ScienceNews Explores
May 2025

WHAT IS A DINOSAUR?
P28

TREES ON THE RUN

DINOSAURS ARE ALIVE

Here's how we know that modern-day birds are descended from ancient reptiles

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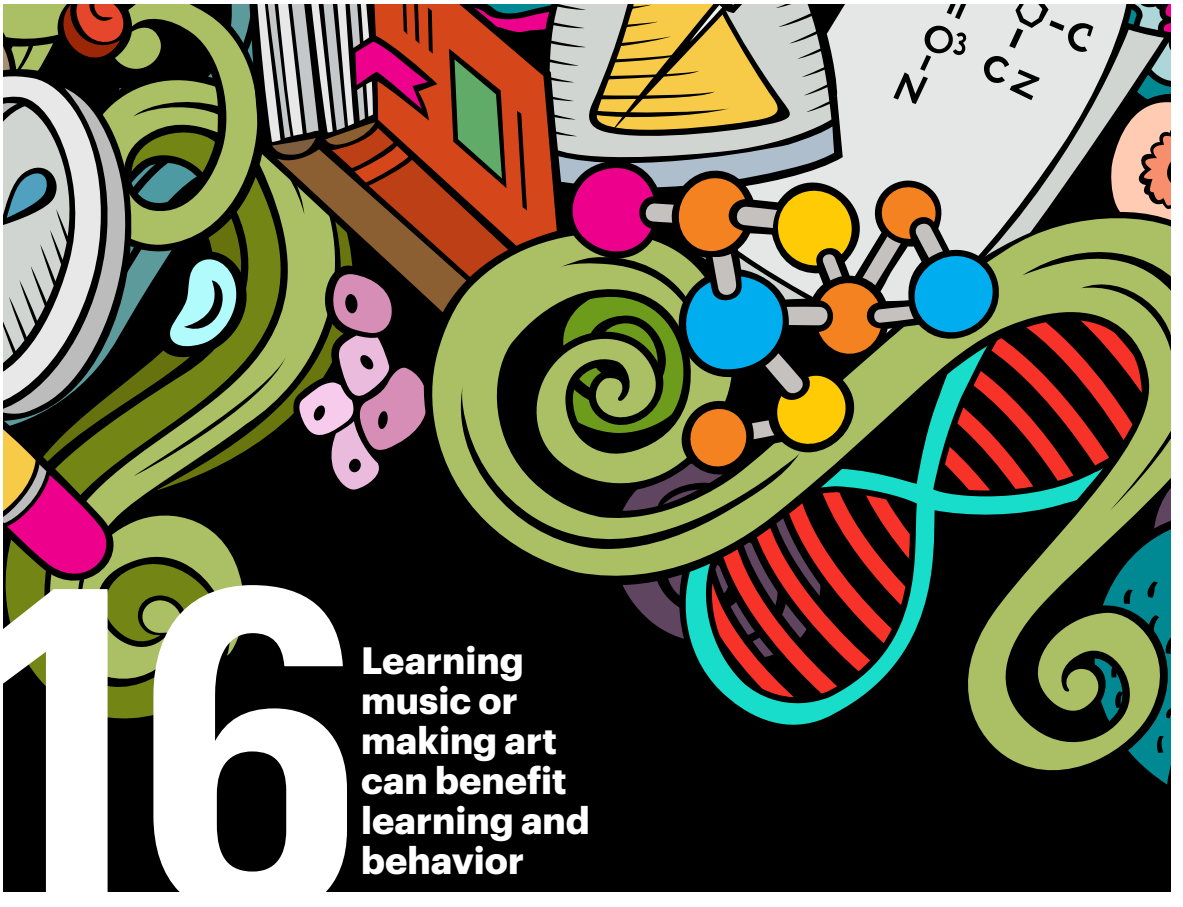

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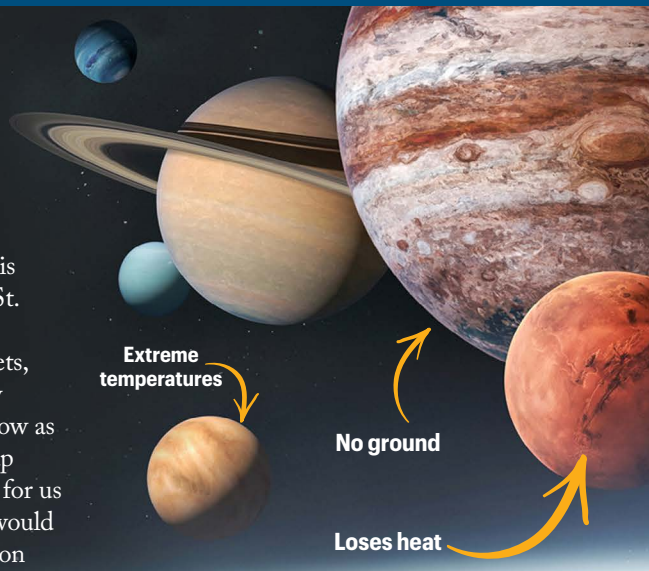
Q Which planet in our solar system is the most dangerous and why?

— David J.

A Picking the most dangerous planet in our solar system is impossible, says Paul Byrne. At Washington University in St. Louis, Mo., Byrne studies how planets form. "They're all dangerous." Mercury has no atmosphere. Other rocky planets, such as Mars and Venus, face extreme temperatures. Mars loses heat easily thanks to its thin atmosphere. Travelers there would experience temps as low as –153° Celsius (–243° Fahrenheit). Venus' greenhouse gases, in contrast, trap heat, raising temps to about 465° C (869° F). The gas giants have "no land for us to step on," Byrne notes. Instead, astronauts reaching Jupiter or Neptune would plunge toward the planet's core, facing deadly temperatures and pressures on their journey. "[They] would become some kind of spaghetti paste," Byrne says. The only exception is Earth. "Even then," he says, "there are plenty of places on Earth where humans shouldn't go."



Q How can archaeologists tell how old something is?

— Elise D.

A "Archaeologists have many different ways of finding out how old something is," says Alex Fitzpatrick. "It just depends on what sort of object or remains we're looking at." Fitzpatrick is a zooarchaeologist at the Science Museum in London, England. Features of humanmade artifacts, such as patterns on pottery or other art, can give experts a general idea of when something was created, Fitzpatrick says. But more exact dates can be found by looking at ratios of different isotopes, or forms, of various elements. For instance, carbon in plant or animal remains can reveal how long it's been since that lifeform died, she says. Potassium and argon provide clues to the ages of rocks and minerals. That can help archaeologists date the earth where objects or remains were found. And uranium and thorium can be used to date very old fossils and rocks. These data are most well-known for pinpointing the ages of cave paintings.

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Sarah Zielinski
Editor, *Science News Explores*

VADIM SADOVSKI/SHUTTERSTOCK

MATH

Two teens have proved an ancient math rule — again

The students came up with 10 new proofs of the Pythagorean theorem

Three years ago, a couple of high-school classmates each composed a mathematical marvel. It was a trigonometric proof of the Pythagorean theorem. Last year, at age 19, they did again — 10 times.

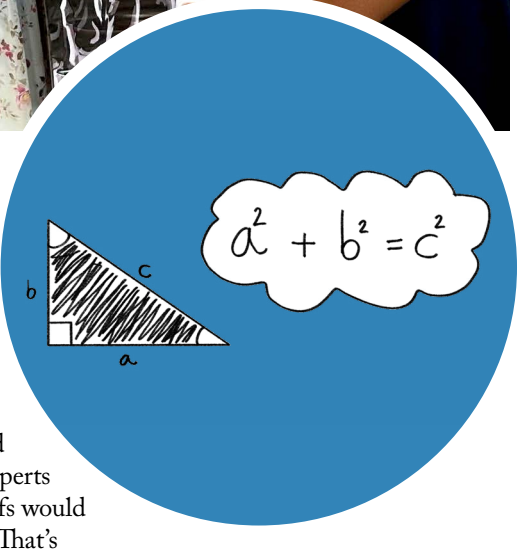
Such proofs were once considered impossible. That didn't deter Ne'Kiya Jackson and Calcea Johnson.

"Some people have the impression that … [you have to] spend years and years in academia before you can actually produce some new mathematics," says Álvaro Lozano-Robledo. A mathematician, he works at the University of Connecticut in Storrs. But Jackson and Johnson show that "you can make a splash even as a high-school student."

The Pythagorean theorem is used to measure right triangles. Those have a 90-degree angle in one corner. The length of each shorter side squared (meaning each multiplied by itself), when added together, equals the square of its hypotenuse (or longest side).

The rule is written as $a^2 + b^2 = c^2$. In this algebraic phrase, a and b are the right triangle's shorter two sides. The third, c, is the hypotenuse.

This formula has been proven many times using algebra and geometry. A century ago, it was thought that the Pythagorean theorem could not be proven using the rules of trigonometry.



Ne'Kiya Jackson (left) and Calcea Johnson (right) used trigonometry to prove the Pythagorean theorem. That equation is written as $a^2 + b^2 = c^2$ (inset). It's used to measure right triangles, which have a 90-degree angle in one corner. The longest side (c), or hypotenuse, is always opposite the right angle. The other two shorter sides (a and b) may be equal or different lengths.

