in many ways. But just how different? Do they have consciousness, for example?

Scientists and philosophers are trying to work out how to find answers for such hard questions.

"I want to get into the minds of the animals. I want to know what it feels like," says Rafa Rodríguez. "That's doomed to failure. But I want to get as close as possible." Rodríguez is a biologist at the University of Wisconsin–Milwaukee. The closer that scientists like him get into the minds of invertebrates, the closer they'll come to knowing if these animals have consciousness.

Not all researchers agree on how to define consciousness. Some people use the word "sentience" — being able to feel things. Others use "self-awareness" — a term that means understanding you are an individual. Both describe the ability to have experiences and know that you're having them.

Jennifer Mather has a simpler definition. This biologist studies octopuses at the University of Lethbridge in Alberta, Canada. Mather says that basically, consciousness means "somebody's home."

Despite working with different definitions, scientists are making progress toward learning if invertebrates are conscious. Experiments have hinted that insects, crustaceans and other critters can feel things such as pain and fear. And invertebrates like spiders show excellent memory and planning skills. Those are all features of consciousness in people.

But the findings raise an even deeper question: Can we use our own experiences to decide what consciousness looks like in critters so different from us?

Making trade-offs

Scientists often use pain as a stand-in for consciousness. If an animal can feel pain, then it's safe to say it's conscious, explains Heather Browning. She's a philosopher at the University of Southampton in England. She studies animal consciousness there.

But how do you know if an animal feels pain? Pulling away to avoid something that might harm it may be just a reflex. This is when the body responds to a stimulus without consciously thinking about it. When something consciously experiences pain, its behavior changes in more deliberate ways.

For instance, if you burn your hand on a hot stove, you might yank your hand away by reflex. But because you also consciously experienced that pain, you might choose to run your hand under cool water — or not touch a hot stove again.

Barry Magee and Robert Elwood work at Queen's University Belfast in Northern Ireland. While working with hermit crabs, these biologists found a clever way to tell the difference between reflexive and conscious reactions to pain.

Experiments with hermit crabs and other invertebrates have led some scientists to believe these animals show evidence of consciousness. For instance, hermit crabs seem to make conscious decisions about when to abandon their shells.

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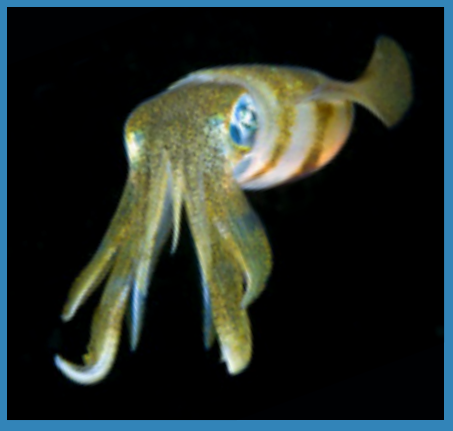
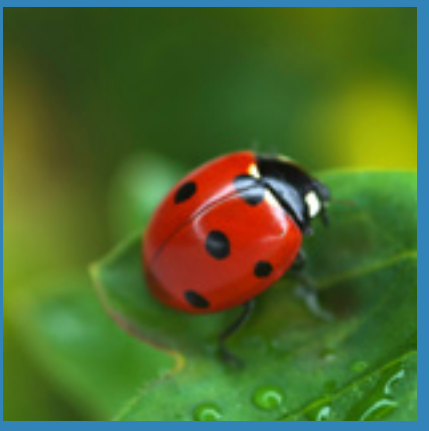


Anybody home?

Invertebrates — including squid (left), beetles (center), crayfish (right) and many other species — make up around 97 percent of all animals on Earth. Scientists now want to know how self-aware these critters are about their place in their environment.

Hermit crabs don't grow shells of their own. They choose their shells from among those shed by other critters. When the crabs find a good shell, they stick with it. When Magee and Elwood gave crabs small electric shocks, the crabs left their shells to find others. But if a crab was in a really good shell, it took more electric shocks to make it leave.

When the researchers put the scent of a predator in the water near the crabs, it took even more shocks for them to give up the safety of their shell to look for shelter that didn't come with shocks.

These data show that crabs don't respond to pain just by reflex, the researchers now argue. Instead, each crab is making a trade-off. It's deciding if it should take the risk of encountering a predator or stay in the shell and possibly get shocked again.

"One of the best theories about why sentience evolved," says Browning, "is so that animals could make these kinds of trade-offs." A brain that's not conscious — not sentient — wouldn't be able to make these kinds of decisions, she says. It would just respond by reflex. A hermit crab would always leave its shell after a shock, even if that wouldn't be best for its survival.

Fearful flies and pessimistic bees

Invertebrates might be able to feel not just pain, but also emotions — such as fear. One study looked at how fruit flies reacted to a threatening shadow flying overhead. The flies jumped and sometimes froze. These reactions, the researchers say, suggest the flies are experiencing something similar to what humans would call fear.

Pessimism is the tendency to expect that something bad will happen. Experiments have hinted that honeybees that had just experienced something bad were more likely to expect more bad things would come.

Stephen Buchmann is a pollination ecologist at the University of Arizona in Tucson. He studies bees and wrote the book, *What a Bee Knows: Exploring the Thoughts, Memories, and Personalities of Bees*. Buchmann is not ready to say that bees have emotions like ours. But he does think they can become anxious.

DIVELVANOV, VIKTORIIA PLETSKA2020, LASTSHOTLIFE/SHUTTERSTOCK; NAIBANKFOTOS/SHUTTERSTOCK

He bases that view, in part, on an experiment with robotic spiders. Researchers in England placed the mechanical critters in an area where bumblebees foraged. From time to time, a fake spider would grab a bee. The spider would hold the bee for a couple of seconds, then release it.

This near-death experience had a big effect on the bees. Those grabbed by the spider approached flowers more cautiously later on. They were skittish. They even avoided flowers without spiders.

Who raided the pantry?

Another way to investigate consciousness is to see if animals can remember the past and plan for the future. Memory and planning are thought to be important signs of consciousness.

Spiders, for instance, have very good memories. In one experiment, Rodríguez replaced webs of spiders that had food in them with webs with no food. The spiders looked for where the food had been in the old webs. And they kept looking, even when Rodríguez put new food in the web. Spiders looked longest in the places where the best food had been.

This means that spiders notice when their environment doesn't match their memories of it. Rodríguez sees that as a sign of higher intelligence. This alone does not prove spiders are conscious, Rodríguez says. But it's what he calls a "building block" of such evidence.

There are more building blocks. For instance, research has shown that spiders can plan ahead.

In one experiment, researchers placed jumping spiders on a tower surrounded by water. These spiders have very good vision. From the tower, the spiders could see two boxes. One contained dried leaves. The other held one of their favorite foods. To reach the food without getting wet, the spiders had to climb down the tower, then choose a path to the meal.

Most spiders chose the path that led to the food — even though they had to first move away from the food and bypass another path. They only could have gotten the information they needed by looking from the tower. This shows that the spiders planned their route in advance.

Emotions may indicate consciousness. Honeybees (upper left) can become pessimistic. Bumblebees (upper right) became skittish — maybe even anxious — after an encounter with a robotic spider. And orb weavers (lower right) may have good memories.

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Where consciousness came from

How animals behave can tell us a lot about their consciousness. But to decide if invertebrates are conscious, experts also look at the animals' brains. Invertebrate brains differ a lot from our brains and those of other mammals. But some researchers believe invertebrates may well have the brainpower for consciousness.

Scientists have long thought consciousness originated in a part of the brain known as the cortex. This area plays a role in higher-level thinking. It's responsible for things like memory, decision-making, reasoning and language.

But Björn Merker has argued that consciousness didn't originate in the cortex. Research by this Swedish neuroscientist and others suggest that children who were born without a cortex still are conscious.

One study showed such children could recognize familiar people and interact with their families. One child began to cry when her babysitter cried. When an object she was looking at was moved behind her, she turned around. This makes it seem likely that the cortex is not needed for consciousness. Instead, Merker thinks consciousness may have begun in a much older part of the brain: the midbrain.