Often just called "trig," this math deals with the angles and the lengths of triangles' sides.

Because many trig rules assume the Pythagorean theorem is true, trying to prove it would rely on rules based on the theorem itself. Experts assumed trig-based proofs would fail due to circular logic. That's

C. JOHNSON; WATTHANA TIRAHIMONCHAN/SHUTTERSTOCK

a type of false reasoning that only works by first assuming its conclusion is true.

The first trig-based proof of Pythagoras' theorem was announced in 2009 and the second in 2015. These were the only two until 2022, when Jackson and Johnson presented their first proofs. At the time, both were high school seniors at St. Mary's Academy in New Orleans.

The teens first formally presented their work at an American Mathematical Society meeting in March 2023. In October 2024, while starting college, they published their findings in *American Mathematical Monthly*.

"It was important to me to have our proofs published to solidify that our work is correct and respectable," Johnson says. Johnson is now studying environmental engineering at Louisiana State University in Baton Rouge. Jackson is studying pharmacy at Xavier University of Louisiana in New Orleans.

The pair developed four proofs for right triangles with sides of different lengths. They also created one for right triangles with two equal sides. Among these, one proof stands out to Lozano-Robledo.

In it, the students fill one larger triangle with an infinite sequence of smaller triangles. Then they use calculus (another type of math) to find the lengths of the larger triangle's sides. "It looks like nothing I've ever seen," Lozano-Robledo says.

Jackson hopes that the proofs will inspire other students to "see that obstacles are part of the process. Stick with it, and you might find yourself achieving more than you thought possible."

— *Nikk Ogasa*

PHYSICS

Eyelashes help fling water from eyes

The hairs' water-wicking abilities could help keep vision clear of rain, sweat and tears

Next time you're caught in the rain, thank your eyelashes for clearing your vision. Several traits help eyelashes fling water away from the eyes.

One secret to their water-wicking superpower is their structure. The outside of an eyelash, or cuticle, is covered in scales. These scales overlap like shingles on a roof. That structure acts like a "micro-ratchet," researchers in China now find. Water can flow easily from root to tip, but not the other way round.

In one experiment, scientists dipped loose eyelashes in water and pulled them out again. More force was required to move the eyelash when the water was working against the ratchet than when going with it.

In another test, researchers dripped water on loose eyelashes. This showed that eyelashes are hydrophobic. That is, water beads up on them and tends to roll off.

A team at the Chinese Academy of Sciences in Beijing did the research. It shared the findings in *Science Advances*.

Eyelashes also are shaped like a brachistochrone. This type of curve minimizes the time it takes to get from point A to B under the force of gravity.

To test how this might affect the ability of eyelashes to remove water, the scientists worked with nylon fibers. These had a size and stretchiness similar to eyelashes. They compared fibers in the shape of a brachistochrone to those that were straight or curved in some other shape. The droplets slid fastest off the brachistochrone.

Eyelashes were known to guard against dust. But they hadn't been known for their water-flicking traits. This newfound effect could help keep vision clear when out in the rain, bathing, sweating or crying.

Beauty treatments could mess with this ability, though. Mascara can make eyelashes attract water instead of repelling it. And curling lashes alters their shape.

— *Emily Conover*

Eyelashes are optimized to protect your eyes. Water beads up and rolls off smoothly because your eyelashes are hydrophobic. Scales on the lash direct water drops away from the eye. And the eyelash's curve — called a brachistochrone — flings those drops away faster than any other shape.

LEDYX/SHUTTERSTOCK

ANIMALS

A surprising number of animals eat poop

They eat feces for nutrition, digestion, sanitation and other reasons

Scientists have counted more than 150 animals that eat poop, including rabbits (left), parrotfish (top right) and Eurasian jays (bottom right).

The idea of eating poop — or coprophagy — might be gag-inducing. But for many animals, poo is perfectly normal to have on the menu.

Researchers counted up all the vertebrates (animals with backbones) that scientists have caught eating poop. And the tally totaled more than 150 poop-consuming species. The team shared these findings in *Animal Behaviour*.

"I had no idea how many baby animals ate their mom's poop to get microbes to help populate the gut," says Elaine J. Power. She's a retired evolutionary biologist in Eugene, Ore., who worked on the study.

Young animals that eat their mom's feces include koalas, desert tortoises and ostriches. Pikas, meanwhile, may make it through harsh winters by chowing down on yak poop. And cavefish, which can't leave their caves to forage for food, depend heavily on the poop of bats that can.

"Rats are fun, if you happen to have a particular sense of humor," Power says. They eat up to 40 percent of their own poop. "If you stop them from doing it, they get vitamin B12 deficiencies," she says. "They get sick."

For rabbits and other small plant-eating animals, eating food that's been through a gut once — aka poop — helps them get hard-to-extract nutrition. Poop-eating takes a special form in some of these critters, such as capybaras. A bit of intestine called the caecum catches some of the waste as softer, fine-grained masses that an animal, as Power puts it, then "can lick off its anus."

Eating poop can also show up as part of parenting. Take a type of bird called a swift. While tending frail new hatchlings, a parent swift will, on occasion, gulp down a saclike dropping. Is it cleaning up? Quenching a thirst? It's hard to tell for birds on a nest. But mama black bears do something similar when stuck alone in a den with a cub too young to go out foraging. Power suspects they eat poo for both sanitation and thirst reasons.

— *Susan Milius*

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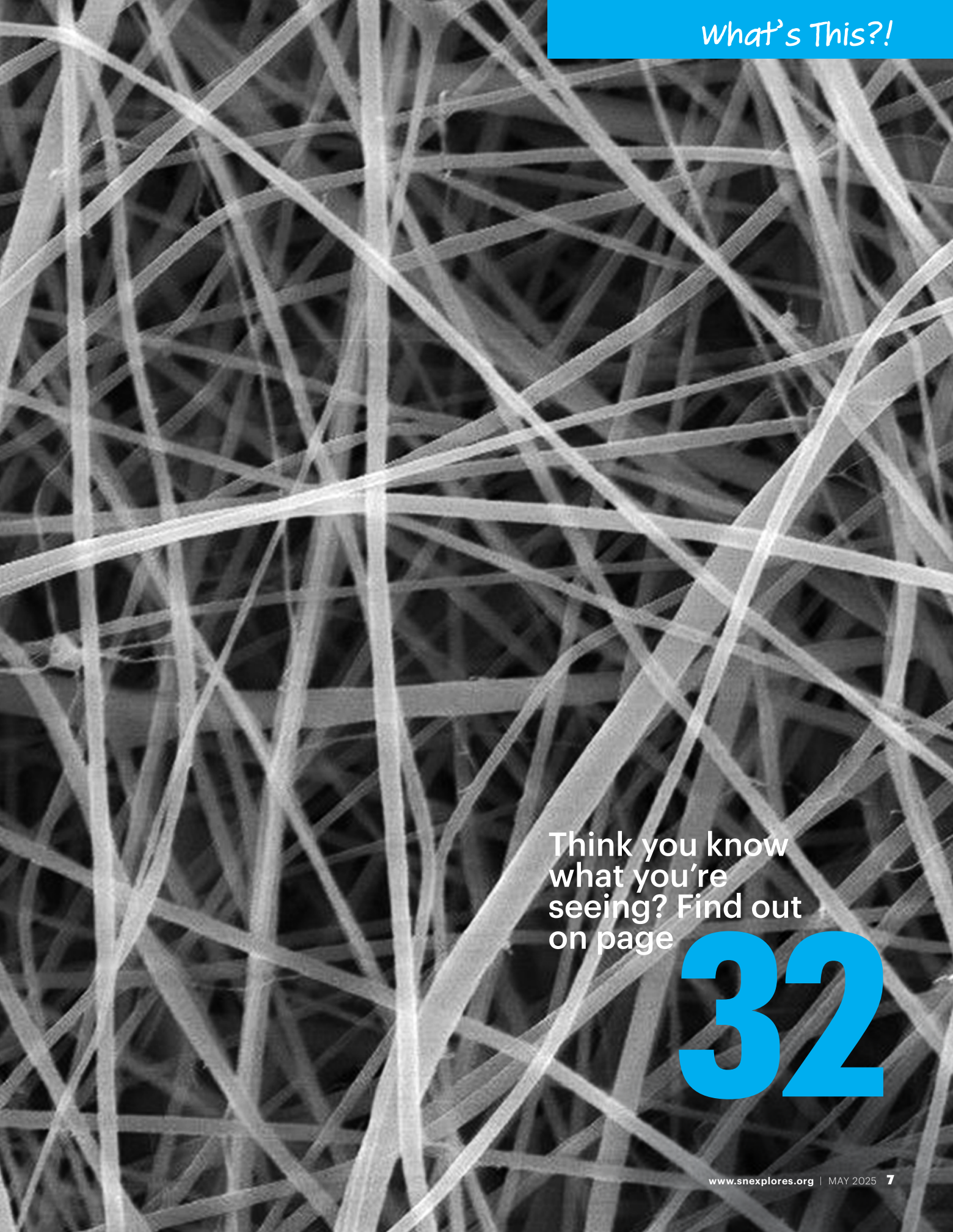
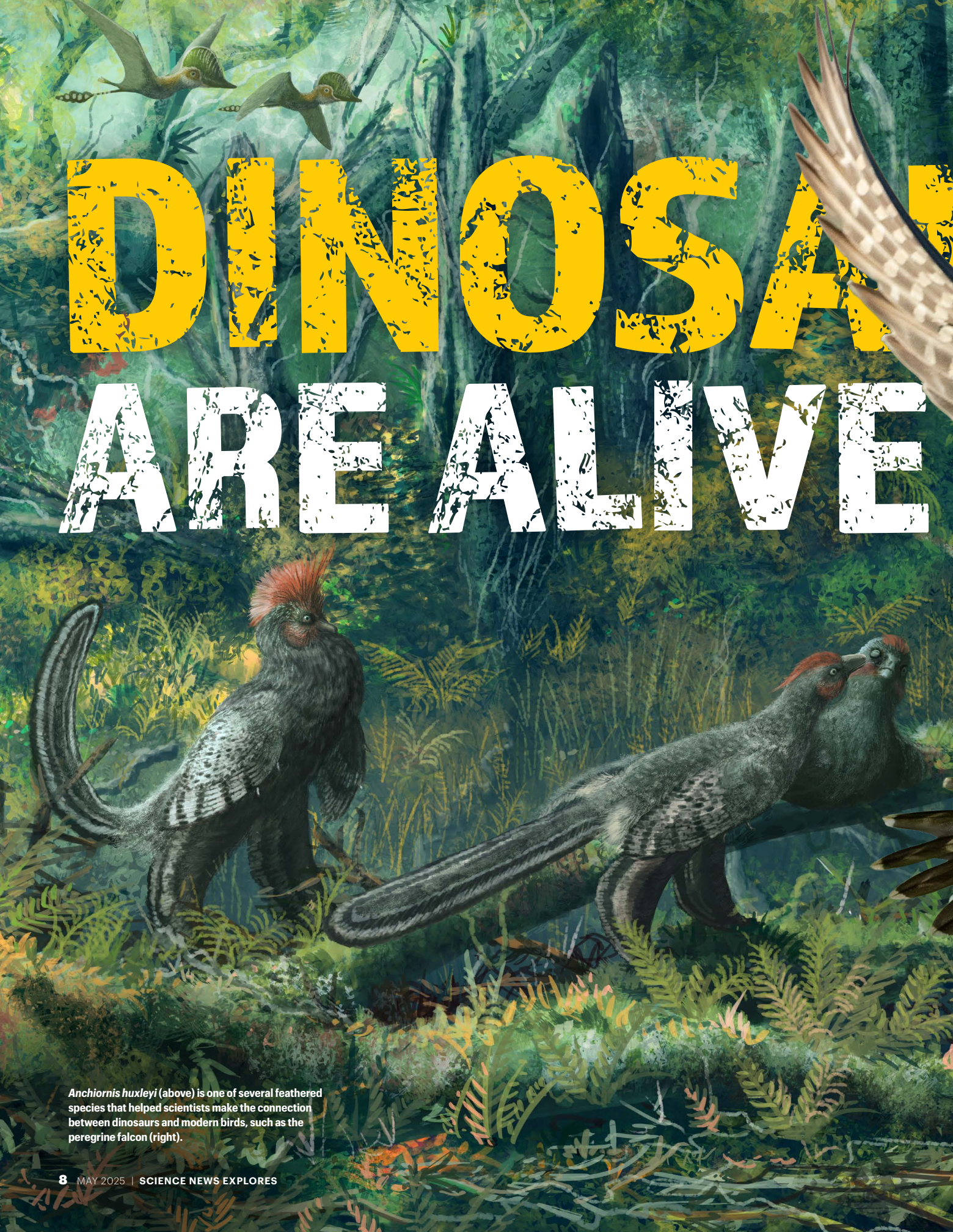


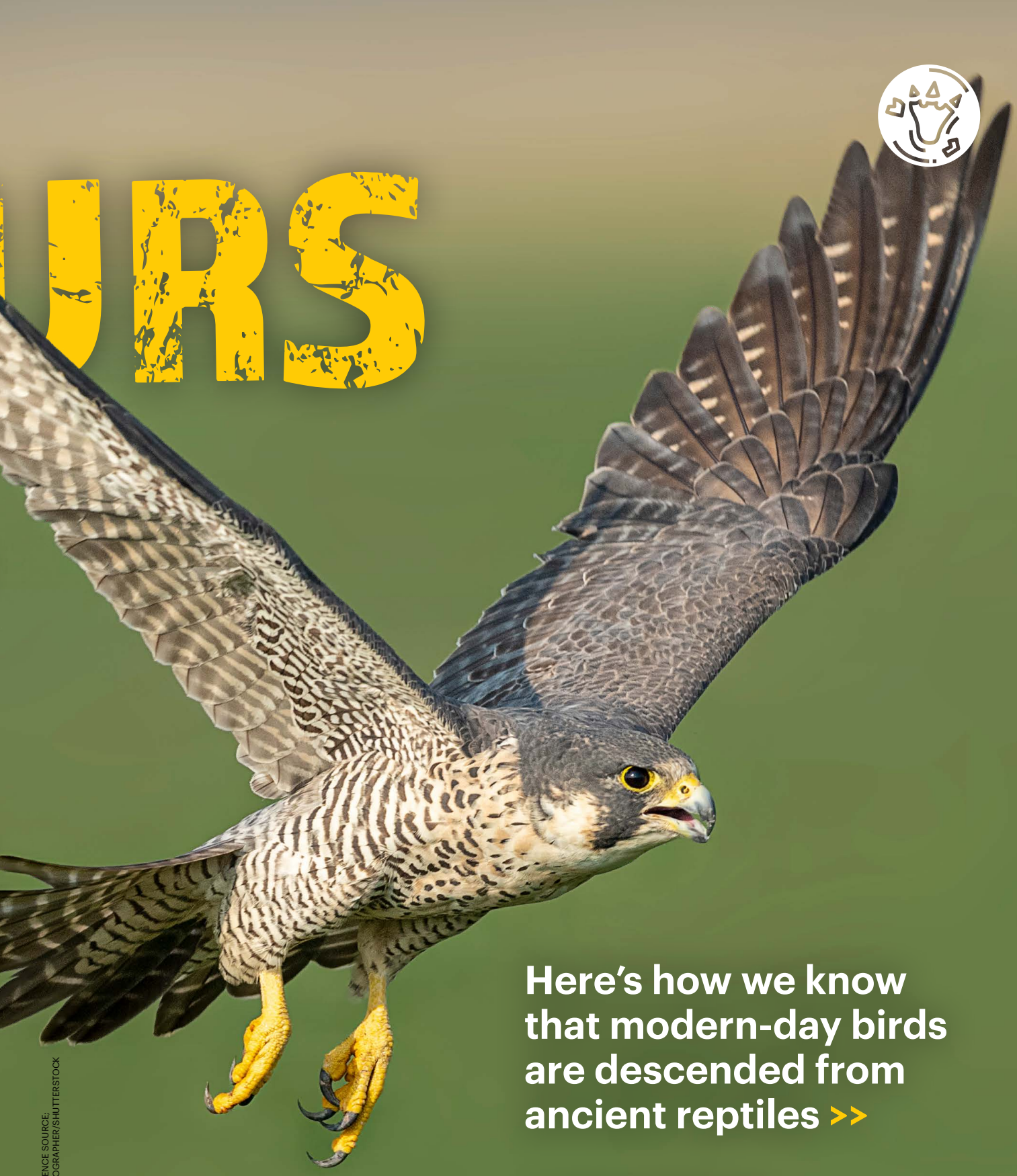
Think you know what you're seeing? Find out on page **32**

DINOSA
ARE ALIVE



Anchiornis huxleyi (above) is one of several feathered species that helped scientists make the connection between dinosaurs and modern birds, such as the peregrine falcon (right).

URS



Here's how we know that modern-day birds are descended from ancient reptiles >>

By **Aaron Tremper**

LEFT: MARK P. WITTON/SCIENCE SOURCE;
RIGHT: SRIRAM BIRD PHOTOGRAPHER/SHUTTERSTOCK

Across the river from Washington, D.C., sits Potomac Overlook Regional Park. Hiking paths wind through acres of forest and cultivated land. Peer into the thick woods and you may glimpse a chipmunk or deer. And at the visitor center, there are real-life dinosaurs.

One of these dinos is Twiggy. Sitting on her caretaker's arm, her massive brown eyes blink in the afternoon sunlight. Ribbons of brown and white streak her chest, mimicking sunlight hitting speckled tree bark. Her long black talons squeeze into the leather glove she perches on.

"When Twiggy is gripping my glove, I feel every bit of it," says Matt Felperin. At NOVA Parks in Arlington, Va., Felperin works as a naturalist.

Twiggy is a barred owl. These birds of prey can be found throughout much of eastern North America. Other dinosaurs at the park include Squeaker, the red-shouldered hawk who chirps as she snacks on mice. And there's pint-sized Smoke, an Eastern screech owl that weighs about as much as a baseball.