Andrew Barron and Colin Klein note that if Merker is right, then insect brains may be capable of self-awareness. Barron studies bee brains at Macquarie University in North Ryde, Australia. Klein is a philosopher of consciousness at the Australian National University in Canberra.

Insect brains lack a cortex. They do, however, have structures similar to our midbrain. And those structures have a lot of processing power, Barron says. They have at least enough for an insect to have a sense of its own body and how its body moves through its environment.

Barron and Klein think human consciousness may have evolved from these same brain structures. But consciousness didn't have to evolve just once or in just one way. Sometimes the same feature evolves separately in more than one type of organism. This is called convergent evolution.

Flight is a good example of that, says Marlene Zuk. She's an evolutionary biologist at the University of Minnesota in St. Paul. Birds and bats both developed the ability to fly. But they did it separately. "Similar evolutionary pressures can produce similar solutions," says Zuk. "I don't see why the same thing can't be true of consciousness."

Not just about me

One reason it's so hard to determine whether invertebrates have consciousness is because they differ so much from us. We tend to compare other animals to ourselves. We think they're intelligent if they're like us. We decide if they're conscious the same way — testing whether they experience feelings or a sense of self the way people do.

This is a mistake, says Zuk. She works with lots of insects, especially crickets. "Insects are not just little people," she says. They experience the world in very different ways because they are different.

For example, humans rely mostly on vision to sense our environments. Most insects rely more on sound or smell. Animals that experience the world so differently from us may experience consciousness differently, too.

If we want to know if invertebrates are conscious, scientists must design experiments tailored to the species they're studying, Rodríguez says. Doing this requires a detailed understanding of how those animals sense their world, where they live, what they eat and other aspects of their lives.

In the end, we may never know for sure if invertebrates have consciousness, says Zuk. That doesn't mean we shouldn't try.

And whether or not we can prove invertebrates are conscious, we still should be thoughtful of them, says Scott Hoffman Black. He's the executive director of the Xerxes Society, a group based in Portland, Ore., that focuses on invertebrate conservation.

"I'm not saying don't swat that mosquito that's biting you," Black says. "We all kill insects. We kill them with our cars when we drive. We step on insects we never knew were there." But we do need to be thoughtful about how we treat these animals, he says: We must not disregard them.

READ MORE

Buzzkill: A Wild Wander Through the Weird and Threatened World of Bugs

By Brenna Maloney, illustrated by Dave Mottram

No need to bug out. Insects may seem gross, but they offer a lot of benefits. Learn how to help these misunderstood animals in this book about all things six-legged.

MACMILLAN PUBLISHERS

Dancing spiders inspired this biologist to teach others

Sebastian Echeverri uses his background in animal communication to help others appreciate arachnids

Sebastian Echeverri always had a passion for animals. Studying spiders, though, wasn't originally part of the plan. That changed when a professor showed him a video of the fiery-haired paradise jumping spider. Regular fashionistas, the males of this species sport a bright red face and green legs. They also "sing" through the ground using vibrations as part of a choreographed dance. The males move their colorful legs along with these vibrations to woo females.

"The moment that I first saw this dance was when I got hooked on spiders," says Echeverri.

Echeverri went on to study these grooving arachnids as part of his research on sensory ecology. That's the study of how animals interact with their environments and each other using their senses. While he enjoyed his work, Echeverri struggled with undiagnosed autism and ADHD (attention deficit hyperactivity disorder). He also felt that academia failed to support students from diverse backgrounds. "And [those issues] made it hard for me to do the fun science that I loved," says Echeverri.

Inspired by his research in animal communication, Echeverri began exploring ways to teach others about science. Today, he shares his passion for spiders as a science communicator. In this interview, Echeverri shares his experiences and advice with *Science News Explores*. (This interview has been edited for content and readability.)
— Aaron Tremper

Male fiery-haired paradise jumping spiders, which Echeverri has studied, use bright colors, waving legs and vibrations to grab the attention of a potential mate.

S. A. ECHEVERRI

Q How do you get your best ideas?

A This is something that I'm still learning how to do. I only started to understand how my brain works. I spent the first 30 years of my life not knowing that I am autistic and have ADHD. And simply feeling that I was really bad at everything that everyone else could do very easily.

Now, I'm feeling a lot better. I've gone to therapy and am taking ADHD medication, which helps a lot. If I'm trying to come up with a new idea for something, I'll just brainstorm with no expectations. I'll sit down with a blank piece of paper and write down what comes to mind with no intent to make it legible or good in any way. Then I'll put that down for a while and do something else. When I let it sit, I can come back and reassess.

Q What is your biggest success?

A I grew up watching nature documentaries, including those on the BBC. I never thought that I

As a Ph.D. student, Echeverri taught people about spiders at his local museum. Helping others learn about these misunderstood, and often feared, animals inspired him to pursue a career in science communication. "The more I did it," he says, "the more I realized that this is what I really love."

could make one of those. I got an email asking if I'd be interested in applying to be the co-host of the BBC Earth podcast. I thought that email was spam when I first read it. The next year, I co-hosted and produced a wildlife podcast series with the BBC Earth team. It had all of these cool stories about people connecting with animals. There's something special about getting to do what I would watch and listen to as a kid.

Q What piece of advice do you wish you'd been given when you were younger?

A Right now, we have an amazing opportunity to connect with scientists and educators as people. I wish that when I was a kid, I had been able to see the diversity of people and careers in this field. I would say, go look into and follow scientists that are doing the work you're interested in. You'll get exposed to a lot of possibilities that you might not see in other cases.

By **Jane Palmer**

YOU MIGHT BE WRONG — AND THAT'S OK

Challenging your beliefs can help you learn

DELCARMAT/SHUTTERSTOCK

Growing up in Italy in the 1570s, Galileo Galilei believed what everyone "knew" to be true at the time. Earth was the center of the universe.

He went on to train as a mathematician. And in 1609, he built one of the first telescopes able to resolve details of celestial objects. The next January 7, he spotted what looked like four stars close to Jupiter. Over time, however, he noticed something strange. Each star's distance from Jupiter seemed to be rapidly changing.

Eventually, Galileo realized that these objects — celestial bodies that would later be known as moons — were circling Jupiter. This discovery caused him to begin questioning his beliefs. He was taught that Earth was the center of the universe and that everything else merely moved around it. So how could those four starlike objects be spinning around Jupiter instead?

Galileo came to conclude that the sun was actually the center of the universe. The Earth and other planets rotated around the sun. This idea made him very unpopular. In 1633, the Catholic Church put Galileo on trial. Its leaders pointed out that his newfound belief contradicted the Bible. The church convicted the scientist of heresy and sentenced him to house arrest for the remainder of his life.

With time, Galileo's ideas would become a basis for helping scientists understand the universe. (Others would show the sun was the center of our solar system, not the entire cosmos.) Galileo also made other important discoveries. For such achievements, Albert Einstein referred to Galileo as the "father of modern physics — indeed, of modern science altogether."

Scientists now point to one factor that may have contributed to Galileo's scientific success: his ability to challenge his own beliefs and admit they might be wrong.

For many years, Mark Leary has studied the role of people's beliefs in their behavior. Leary is a neuroscientist at Duke University in Durham, N.C. Admitting you could be wrong can lead you to pay more attention to any evidence you encounter, he's found.

Galileo "wasn't just the right person against the wrong establishment," Leary says. In fact, Galileo started out as wrong as everyone else. But then, Leary notes, Galileo "suddenly realizes: 'Oh man, I was wrong!'"

"Knowing our beliefs could be wrong helps us in a few ways," says Tenelle Porter. She's an educational psychologist at Rowan University in Glassboro, N.J. "If we can recognize that our ideas about something might be wrong, we're more likely to do what it takes to get them right." Being humble is an overlooked learning superpower.

Avoiding overconfidence

Self-confidence is trusting in our abilities or qualities. It's usually seen as a good thing. But most of us might benefit from a little less confidence in our beliefs.

For instance, Leary asked a sample of adults to think back on recent disagreements. How often had their positions been the ones in the right? You'd expect them to say they were right about half the time. Instead, a whopping 82 percent — more than four in every five — said they were right more than half the time. That suggests they were overconfident. They had likely overestimated their knowledge and how sound their beliefs were.

In Galileo Galilei's time, the church and scientists thought everything in the cosmos revolved around Earth. Galileo's observations proved that view wrong and advanced science — but won him house arrest for the rest of his life.

HULTON ARCHIVE/STRINGER/GETTY IMAGES

Galileo's observations that Jupiter was orbited by moons (here, an artist's rendering of Jupiter and its four largest moons) challenged the belief at the time that everything in the cosmos revolved around Earth.

In this drawing, do you see a young woman? An old woman? Both? This ambiguous picture is an example of how one image, event or situation can appear to illustrate two different things, depending on how you look at it.

SN VFX/SHUTTERSTOCK; W. E. HILL, PUBLIC DOMAIN, VIA WIKIMEDIA COMMONS

Scott Plous believes such overconfidence is very common, especially when it comes to what people believe to be true. A psychologist, Plous works at Wesleyan University in Middletown, Conn. Overconfidence, he says, can lead to catastrophic decisions. In 1986, for example, NASA believed that the risk of loss for any single space-shuttle flight was roughly 1 in 100,000. It was an overconfident belief and might have contributed to the explosion that year of the space shuttle *Challenger*.

The good news, he adds, is that there's a "vaccine" for overconfidence: recognizing that your beliefs could be wrong. Scientists call it "intellectual humility." And it can help you in many ways.

This way of thinking, Leary says, is like having a wise friend on your shoulder asking you to consider whether you could be wrong about a belief. In contrast, overconfidence is like having a not-so-good friend who's always telling you that you're right and everyone else is wrong.

To benefit from intellectual humility, Leary says, you may not need to change your mind about something. It's more about being open to the idea that what you believe might be in error. "You are not throwing your belief out the window," he says. "You are just double checking."

Elizabeth Krumrei-Mancuso is a research psychologist at Pepperdine University in Malibu, Calif. She asked 144 college students to complete a survey to gauge their intellectual humility. The survey also measured how curious students were and how much they liked challenging, intellectual tasks.

Students who saw that their thinking could be flawed tended to be more curious, found the study, which appeared in the *Journal of Positive Psychology*. They also were motivated to seek out new knowledge. Because these students were aware they might be wrong, they hunted out new information, Krumrei-Mancuso says. "So, they end up knowing more at the end of the day."

The opposite is also true, her data suggest: "If you don't think that you've got anything in your worldview that needs analysis or correction, why would you even look at it?" That is an attitude that can really harm your ability to learn or acquire knowledge.

In short, Leary says, it pays to be humble.

"Smart people are smart enough to know that they don't know everything." And, he adds, "They're smart enough to know that some of the stuff they think they know will eventually turn out to be wrong. That's part of being smart."

Learning to study smarter

Knowing you could be wrong can lead you to seek — and ultimately collect — more accurate knowledge. But does it actually help you beyond that?

In one study, Porter found, high school students who could see that their beliefs might be wrong were much more likely to use strategies to test their knowledge while they were studying. These kids would quiz themselves. They'd check to see that they really understood the material. And they'd seek out potential holes in their understanding.

Students who didn't see that their knowledge could be flawed might instead just sail through their studying, Porter says. They won't stop to ask themselves if they truly understand what they read, heard or did.

Such students can fall prey to a "knowledge illusion." This is where they think they've got a subject down pat. "But that illusion is punctured very quickly when you're asked to explain it on a test," she points out. Only then does it become "very clear that you don't actually understand as much as you thought that you did."

Students who knew their beliefs could be wrong used skills that helped them in studying and test-taking, her team found. And after getting test scores back, such students were more likely to say they'd change their study strategies, Porter found. In this study, high-school math students willing to question their beliefs also appeared to be more persistent than others. Going forward, they said, they would determine how to improve their performance and master the material for the next test.

But these students weren't just going to "try, try and try again" in some mindless way, Porter adds.

Questioning what you think is true can lead to a different approach or interpretation. For instance, a baker may reevaluate what it takes to yield a better treat.

Students who are willing to challenge what they assume to be true are more open to learning, studies show.

MASKOT/MASKOT/GETTY IMAGES PLUS

They said they'd be taking an honest look at what they'd done wrong and try to figure out how to avoid that the next time.

The students who questioned their beliefs also ended up with higher grades in math. Porter shared her team's findings in *Learning and Individual Differences*.

"There's not a person out there that doesn't run into failure," Porter says. "But really, the only way to get better is by persisting and learning from your failures."

Baby steps

Although it might be good for you, questioning your beliefs can be truly hard. Nobody wants to be wrong. Few of us even want to think about being wrong.

Our beliefs can act as a security blanket. They can help us feel safe and certain. And we may not want to lose that feeling. Still, it's important to remember that questioning beliefs isn't always about swapping old ones out for new ones.

"We don't change our beliefs willy-nilly," Krumrei-Mancuso says. It's more about being open to considering new evidence.

This is a digitally restored engraving of Galileo being questioned by leaders of the Catholic Church over what they claimed was his "heresy" — saying that the sun, not Earth, was the center of our solar system.

ANDRESR/E+/GETTY IMAGES PLUS; MIKROMAN6/MOMENT/GETTY IMAGES PLUS

It can help to think of where you may do this already. In cooking, for example, people regularly experiment with a recipe. Would it taste better with a little more sugar — or maybe a little less? Perhaps it should bake for less time? Similarly, to get better at shooting hoops you would try new approaches and see what works. What if you hold the ball differently? Or aim higher above the basket's rim?

"We do this in a lot of domains very naturally. It's not a bad thing to keep checking," Leary says. "But for some reason, people think there is something wrong with checking their beliefs." Leary suggests that people view their questioning of beliefs as a helpful habit. People get in habits of challenging themselves or following celebrities on Instagram. Questioning beliefs, he says, can simply be a new habit.

Leary cautions against trying to do this every single time you make a decision. That would become exhausting, he says. Practice it when you're thinking about whether something is correct or making some really important decision. This might prove most beneficial when you feel really strongly about something, Leary says. "Ask yourself: Am I certain I am right about this?"

If you find it hard to question a belief, try taking "baby steps," he says. Start looking at why you hold that belief. See if the reasons you do make sense. Think about who you may have gotten a belief from, for example. Then ask that person how sure they are that they're correct — and what convinced them. Or ask yourself why you might want to hold some belief. Does it help you feel safe or fit in? Scientists before Galileo may not have wanted to question whether the Earth was the center of the universe — perhaps because they were worried what might happen to them. (And with good reason, it turns out.)

Galileo suffered for changing his beliefs. But today, questioning beliefs can bring benefits in the classroom and beyond. And even for Galileo, there was an upside. By changing his beliefs, he shined a light on an exciting "new" universe to investigate with his research. Similarly, checking your beliefs can open up your world, Porter says. "You get to discover something new," she says. "It's such an adventure."

Funding for this story was provided by University of California, Berkeley's Greater Good Science Center and the John Templeton Foundation.

PLANTS

Can plants stop soil erosion?

Plant your own mini garden to find out

By Science Buddies

Water can wash away, or erode, soil. That can damage farmland, carry pollution into waterways and contribute to landslides. Could plant roots, which absorb water and grab onto soil, help reduce erosion? Let's use mini "hillsides" to investigate.

OBJECTIVE

Find out if plants reduce the amount of soil eroded from a hill due to rainfall

EXPERIMENTAL PROCEDURE

1. Fill six pans with soil. Plant radish seeds in three.

2. Put the pans near a sunny window. Water them once per day until the plants are roughly 10 centimeters (4 inches) tall.

3. Take the pans outside or to a bathtub.

4. Cut the short side of each pan so you can fold down the top half of that side to expose the soil.

5. Place the cut end of one pan inside a larger pan. Prop up the other end.

6. Pour water from a watering can onto the smaller pan, covering its entire surface, for five seconds.

7. Drain the water out of the larger pan to leave only the soil that washed out.

8. Weigh that pan and soil. Subtract the weight of an empty pan to get the weight of the soil alone. Write it down in a lab notebook.