"When people think 'dinosaur,' [what] immediately pops up is, like, a *Stegosaurus*," says Jingmai O'Connor. "Or something that's just not closely related to birds at all." But for O'Connor and many other researchers, birds are dinosaurs, too. At the Field Museum of Natural History in Chicago, Ill., O'Connor studies how early birds evolved.

"Birds are feathered dinosaurs," says Hans Sues. He's a curator of vertebrate paleontology at the Smithsonian Museum of History in Washington, D.C. Birds are a subgroup of dinosaurs, which, in turn, are a kind of reptile. Evolutionarily speaking, this makes birds "feathered reptiles," he says.

Over the past 150 years or so, paleontologists have unearthed this connection through fossils. At first, the idea that birds are dinosaurs ruffled the feathers of the scientific community. But fossils have helped researchers piece together the true origins of birds. These are some of the discoveries that helped unveil what makes today's birds so unique.

The first bird

Some 150 million years ago, a creature washed into a shallow sea in what is now Germany. About the size of a crow, it sported black wing feathers. Its arms were tipped with claws, and rows of teeth filled its snout. The body churned in a cloud of silt before sinking to the riverbed. Soon, its body disappeared completely, buried under layers of fine sediment.

This scenario may have been how some fossils of *Archaeopteryx* formed. Its discovery in 1861 helped scientists first understand the connection between birds and dinosaurs, says Roger Benson. At the American Museum of Natural History in New York City, he studies how reptiles evolved. "*Archaeopteryx* contains a lot of information about what the ancestor [of modern birds] would have looked like."

The Berlin specimen (left) is one of 13 known skeletal fossils of *Archaeopteryx*. Discovered in the mid-1870s, the fossil includes impressions of feathers along the animal's wings and tail. The next dinosaur fossil with preserved feathers wouldn't be found until over a century later.

H. RAAB/WIKIMEDIA COMMONS (CC BY-SA 3.0); FOXY FOX/SHUTTERSTOCK; A. TREMPER

Visitors to Potomac Overlook Regional Park in Arlington, Va., can get close to several modern dinosaurs, such as Twiggy, a barred owl.

EMILY WILOUGHBY/STOCKTREK IMAGES/GETTY IMAGES PLUS; A. TREMPER; NOVA PARKS

The discovery of *Deinonychus* (top) in the 1960s showed that dinosaurs were intelligent, fast-moving animals. Fossils of creatures such as *Deinonychus* have been key in showing the link between dinosaurs and modern birds (inset, red-shouldered hawk, top, and Eastern screech owl, bottom).

These fossils showed an animal with flat, asymmetrical wing feathers similar to today's flying birds. In modern birds, such feathers improve lift and stability during flight. But unlike modern birds, *Archaeopteryx* sported teeth, clawed wings and a long, bony tail.

Researchers quickly noticed this mishmash of reptilian and birdlike features, says Benson. Some used *Archaeopteryx* to argue that dinosaurs were a stop on the evolutionary tree between reptiles and birds.

But there was one key clue in the *Archaeopteryx* fossil. Unlike other dinosaurs discovered at the time, *Archaeopteryx* had a wishbone. Reptiles don't have this bone. Modern birds do. Because of this, scientists saw *Archaeopteryx* as the first bird.

Researchers wouldn't find dinosaurs with wishbones until much later. So at the time, the debate over whether dinosaurs were related to birds fizzled out. "For the next 60 years or so, [scientists thought] birds and dinosaurs had no connection at all," says Sues.

Not your typical dinosaur

A 3-meter-long (10-foot-long) dinosaur stalked across a wide, flat grassy plain 115 million years ago in what is now Montana. A small, mouselike mammal scurried from a nearby bush. The dinosaur pursued, catching up in a few strides. It pinned its prey with a long sickle claw before tearing it apart with its teeth.

Meet *Deinonychus*. This dinosaur wasn't a bird. Instead, it belonged to a group of closely related dinosaurs called dromaeosaurs. When paleontologist John Ostrom discovered it in the 1960s, it helped reignite the debate over whether birds and dinos were related.

To Ostrom, *Deinonychus* very much resembled *Archaeopteryx*. He kept finding "more and more unique similarities between this group of meat-eating dinosaurs and early birds," says Hues. This included wrist bones similar to those in both *Archaeopteryx* and modern birds. That would have given *Deinonychus* very flexible wrists, an adaptation researchers see as a necessary step toward evolving flight.

There were also similarities in the shapes of the hands, pelvises and feet.

Deinonychus and other dromaeosaurs belong to a group of two-legged, mostly meat-eating dinos called theropods. (This group also includes *Tyrannosaurus rex*.) Ostrom used his observations of *Deinonychus* as evidence that modern birds descended from theropods. And today, researchers agree that birds arose from small theropods about 160 million years ago.

Ostrom's work ushered in renewed interest in how dinosaurs moved and behaved. During this "Dinosaur Renaissance," researchers moved away from the idea of dinosaurs as sluggish, cold-blooded animals. Some dinosaurs, it appeared, were intelligent and warm-blooded — like today's birds.

Still, most paleontologists remained doubtful that modern birds descended from dinosaurs. It would take another 20 years to find evidence that convinced skeptics.

Ruffling feathers

A chicken-sized dinosaur perched on a branch in a forest some 125 million years ago, in what is now northeastern China. It yawned, bristling long, iridescent black feathers on its arms and legs, giving the appearance of four wings. A tree crashed in the distance, making the dino leap. Splaying its arms and legs allowed it to glide to the forest floor before bolting into the underbrush.

Called *Microraptor,* this dinosaur was one of many feathered dinosaurs discovered in northeastern China starting in the 1990s. These creatures were crucial to understanding how dinosaurs evolved into birds. "They were really what pinned it down," says Sues. "These exceptionally preserved fossils that have full plumage."

The first such fossil, *Sinosauropteryx*, only had hairlike fuzz. Found in 1996, this small meat-eater was the first feathered dinosaur found that wasn't closely related to birds. It offered proof that birds inherited feathers from dinosaur ancestors.

These early feathers emerged millions of years before those used for flight, says Daniel Ksepka. They may have helped early dinosaurs feel their environment. Ksepka studies bird evolution at the Bruce Museum in Greenwich, Conn. Over time, feathers changed in ways that helped dinosaurs — and eventually birds — keep warm, attract mates and fly.

"When *Microraptor* was first discovered, it was very unique," says Ksepka. That's because this dinosaur had wing feathers growing from its legs. "Some people call them 'trousers,'" Ksepka says. Researchers suspected these four wings worked together to help the dino fly like a biplane.

Researchers soon started finding these "trousers" in early birds, dromeosaurs and other closely related dinosaurs. Among these were *Anchiornis* and *Xiaotingia*, which lived about 10 million years before *Archaeopteryx*. At one time, researchers suspected these two were among the first birds. It's more likely, though, they are just close cousins to the ancestor of true birds. But the earliest birds would've probably looked very similar.

"Think of the ones in *Jurassic Park,* shrunk down to the size of a crow or pigeon," says Hues. "Then put feathers on them."

O'Connor and her team have been studying these feathers to see how flight might have evolved. They studied living bird species and found a consistent set of "rules" for birds that could fly: All birds capable of powered flight had nine to 11 primary feathers. These outermost feathers are attached to a bird's fused hand bones. These feathers are also uneven in shape. In modern birds, this helps generate lift.

Her team then examined fossils from 35 species of non-bird dinosaurs and early birds. The scientists found that while *Archaeopteryx* and *Microraptor*

Microraptor's long wing feathers on its legs — sometimes called "trousers" — also appeared in some early birds and other closely related dinosaurs.

The chicken-sized dinosaur *Microraptor* lived some 35 million years after the first birds appeared. Its discovery in the early 2000s helped confirm that birds evolved from small, feathered dinosaurs. Researchers are still studying how well this dino could take to the air.

SERGEY KRASOVSKIY/STOCKTREK IMAGES/GETTY IMAGES PLUS

seemed capable of flight, other birdlike dinosaurs did not. *Anchiornis* — once a contender for the first bird — had about 20 primaries and relatively symmetrical feathers. "It's a very high number. Clearly different from the nine to 11 that you see in flying birds." Her team published its findings in the *Proceedings of the National Academy of Sciences.*

Snoozing dinos

A flash rainstorm arrived in what is now the Gobi Desert, in Asia, about 70 million years ago. In a sandy burrow, a small dinosaur tucked its long legs under its body, resting its head on its knee. Its fuzzy tail curled around its body. Soon, the dinosaur was fast asleep. Rain steadily gathered above the burrow, causing the sands to shift. Suddenly, the sand loosened, burying the dinosaur as it slumbered.

This is probably how the theropod *Jaculinykus* died, says Kohta Kubo, who studies theropods at the University of Tokyo in Japan. *Jaculinykus* had long legs and stubby arms ending in a single claw. Kubo discovered the nearly complete skeleton of one from Mongolia in 2016. His team published the findings in *PLOS One*.

The fossil showed this meter-long (3-foot-long) dinosaur preserved in a position similar to the way modern birds sleep. Kubo's team suspects the pose helped smaller dinosaurs conserve heat. The first such slumbering dino was found in 2004. It belonged to *Mei long*, a dinosaur even more closely related to birds than *Jaculinykus*.