9. Repeat steps 5–9 for each remaining pan.

10. Compare the average weight of the soil for pans with and without seeds to see if the plants helped reduce erosion.

Find the full activity, including how to analyze your data, at snexplores.org/erosion. This activity is brought to you in partnership with Science Buddies.

SCIENCE BUDDIES

MEECHAI39/SHUTTERSTOCK

These words are hiding in this issue. Can you find them?

The words below came from the stories in this magazine. Find them all in the word search, then search for them throughout the pages. Some words may appear more than once. Can you find them all?

Check your work by following the QR code at the bottom of the page.

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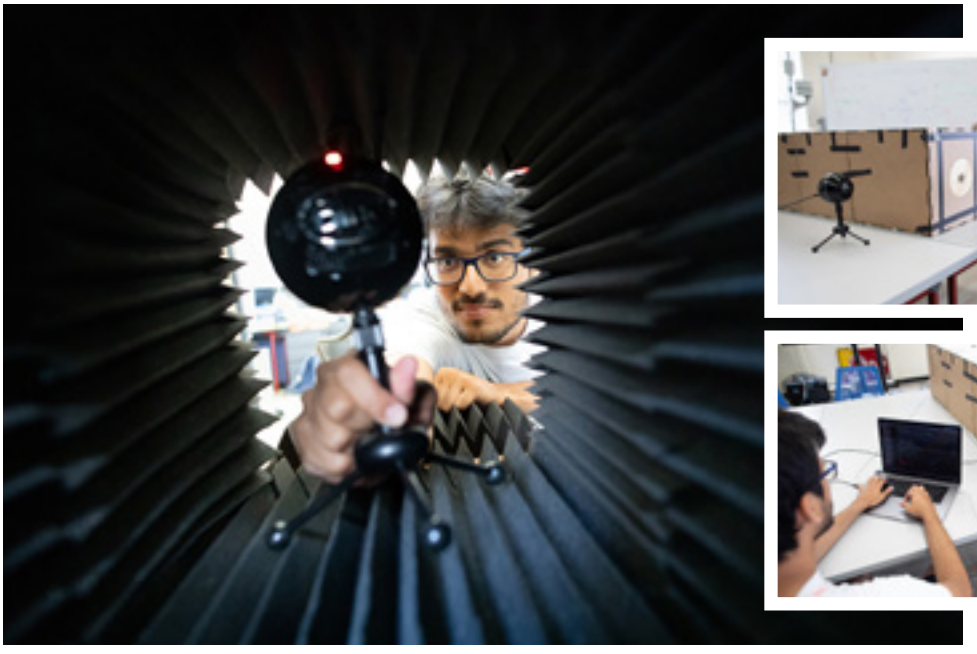
PATPITCHAYA/SHUTTERSTOCK

TECH

Talking through a tube can trick voice-recognition AI

Voice-ID systems don't yet protect against this type of hack



Team member Yash Wani (above) sets up a test of a simple system designed to make a person's voice sound like someone else. It uses a microphone (left), box and plastic tube (right upper and lower).

TODD BROWN/UNIVERSITY OF WISCONSIN–MADISON

Grab a paper towel tube and talk through it. Sounds weird, huh? Your wacky tube voice probably wouldn't fool your family or friends into thinking you were someone else. But it could trick a computer, new research finds.

In an experiment, people used specially designed tubes to make their voices sound like someone else's. Those fake voices could fool an artificial intelligence, or AI, model built to identify voices.

Since voice-recognition AI is used to guard many bank accounts and smartphones, criminals could craft tubes to hack those accounts, says Kassem Fawaz. He's an engineer at the University of Wisconsin–Madison. His team described the findings last summer at a security conference in Anaheim, Calif.

"This was really creative," David Wagner says of the new study. He was not involved in this research. But he is a security expert at the University of California, Berkeley. "This is another step," he says, "in the cat-and-mouse game of [cybersecurity] defenders trying to recognize people and attackers trying to fool the system."

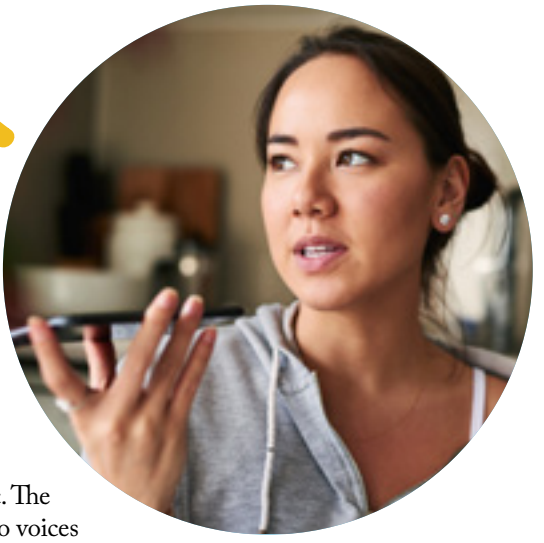
TRICKY TUBES

Bad guys have already found ways to hack voice-ID systems. Typically, they do this to steal from bank accounts. Most often, they use what's known as deepfake software. It uses AI to create new speech that mimics the owner of the targeted bank account.

In response, many voice-ID systems have added protections. They check whether there's any digital trickery behind a voice. But Fawaz's team realized that these systems weren't checking for non-digital tricks — such as tubes.

Tubes can alter someone's voice by tampering with sound waves. The sound of a voice contains waves of many different frequencies. Each frequency is a different pitch. As sound waves travel through a tube, the tube vibrates. The way it vibrates makes some pitches louder and others softer. And the way this alters pitches will depend on the length and width of the tube.

So Fawaz's team came up with a math equation. It told them what tube dimensions would alter



You may have used a voice-ID system when talking to Siri or other AI assistants.

one person's voice to sound like another's, at least according to an AI model. The two starting voices couldn't be too wildly different, though. For example, a person with a male-sounding voice usually couldn't use a tube to impersonate someone with a female-sounding voice, and vice versa.

The team didn't try to hack anyone's account. Instead, they tested out their tube trickery on AI models trained to recognize celebrity voices. Fourteen volunteers tried this out using a set of three 3D-printed tubes.

"Each participant who tried our system could impersonate some of the celebrities in the dataset," says Shimaa Ahmed. She's a graduate student who works with Fawaz.

One person's tube voice mimicked singer Katy Perry. Another volunteer got to impersonate Bollywood star Akshay Kumar. The tube voices fooled the AI models "60 percent of the time on average," Ahmed says.

A DIFFERENT WAY OF LEARNING

People, however, weren't so easily duped.

The researchers presented a separate group of volunteers with tube-altered voices paired with the celebrity voices they were meant to mimic. The volunteers thought the two voices were the same person a mere 16 percent of the time.

The reason AI was easier to fool is that it doesn't learn to recognize voices the same way we do. To learn to recognize some voice, AI models must study training data — such as a set of celebrity voice recordings. And they can only learn what's in their training data. People don't often talk through tubes. So this feature is missing from training data.

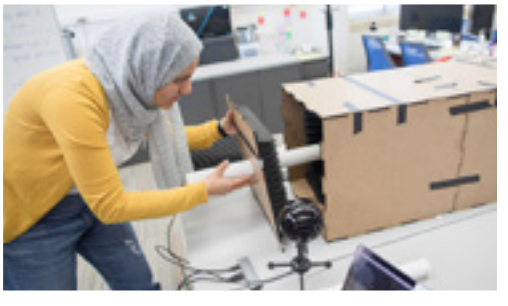
Now that this clever tube hack has been revealed, other engineers can get started testing the hack on the voice-ID systems that many people use with their banks and personal devices. Their goal is to learn ways to prevent such tube attacks, explains Wagner.

Meanwhile, Fawaz and his team are designing more elaborate devices involving multiple tubes or twisted shapes. These could make it possible to transform voices in more extreme ways. Could it be possible for anyone to mimic anyone else using one of these? Stay tubed, er, tuned.

— *Kathryn Hulick*

MYSTIQUE

Shimaa Ahmed wondered if a simple device could alter someone's voice. First, she tried putting her hands over her mouth. Then she grabbed a paper-towel tube. And surprise: "It actually worked to fool the [artificial-intelligence] model." A little more than a year later, her team had developed the version seen here, called Mystique.