"Very rarely, we get dinosaurs that are preserved in their life positions," says Benson. Most fossils get jumbled over time. But some skeletons have revealed complex behaviors, such as brooding over eggs. These remains have shown that "when theropod dinosaurs do those behaviors, their postures are really birdlike," he says. These remains add evidence that birds inherited these behaviors from dinosaurs.

New threats

Back at Potomac Outlook Regional Park, Tiger the great horned owl rests on a perch in his enclosure. He looks typical for his species: Two earlike tufts of feathers sprout from his head. Fluffy, cream-colored feet poke out from the cover of his mottled brown and gray wings. But a laminated sign next to his exhibit points out something else: his missing eye.

Over 20 years ago, a car struck Tiger in Virginia, damaging an eye that was eventually removed. "He's a skittish and nervous bird because he can't see," Felperin says.

Raptors often hunt alongside roads, he notes. Food tossed out from vehicles attracts rodents, which attract birds. "A lot of people who are throwing out this food waste think it's harmless because it's biodegradable stuff," says Felperin. But it's not.

Human activities, like the car strike that hurt Tiger, threaten birds around the world. Researchers and citizen scientists are working hard to conserve important habitats that birds need to thrive. There is hope, though. After all, birds are some of the most resilient animals on Earth.

Many of the birds we recognize today emerged quickly after the extinction event 65 million years ago that killed off non-bird dinosaurs, says Ksepka. Most modern bird groups were around by about 50 million years ago. Some even sooner.

"Birds are one of evolution's great success stories," says O'Connor. More than 11,000 species exist today. While many fly, emus, ostriches, cassowaries and kiwis dart through forests and grasslands on strong legs. Penguins dive into dangerous oceans after prey.

"We are so used to thinking that dinosaurs are extinct and they're part of Earth's long-past history," says O'Connor. "But, actually, dinosaurs are the most successful group of land vertebrates on our planet today."

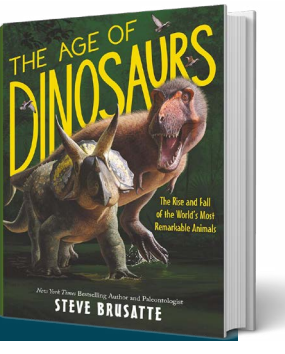
Over 20 years ago, a car struck Tiger. This left the great horned owl with a damaged right eye that was removed in 2023.

Owls and other birds of prey often hunt alongside roads. Tossed food from passing vehicles attracts rodents which, in turn, draws these predators. This increases their chances of getting hit.

READ MORE

The Age of Dinosaurs:
The Rise and Fall of the World's Most Remarkable Animals
By Steve Brusatte

Curious about how paleontologists extract information from fossils to learn things like how modern birds are really dinosaurs? This book delves into new ways scientists are studying prehistoric creatures.



NOVA PARKS; QUILL TREE BOOKS

This paleontologist solved a nearly 50-year-old dino mystery

ReBecca Hunt-Foster described what is now the state dinosaur of Arkansas

Paleontologists have unearthed many iconic dinosaurs, such as *Tyrannosaurus rex* and *Triceratops*, from the western United States. Relatively few species, however, have popped up east of the Great Plains. In 2017, ReBecca Hunt-Foster described one of these rarities from the 113-million-year-old remains of a right foot.

Describing a fossil requires making a detailed report on how an extinct animal lived. If it's the first fossil of that species, this is when it gets its official name. "At the time, [this dino] was the only dinosaur fossil known from Arkansas," says Hunt-Foster. Its name is *Arkansaurus fridayi*. It's now the official state dinosaur of Arkansas.

Arkansaurus belonged to a group of dinosaurs called ornithomimids. These agile dinos would have looked similar to today's ostriches, with long arms instead of wings. Many sported long necks and beaks used to forage for lizards, insects and eggs. Their legs were also long, allowing them to make speedy getaways from predators. Some researchers suspect *Arkansaurus* may have reached 4.6 meters (15 feet) long.

Today, Hunt-Foster is the lead paleontologist at Dinosaur National Monument in Jensen, Utah. In this interview, she shares her experiences and advice with *Science News Explores*. (This interview has been edited for content and readability.)
— *Aaron Tremper*

Q What inspired you to pursue your career?
A I've always really loved being around animals and in nature. When I was younger, I tried to find a way to combine those two interests into a possible career. My mom is a librarian and she used to bring books home for me to read. When I was about 12 years old, she brought home a copy of Jack Horner's book, *Digging Dinosaurs*. [Jack Horner is a well-known American paleontologist.] I read that one summer, and it just completely captivated me.

Q What about dinosaurs caught your interest?
A I've worked on everything from billion-year-old algae to more recent animal remains in cave deposits. But there's just something about dinosaurs that is really interesting to me. We don't have any modern representatives, other than all of our fabulous birds.

With dinosaurs, you also don't always find the whole animal. That means you only have bits and pieces to work with. Like that right foot of *Arkansaurus fridayi*. Or you may only have tracks.

A book by famous researcher Jack Horner sparked ReBecca Hunt-Foster's interest in dinosaurs when she was a child. Today, she works as the lead paleontologist at Dinosaur National Monument in Utah.

FOXY FOX/SHUTTERSTOCK

R. HUNT-FOSTER; BRIAN ENGH/LIVINGRELICPRODUCTIONS.COM

Hunt-Foster described the dinosaur *Arkansaurus fridayi* using the remains of a 113-million-year-old foot (inset left). A model of the foot (inset center) can be found at the University of Arkansas Museum in Fayetteville. This ostrich-like dino (inset right) used its long neck and beak to forage for small animals and eggs.

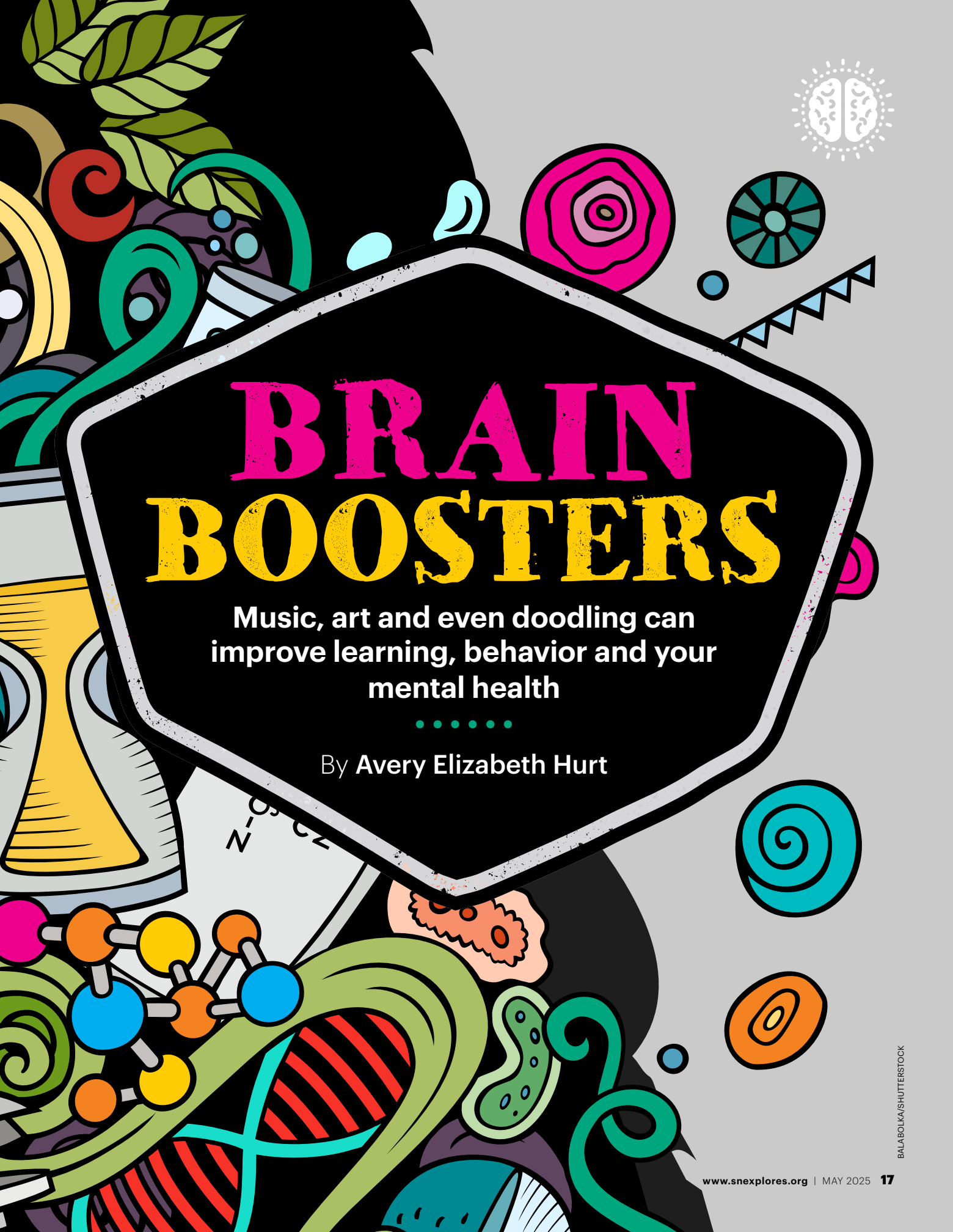
It's like trying to complete a puzzle with only half of the pieces in the box.