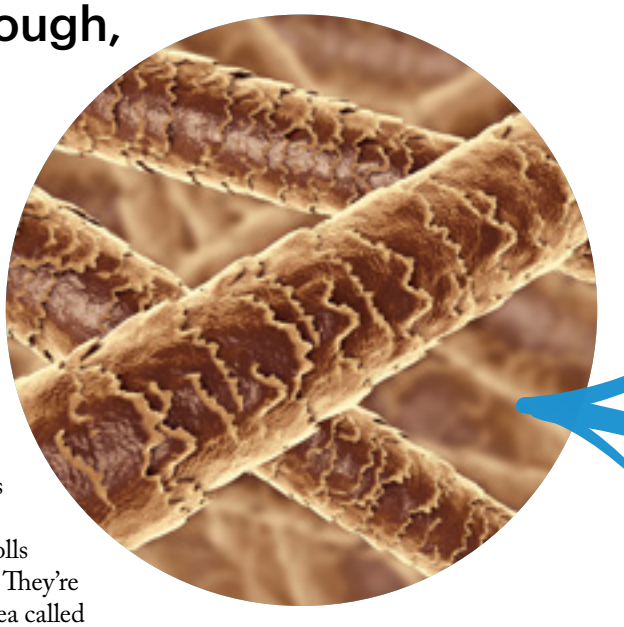
HIRAMAN/E+/GETTY IMAGES; TODD BROWN/UNIVERSITY OF WISCONSIN-MADISON

LISTEN ONLINE, AND JUDGE FOR YOURSELF!

Which of these pairs of voices are the same speaker? Which pair is two different people? A tube changes someone's voice, but the changes don't easily trick people.

Rapunzel's hair would make a great rope ladder

Growing it to that length, though, would be a challenge



If Rapunzel were trapped in a 10-meter (33-foot) tall building, it would take at least 66 years for her hair to grow long enough to reach the base.

KATERYNA KON; VOLKANAKMESE/SHUTTERSTOCK

In the classic fairy tale, Rapunzel is trapped high in a tower. A dashing prince comes to rescue her. "Rapunzel, Rapunzel, let down your hair," he calls. She unfurls her lengthy locks, draping them out the tower window. The prince then climbs up that magic hair to rescue his lady love.

If Rapunzel had such a handy ladder, one wonders why she didn't just rescue herself. But there may be a little truth behind a human hair-based escape. Hair is some super strong stuff. The challenge would be growing such a lengthy mane in the first place.

A single human hair can take a force of 200 megapascals. This is its tensile strength — how much load it can take before breaking. Pressure is measured in pascals. A pascal is the amount of mass something can take per square meter of material. One megapascal is 1,000,000 pascals. In the case of a human hair, 200 megapascals is 20,000,000 kilograms of force per square meter of human hair.

Those are some big numbers. They mean that a single strand of hair is about half as strong as a piece of steel the same size, notes Ray Goldstein. He studies biological physics — the physics of living materials — at the University of Cambridge in England. Among the things he's studied is the physics of ponytails.

Wen Yang is a materials scientist at the University of California, Irvine. She's performed studies on the strength of human hair. Hair's buffness comes from its structure, Yang explains.

"You might [use an] example of the Russian matryoshka doll," she says. "Inside the biggest doll (the hair), there are millions or more of the smaller dolls." Those smaller dolls are tiny protein chains. They're contained within an area called the cortex. The chains are layered together and covered with an outer coating called the cuticle. "The cuticle looks like a fish scale," Yang says. It holds the protein bundles of the cortex together.

BEYOND STRENGTH

Rapunzel's hair is not only strong but also very long. That length might make her mane overall a little weaker, Rhett Allain notes. He's a physicist at Southeastern Louisiana University in Hammond. Hair's protein chains, he says, "are little atoms connected by springs. If you pull too strongly, the spring breaks."

No chain is perfect. In fact, a longer chain is more likely to have a weak point that snaps under the load. Rapunzel gets around this problem by throwing down a big braid or ponytail of hair, instead of a single strand. The individual protein chains might be weak, but they're strong when bound together.

So strong, in fact, that Yang and Goldstein both estimate that some 500 to 1,000 hairs could support a full-grown human weighing about 80 kilograms (180 pounds). That's not much hair. "A typical human head has about 50,000 to 100,000 hairs," Goldstein notes.

The prince couldn't just yank on the hair, though. "Keep in mind the hair is attached to the head via biological structures," Goldstein says. Those structures are called follicles. And they aren't as strong as hair. A single hair can easily be yanked out. So while the hair could take the weight, the scalp might suffer. The solution is to loop the long hair around a pole or hook, creating a pulley that keeps Rapunzel's hair attached to her head.

Hair is both strong and flexible and clearly would make a climbable rope. Why don't we use it that way? In the past, Yang notes, people did use human hair for some things,

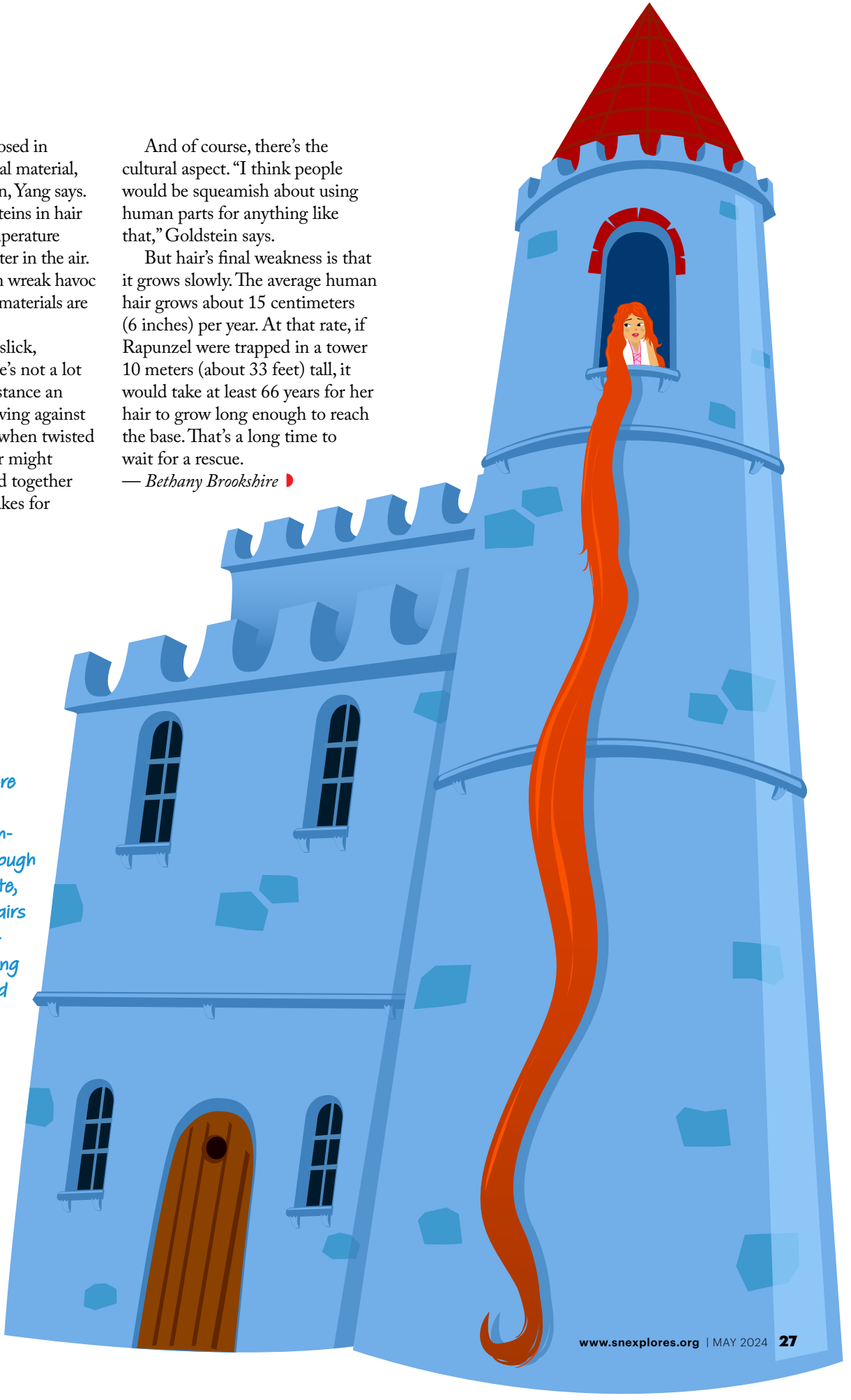
such as sewing skin closed in surgery. But as a natural material, hair easily breaks down, Yang says. Not only that, the proteins in hair can be affected by temperature and the amount of water in the air. Summer humidity can wreak havoc on a hairdo. Artificial materials are more consistent.

Hair also is pretty slick, Goldstein notes. There's not a lot of friction — the resistance an object encounters moving against another object. Even when twisted into rope, he says, hair might be too slippery to hold together well. Regular rope makes for an easier climb.

And of course, there's the cultural aspect. "I think people would be squeamish about using human parts for anything like that," Goldstein says.

But hair's final weakness is that it grows slowly. The average human hair grows about 15 centimeters (6 inches) per year. At that rate, if Rapunzel were trapped in a tower 10 meters (about 33 feet) tall, it would take at least 66 years for her hair to grow long enough to reach the base. That's a long time to wait for a rescue.

— *Bethany Brookshire*



Human hair (seen here under a microscope) is covered with a fish-scale-like cuticle. Though it might seem delicate, some 500 to 1,000 hairs could support a full-grown person weighing 80 kilograms (around 180 pounds).

VOLKANAKMESE/SHUTTERSTOCK

ANIMALS

What are cicadas?

Get ready for a brief, loud party

Those who live in many parts of the eastern United States experience an odd phenomenon every 13 or 17 years. Depending on where you live, insects called cicadas emerge from the ground in huge numbers. They're big and noisy, but don't worry. They don't hurt people or pets. They're just here to party.

It's one of the loudest insect parties you'll ever see — or hear. When large numbers of the adult insects convene, the collective noise made by males can approach 90 decibels or more. That's about the same as a gas-powered lawn mower.

Across some small areas, cicada concentrations may approach 1 trillion insects per square mile. That's like having nearly 4 million cicadas emerge from a patch of ground the size of your bedroom floor (but not all at once, of course).

There are more than 3,000 species of these insects. The best-known species in North America are periodical cicadas. These 5-centimeter- (2-inch-) long insects typically emerge from the ground once every 13 or 17 years. There are 15 different cicada broods, which emerge in a specific region of the country and are identified by a Roman numeral. In 2024, two groups will emerge: Brood XIX, a 13-year variety, and Brood XIII, the 17-year kind.

Periodical cicadas spend more than 99 percent of their life underground. There, they slurp nutrient-rich fluids from the roots of certain trees and shrubs. These underground young are known as nymphs. This immature stage resembles adults.

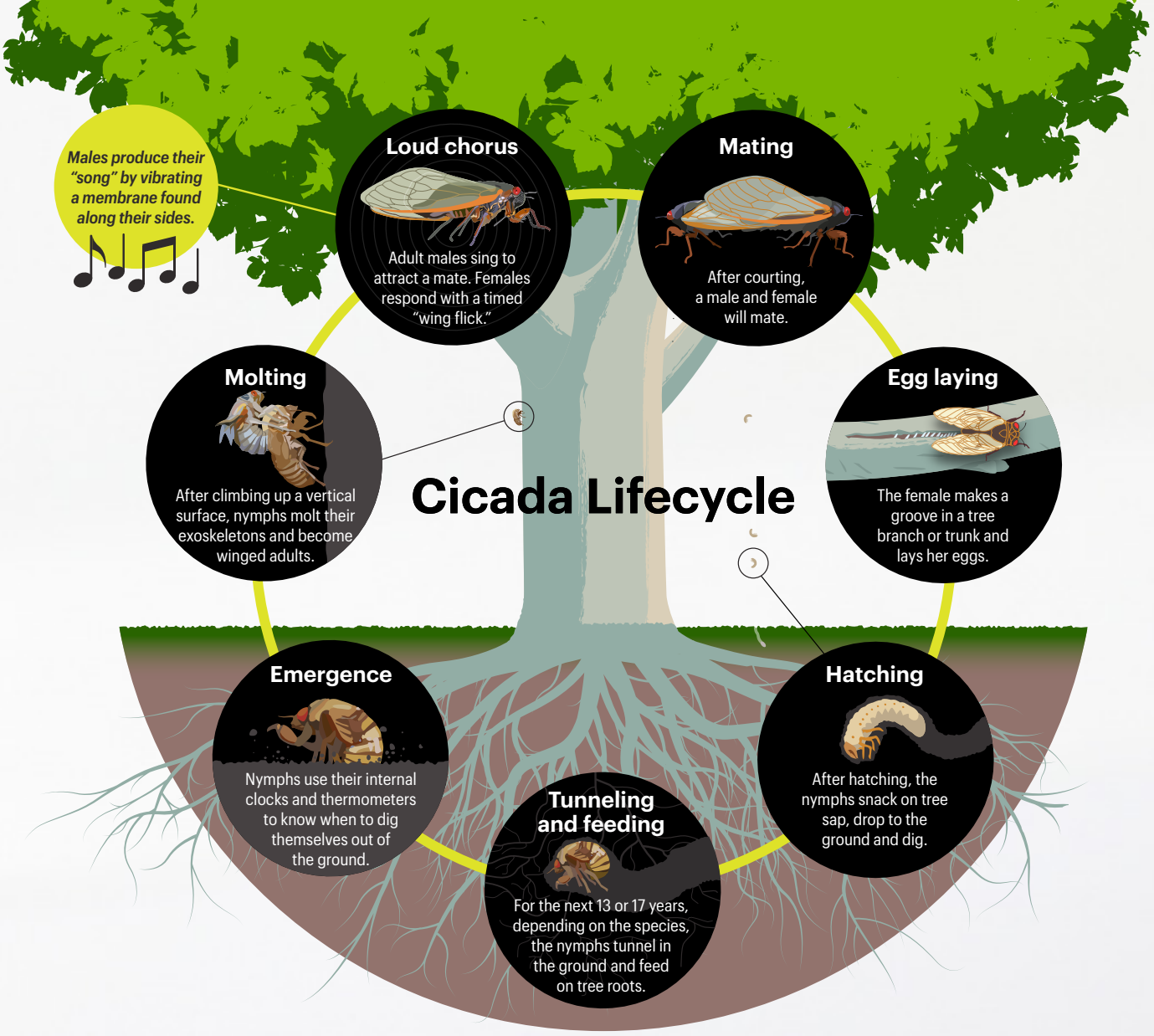
While latched onto roots, nymphs track the passage of time by noticing chemical changes in their meals. Early in the final springtime of their lives, the nymphs burrow escape tunnels to the surface. Then each insect will return to root level until the soil temperature reaches about 18° Celsius (roughly 64° Fahrenheit). At that point, the nymphs will surface again, climb out and promptly ascend the nearest tall object. There each molts one last time, becoming an adult.

Adult cicadas live for only four to six weeks. During that brief time, they mate and then the females lay eggs in the tender young branches of trees. Those eggs hatch after a few weeks. The young drop to the ground. At once, each tiny nymph begins burrowing down to find plant roots to feed on. And the cycle begins anew.

— *Sid Perkins*

Periodical cicadas spend some 99 percent of their lives underground. When they emerge in large numbers, the party can produce sounds as loud as 90 decibels or more. That's louder than a gas-powered leaf blower.