Q What was one challenge you faced, and how did you get through it?

A One challenge that I've had is dealing with learning disabilities. I have dyslexia and something called dyscalculia, which is a math-learning disability. I found ways to cope with it. Learning skills helped me to be successful in what I needed to do.

Q What career paths are available to those interested in paleontology?

A There are many different ways to be part of the field besides working as a professor or museum curator. For a long time, there was this view that those were the only two ways to be a paleontologist. I don't think that's the case today. You can work at a museum as a fossil preparer or paleo artist. Federal employees like me work at national parks or for other public lands. You can even volunteer at a museum or teach high school.

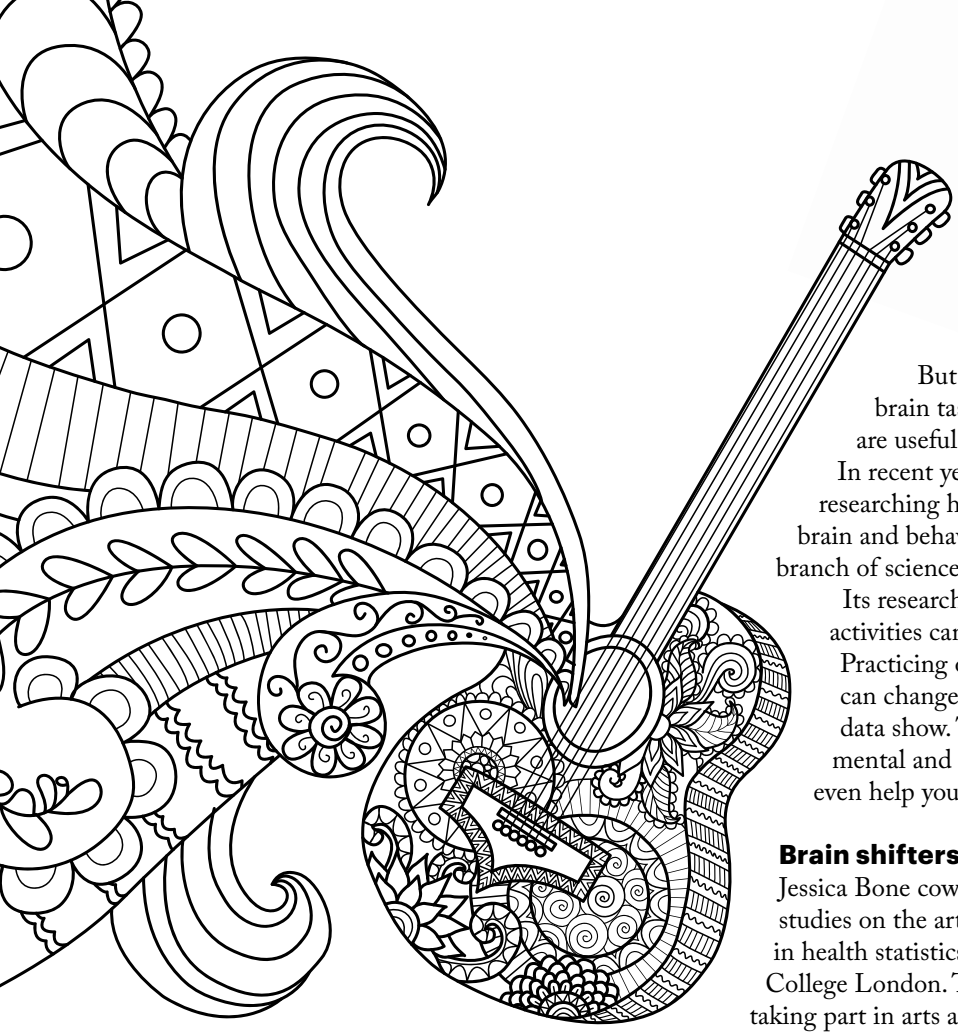


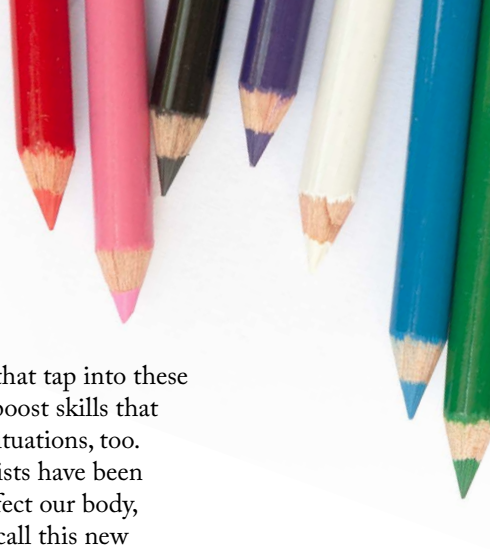
BRAIN BOOSTERS

Music, art and even doodling can improve learning, behavior and your mental health

By **Avery Elizabeth Hurt**

BALABOLKA/SHUTTERSTOCK





You probably know lots of things that are good for your brain. Reading and working puzzles, for instance. Getting enough exercise and sleep. Eating healthy foods. Now here's something else to add to the list: arts.

Arts engage many parts of your brain. Think about playing a musical instrument. That requires control of multiple parts of your body. You also listen to the sounds you make and learn the pattern of which notes come next. To draw, you might imagine a scene and plan how to bring it to life. Dancing requires balance and coordination. Even looking at a painting pushes you to think about what you're seeing and what it might show.

But activities that tap into these brain tasks could boost skills that are useful in other situations, too. In recent years, scientists have been researching how arts affect our body, brain and behavior. They call this new branch of science "neuroarts."

Its researchers are finding that creative activities can be very good for you. Practicing or just enjoying the arts can change your brain and behavior, data show. Those changes can improve mental and emotional health. They can even help you do better in school.

Brain shifters

Jessica Bone cowrote a report that reviewed studies on the arts and well-being. An expert in health statistics, Bone works at University College London. That's in England. Overall, taking part in arts activities can reduce signs of depression and boost motivation in kids and teens, she finds. She found research that linked engaging in art through clubs or other activities with fewer negative behaviors, such as skipping school and substance abuse.

In one study, children who at age 7 enjoyed creative activities — such as telling stories or doing crafts — were less likely than other kids to have behavioral problems at age 11. They engaged more with other people. They also were better able to pay attention to adults. Another study found that dance-movement therapy helped adolescents with mild depression.

But art may not just lift your mood. It may even lead to changes in your brain.

The brain's prefrontal cortex controls things like decision-making, planning and paying attention. It helps you control impulses, organize your time and think creatively about problems. Together, all of these tasks fall into a category known as executive function. Training in arts may affect how the brain handles these tasks.

Assal Habibi is a neuroscientist in Los Angeles. She studies the brain at the University of Southern California's Brain and Creativity Institute. Her work focuses on how music affects the brain. Kids

SOMJAIKING, SYBILLA/SHUTTERSTOCK

in music programs tend to manage executive-function tasks better than kids who aren't involved in music, her group has shown. They are better at taking turns, paying attention to others and listening before they speak.

In one study, Habibi and her team used magnetic resonance imaging, or MRI, to track brain changes and activity in kids 9 to 11 years old. Parts of the brain that process sound were thicker in musically trained kids. That may be a sign of greater function in these parts of their brains. And the effects may last for years, their data showed.

Brains of kids who'd spent two years learning to play a musical instrument showed another interesting change, Habibi's team noted. They showed more activity in regions that help rein in impulsive reactions. Such impulse control is part of executive function. Habibi thinks this may be an added benefit of musical training. For instance, when you play music with others, you have to pay attention to them. You have to wait for your turn. You have to resist the urge to jump in before it's time for your part.

Parents noticed a difference in student musicians, too, Habibi says. After their training, those students seemed less hyperactive and less aggressive. They also were better at interacting well with family and friends.

Making the brain more flexible

Music and other forms of art can trigger brain changes because of what scientists call plasticity. This is the ability of the brain to reorganize itself. Connections between neurons, or nerve cells, can form or break in response to music and other experiences.

"Learning music makes the systems of the brain that are responsible for executive-function skills more flexible," says Habibi. "This makes them more ready to be used — even when you're not playing music."

Habibi has studied how music influences the way we process language. In the lab, she measured the electrical activity in kids' brains as they listened to different types of sounds. Parts of the brain that engage with sound were more active in kids who'd had music lessons than in those who hadn't. No matter what sounds they heard, kids who'd had musical training processed these faster and more efficiently.

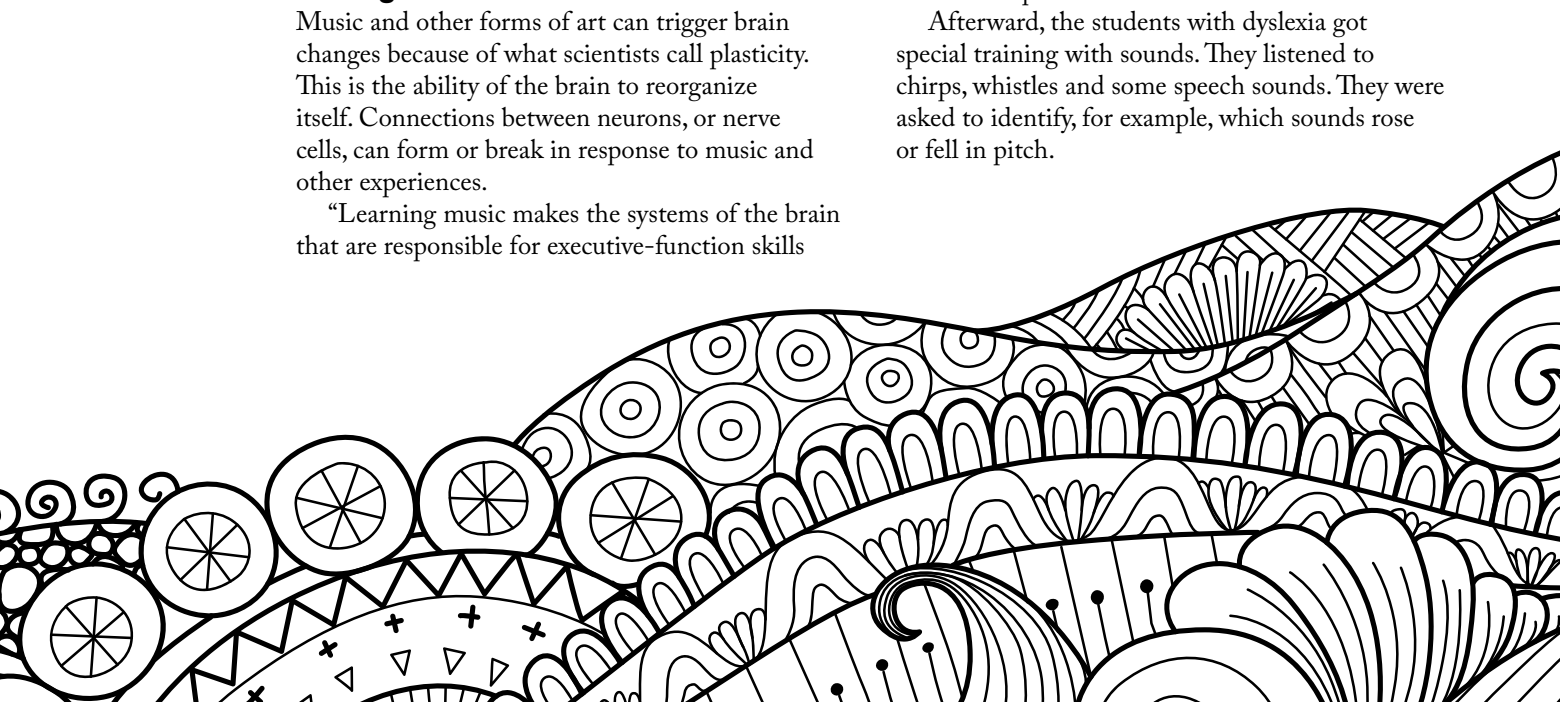
These kids will likely have an easier time learning other things based on sound, such as a second language, Habibi concludes.

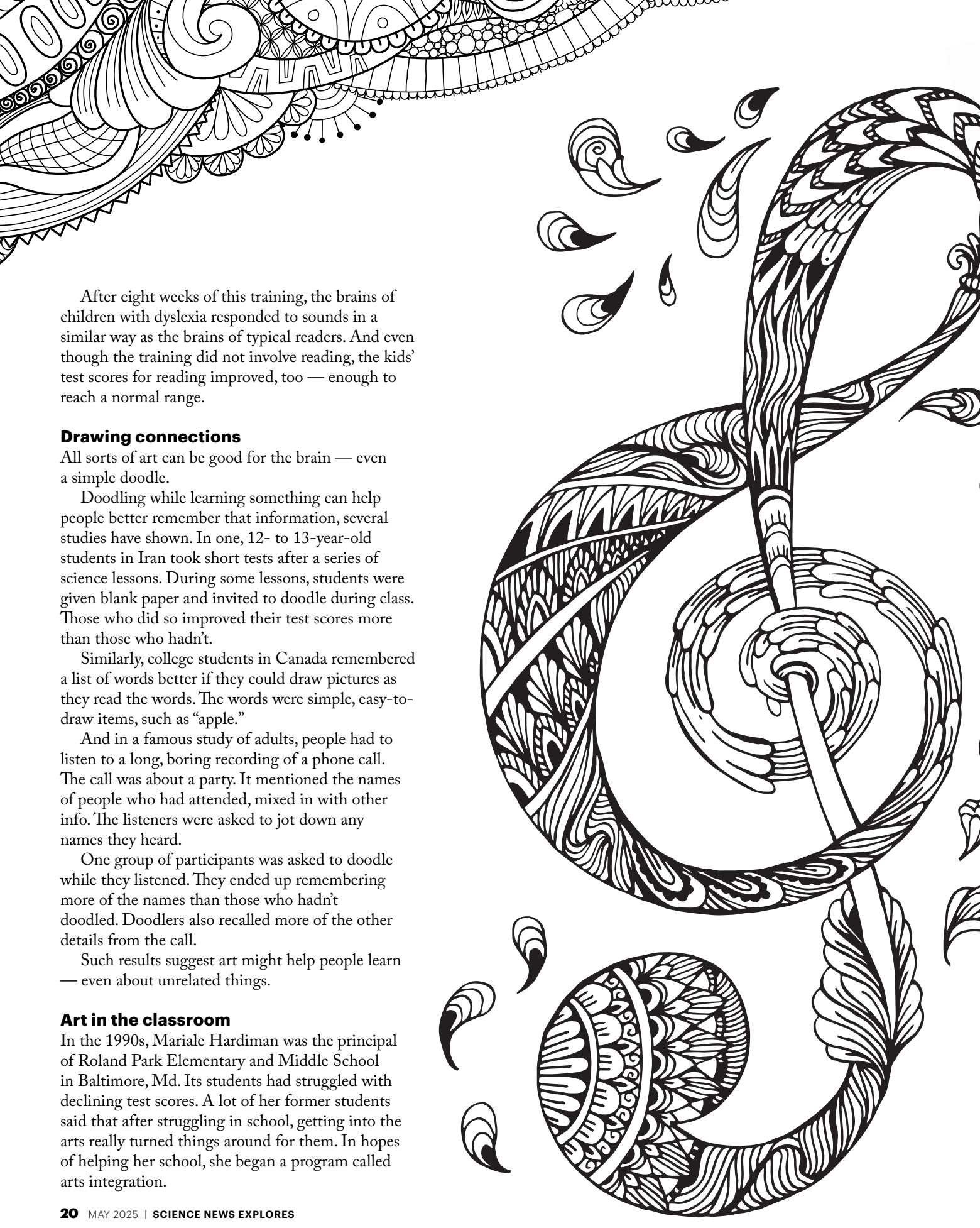
Such training might aid people with dyslexia, a reading disorder. Their brains have trouble working out how speech sounds match up with written words.

In fact, training with sounds can improve dyslexia in kids, Nadine Gaab has shown. At Harvard University in Cambridge, Mass., she studies how we learn language. In one study, 9- to 12-year-olds listened to sounds as they lay in a brain scanner. The sounds weren't words but used rhythms similar to speech.

In 22 kids with dyslexia, the same parts of the brain responded to all the sounds, regardless of how fast they changed. In typical readers, 11 brain regions tended to respond differently when listening to fast sounds compared to slow ones.

Afterward, the students with dyslexia got special training with sounds. They listened to chirps, whistles and some speech sounds. They were asked to identify, for example, which sounds rose or fell in pitch.





After eight weeks of this training, the brains of children with dyslexia responded to sounds in a similar way as the brains of typical readers. And even though the training did not involve reading, the kids' test scores for reading improved, too — enough to reach a normal range.

Drawing connections

All sorts of art can be good for the brain — even a simple doodle.

Doodling while learning something can help people better remember that information, several studies have shown. In one, 12- to 13-year-old students in Iran took short tests after a series of science lessons. During some lessons, students were given blank paper and invited to doodle during class. Those who did so improved their test scores more than those who hadn't.

Similarly, college students in Canada remembered a list of words better if they could draw pictures as they read the words. The words were simple, easy-to-draw items, such as "apple."

And in a famous study of adults, people had to listen to a long, boring recording of a phone call. The call was about a party. It mentioned the names of people who had attended, mixed in with other info. The listeners were asked to jot down any names they heard.

One group of participants was asked to doodle while they listened. They ended up remembering more of the names than those who hadn't doodled. Doodlers also recalled more of the other details from the call.

Such results suggest art might help people learn — even about unrelated things.

Art in the classroom

In the 1990s, Mariale Hardiman was the principal of Roland Park Elementary and Middle School in Baltimore, Md. Its students had struggled with declining test scores. A lot of her former students said that after struggling in school, getting into the arts really turned things around for them. In hopes of helping her school, she began a program called arts integration.