SUSAN LAW CAIN/SHUTTERSTOCK



Active periodical cicada broods of the United States (and year of emergence)

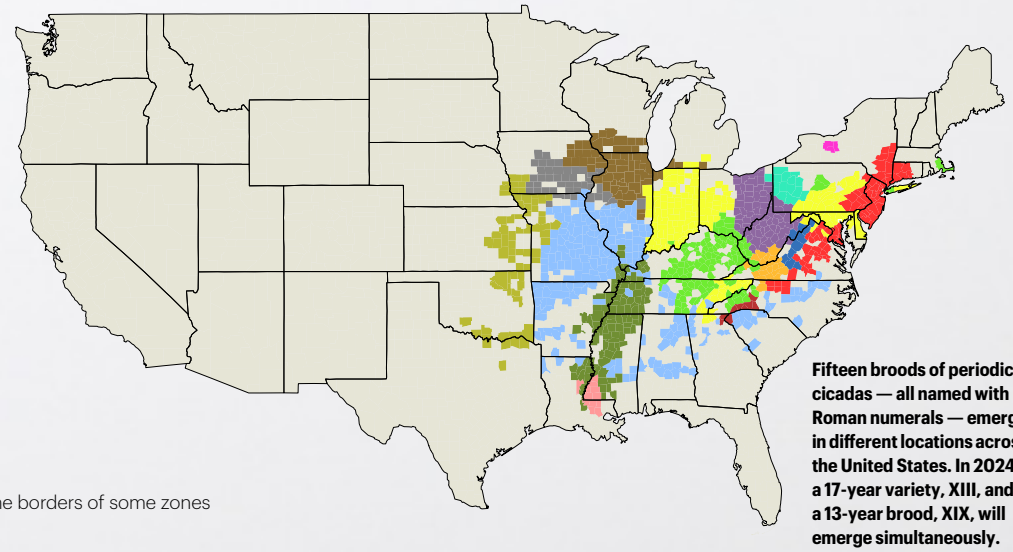
17-year cicadas

Brood I	2029
Brood II	2030
Brood III	2031
Brood IV	2032
Brood V	2033
Brood VI	2034
Brood VII	2035
Brood VIII	2036
Brood IX	2037
Brood X	2038
Brood XIII	2024
Brood XIV	2025

13-year cicadas

Brood XIX	2024
Brood XXII	2027
Brood XXIII	2028

Multiple broods may overlap at the borders of some zones



Fifteen broods of periodical cicadas — all named with Roman numerals — emerge in different locations across the United States. In 2024, a 17-year variety, XIII, and a 13-year brood, XIX, will emerge simultaneously.

ILLUSTRATION BY STEVE MCCRACKEN; MAP SOURCE: U.S. FOREST SERVICE

ANIMALS

Gliding may offer some mammals protection

Soaring above the ground could help them avoid predators

Mahogany gliders (one pictured) can glide an average 30 meters (nearly 100 feet). This ability may help them avoid predators on the ground.

Bats are the only mammals that fly. But other mammals, such as some squirrels and lemurs, can glide through the air. They do so on membranes that stretch between their limbs. Scientists have wondered why these mammals evolved to sail through the sky. New research hints that some glide to avoid predators on the ground.

Among a group of mammals called marsupials, gliding occurs in only one family. This family includes the endangered mahogany glider (*Petaurus gracilis*). To search for clues about the purpose of gliding, researchers compared the behavior of two captive mahogany gliders with that of four brushtail possums (*Trichosurus vulpecula*). These bushy-tailed animals are closely related to mahogany gliders. But they don't glide.

For their research, the scientists caught wild brushtail possums. "If you ever want to trap brushtail possums, use peanut butter sandwiches," says team member Jasmin Annett. "They love them." Annett is an ecologist at the University of the Sunshine Coast in Sippy Downs, Australia. Her team outfitted the creatures with collars or cat harnesses bearing motion sensors. These sensors tracked changes in the animals' speed and direction.

The researchers then trained a computer algorithm to spot different behaviors — such as climbing, eating or sleeping — in recorded motion data.

On average, mahogany gliders used more energy moving around than brushtail possums did. And their activity levels peaked at different times. Mahogany gliders also spent more of their time hanging out in the higher sections of their enclosures.

That suggests that marsupials' gliding may have evolved to help the creatures steer clear of predators on the ground. The team shared its findings in the *Journal of Zoology*.

To better understand activities that set gliders apart, the researchers hope to compare them with other nongliding marsupials. One might be the ringtail possum, which spends more time in the trees than brushtail possums do.

— *Carolyn Wilke*

ACTIVE ANIMALS

Using sensors that tracked movement, researchers logged the activity of two marsupials (Figure 1): mahogany gliders (dark blue) and brushtail possums (light blue). The team also estimated the energy animals spent on movement. Bars show how much energy each species used, on average, each hour of the day. The scientists trained a machine learning algorithm to catalog how brushtail possums (Figure 2a) and mahogany gliders (Figure 2b) spend their time.

FIGURE 1

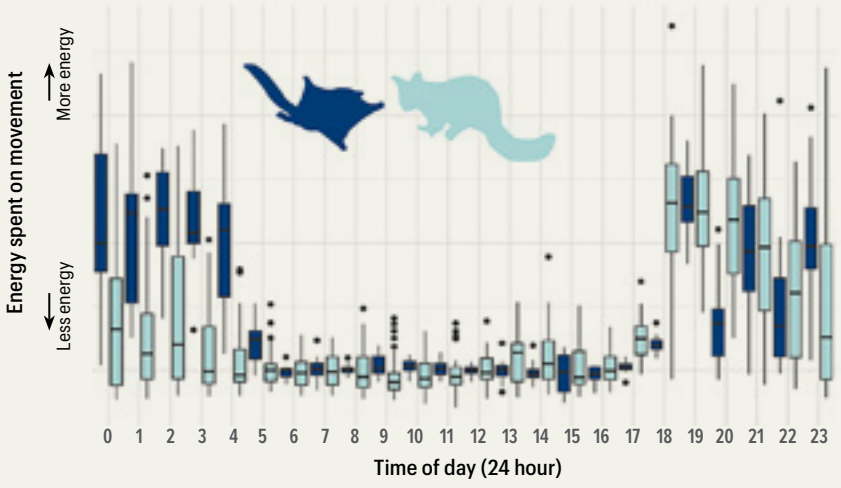
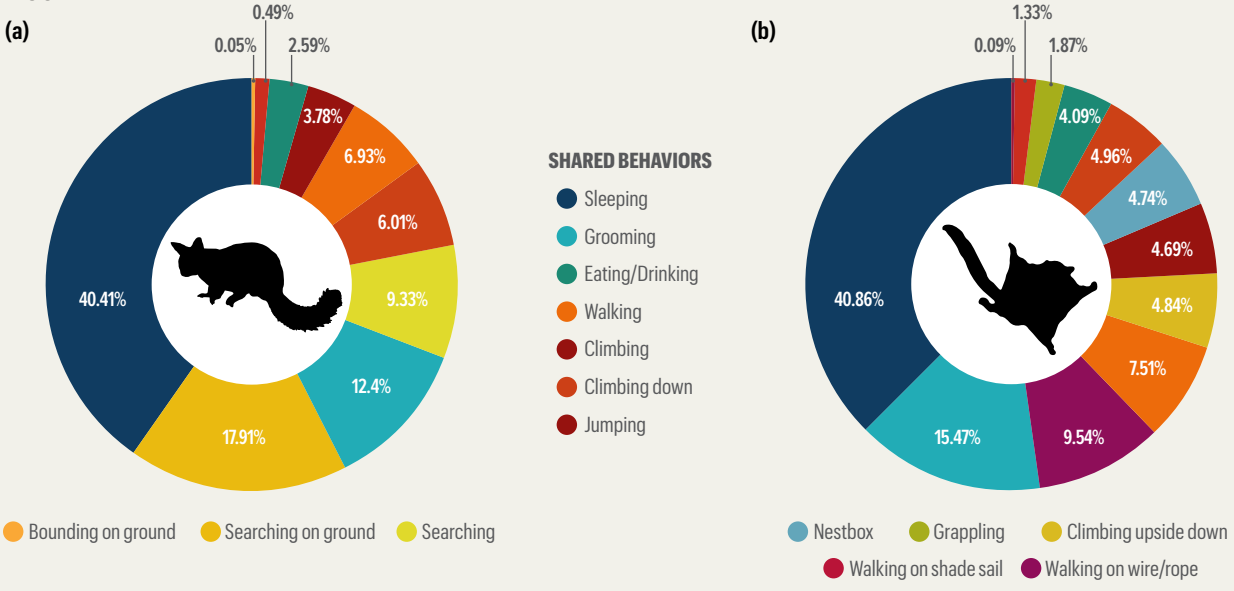


FIGURE 2



DATA DIVE

1. Look at Figure 1. What is the pattern of brushtail possums' activity across the 24-hour day? Are they diurnal (active during the daytime) or nocturnal (active at night)?

2. When were the mahogany gliders most active? How does their activity pattern compare with that of brushtail possums?

3. Look at Figure 2. What behaviors did brushtail possums spend the most time doing?

4. What behaviors did mahogany gliders spend the most time doing?

5. How much time did brushtail possums spend in activities on the ground? How much time did mahogany gliders spend in activities on the ground?

6. Another hypothesis for why gliding evolved is that it allows animals to quickly cover large distances. What are some ways the researchers could study this idea?

J.R. ANNETT *ET AL/JOURNAL OF ZOOLOGY* 2023

ANSWER

Sprinklers sucking up water spin backwards

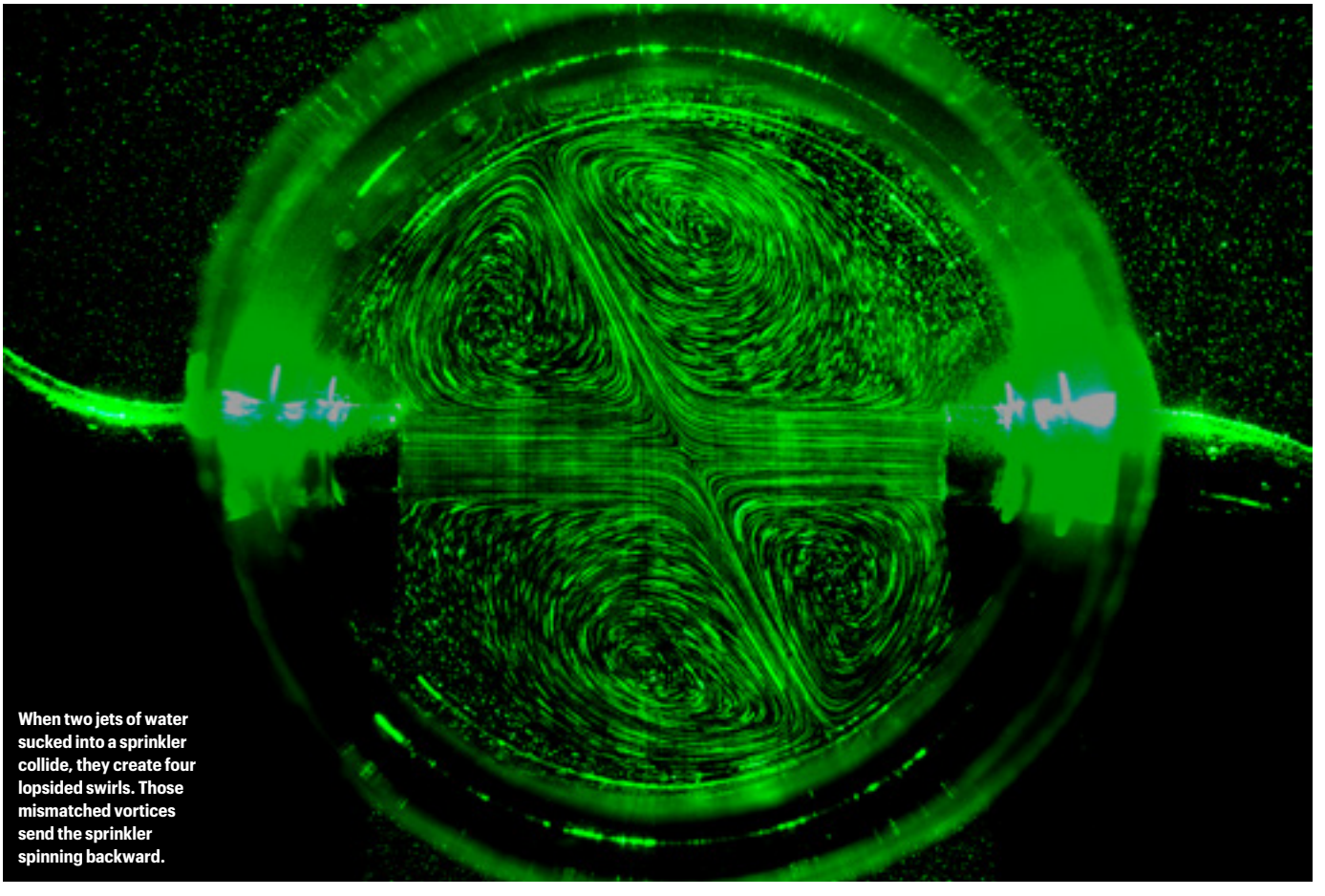
Mismatched jets inside the device power its reverse rotation

A seemingly simple problem has long fascinated physicists. The puzzle centers on a style of sprinkler that squirts water out the ends of an S-shaped tube. The sprinkler normally spins away from the escaping water. But what happens if you submerge the sprinkler and have it suck water in?

Experiments with a see-through sprinkler in a water tank now reveal that a sprinkler sucking up water rotates the opposite way as normal. Leif Ristroph and his colleagues shared the results in *Physical Review Letters*. Ristroph is an applied mathematician at New York University.

To see why the sprinkler spun backward, Ristroph's group added tiny particles to the water. Lasers lit up those particles, showing how they — and, in turn, the water — moved.

Sucked-up water formed two jets inside the sprinkler. Those jets weren't symmetrical. That's because the trip through the sprinkler's curved arms disrupted the flow of water in each jet. So when the jets met in the middle of the sprinkler, they didn't collide head-on. They glanced off each other. These off-kilter collisions formed four mismatched swirls of water inside the sprinkler, which set the sprinkler spinning backward. — *Emily Conover*



When two jets of water sucked into a sprinkler collide, they create four lopsided swirls. Those mismatched vortices send the sprinkler spinning backward.

APPLIED MATH LAB/NYU

INSIDE THE MINDS OF YOUNG SCIENTISTS

A pair of Thermo Fisher Scientific Junior Innovators Challenge finalists answer three questions about their science

Science competitions can be fun and rewarding. But what goes on in the minds of these young scientists? Venice Parnell and Claire Xu, a pair of finalists at the 2023 Thermo Fisher Scientific Junior Innovators Challenge, share their experience.

Venice Parnell

Claire Xu

Q What inspired your project?
A "We had already known that cows are killed for leather, so we wanted to look at alternatives for this," Venice says. Fake leather is made of polyurethane, a type of plastic. "[T]his is also not a very sustainable alternative," she adds. Meanwhile, they noticed lots of food is thrown out at lunch in their school cafeteria. That's when they learned 40 percent of all food in the United States is wasted. "So we wanted to combine these ideas and create a vegan leather," Venice says.

Q What was the biggest challenge in doing this project?
A "At the very beginning, we were trying to find materials for the different fibers of our project, and we looked around different stores," Claire says. "Then we realized that we could just use things that we already have at home, since these products are also cheaper. If we don't use it, it's going to go to waste, so we might as well just use those products."

Q What's next for your project?
A "In the future, we're … planning to collaborate with more organizations, whether it's to retrieve different wasted produce from or to donate our products to," Venice says.

Thermo Fisher Scientific Junior Innovators Challenge finalists

Venice Parnell and Claire Xu

Longtime friends Venice and Claire teamed up to make all-natural leather out of food scraps — an innovation that could help reduce food waste and the environmental impacts of leather production. The pair used pineapple, mango and other produce fibers to create leathers and then used those materials to craft wallets, the roof for a cat house and other products. Claire and Venice are both eighth-graders at the Harker School in San Jose, Calif.

EXPLORE
OUR SOCIAL MEDIA

What are three reasons lightning bugs glow?
Why are giraffe tongues blue?
Why do we knead bread?