SOMJAIKING, HUZA STUDIO, MARAZE/SHUTTERSTOCK

This isn't about tackling art or craft projects that somehow relate to a lesson. Instead, it makes art a part of the teaching in a wide range of subjects. Students might put history facts they're trying to memorize to a rap beat. Or they might make up a song about math rules. Some might create a dance to show the shapes of galaxies or phases of the moon.

Students taught this way remembered more of what they learned. And the school's test scores improved.

Still in Baltimore, Hardiman now works at Johns Hopkins University. There she helped found the Neuro-Education Initiative. Through it, her team has been studying how brains learn. As part of that, they've been probing the science of arts integration in learning.

Art's strongest benefit showed up in students who had been struggling with reading in school. And the benefit they got carried over into classes that hadn't added in the arts.

In one study, a group of students integrated art into their lessons for the first half of the year. Then they learned without it for the rest of the year. Another group of students learned with arts integration only in the second half of the year. Both groups saw an advantage over students who hadn't had art included in any of their classes.

Of note, kids who used arts integration in the first part of the year also did better in the second half. This happened even though their teachers were no longer building arts into the lessons.

Hardiman suspects this was because those students continued to use those artsy tricks on their own. For instance, she found some students kept a sketchbook and drew pictures of what they were learning.

Although data on the benefits of art continue to build, arts programs often are among the first to be cut at schools short of money. According to the American Academy of Arts and Sciences, art education has been declining for 20 years. Habibi finds this shortsighted.

Schools should see arts as a critical part of learning, says Susan Magsamen. She directs the International Arts + Mind Lab at Johns Hopkins University School of Medicine. Such programs teach far more than just art, she says. Studying arts in school helps the brain develop. It guides social and emotional learning. "I don't think we should tie the arts to content areas or use them just for enrichment," she says. The arts should be subject areas all on their own.

No talent? No problem!

Do your portraits of people look like stick figures? Do your songs make your friends cringe? None of that matters when it comes to learning, Habibi says. You don't have to be trained or talented, she says, to make or enjoy art. Just include it in your everyday life.

That might be singing with others or drumming on your desk while you do homework, she says. Making jewelry, keeping a sketch pad or putting together skits with friends are all ways of making art.

"We need to think much more broadly about different types of creativity, especially for young people," says Bone. For instance, "They might be content creators for TikTok. That can involve so much creativity."

So visit museums. Go to concerts. Watch plays. All of these may help boost brainpower in beneficial ways. Let your inner artist shine.

FOOD SCIENCE

A pasta puzzle

How much water is really needed to cook noodles?

By Science Buddies

Pasta is an easy, tasty meal. But the water can seem to take forever to boil. What if you didn't need a big pot of water? What if you didn't have to boil the water before putting your pasta in? Let's see if we can save time and resources by cooking spaghetti faster, in less water.

OBJECTIVE

Find the lowest amount and temperature of water needed to cook pasta.

EXPERIMENTAL PROCEDURE

1. Place a pot on the stove, and fill it with the recommended amount of water (usually 4–6 quarts) for a 1-pound box of spaghetti.

2. Boil the water, then add the pasta. Cook it the recommended time for *al dente*.

3. Record the total prep time and how soft the pasta feels when you bite into it.

4. Empty the pot, place it back on the stove and fill it with 2 quarts of water.

5. Boil the water, then add 1 pound of spaghetti.

6. Every few minutes, try the spaghetti. Once it is as soft as the first *al dente* batch, record the total prep time.

7. Empty the pot, place it back on the stove and fill it with 2 quarts of water and 1 pound of spaghetti. Set the burner to medium.

8. Every few minutes, try the pasta. Once it is *al dente*, record the total prep time.

9. Repeat Steps 7–8 with 1 quart of water.

10. Repeat Steps 1–9 twice more for three trials total with each cooking method.

11. Calculate the average prep time for each method. Which method is fastest?

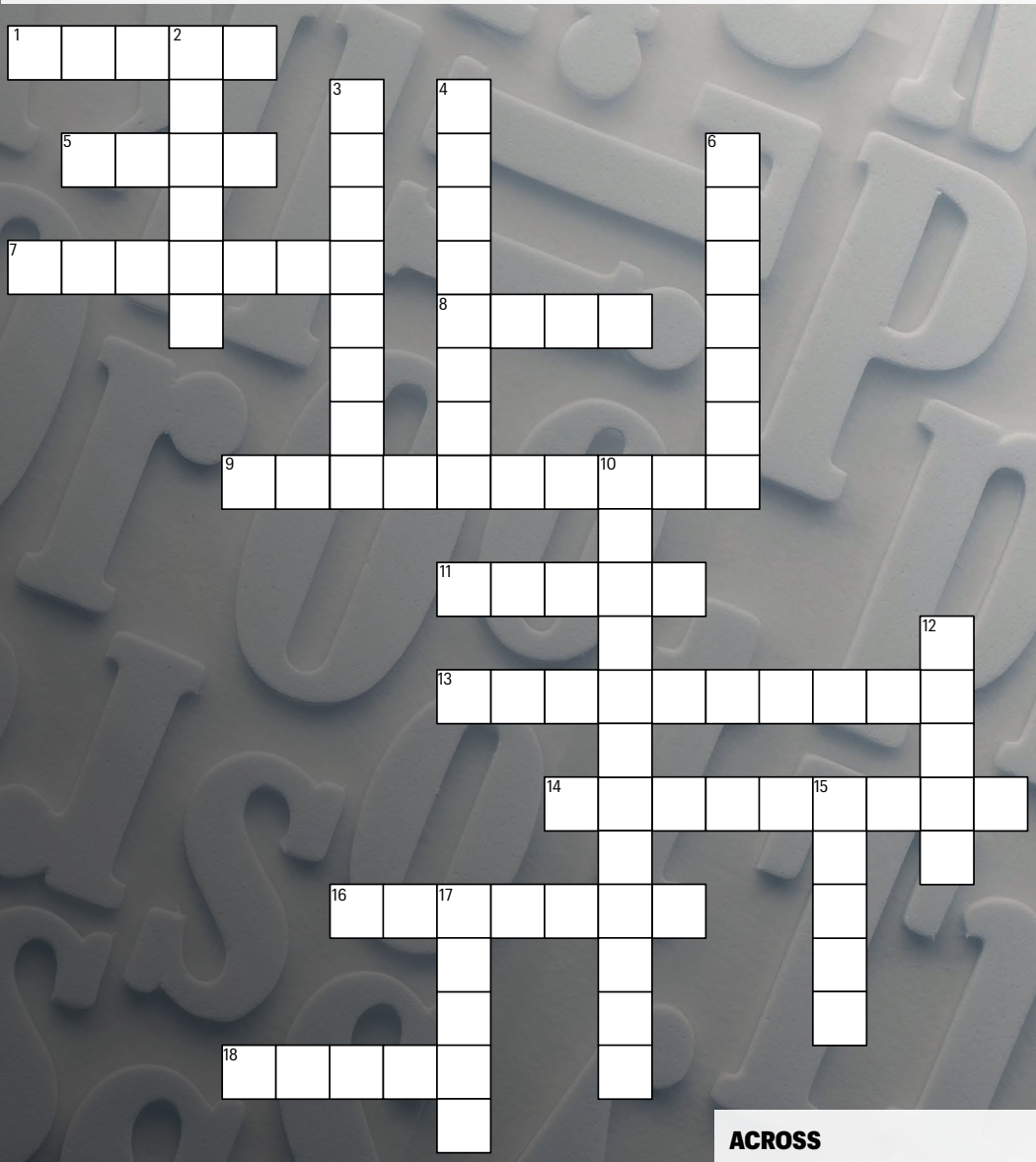
Find the full activity, including how to analyze your data, at snexplores.org/pastapuzzle. This activity is brought to you in partnership with Science Buddies.

SCIENCE BUDDIES

ANTONIO S/SHUTTERSTOCK

Crossword

If you're having trouble figuring out the answers to the clues below, make sure you read all the stories in this issue. Check your work by following the QR code at the bottom of the page.



DOWN

2. Do this to help your brain retain information

3. A bone found in modern birds and some dinosaurs

4. A famous group of reptiles

6. The "L" in ALS

10. A type of math often nicknamed "trig"

12. Another name for a thigh bone

15. A phoneme is a small bite of this

17. The thinnest version is thinner than a strand of hair

ACROSS

1. Avian dinosaurs that still exist today

5. Creatures that practice coprophagy eat this

7. This body feature helps keep water out of the eye

8. An acorn is one example

9. The ____ cortex is in your brain

11. The ionosphere can mess with these signals

13. It surrounds the Earth

14. An element that can reveal the age of a rock

16. If you tried landing on this planet, you'd plunge to its core

18. Trees might move their branches to chase this

BART SADOWSKI PL/SHUTTERSTOCK

BRAIN

A man silenced by paralysis got his 'voice' back, thanks to AI

Implants help turn his brain's electrical signals into words

Casey Harrell reacts to using a computer-linked implant to "speak" for the first time since he became paralyzed due to the nervous system disease amyotrophic lateral sclerosis.

UC DAVIS HEALTH

A few years ago, Casey Harrell was diagnosed with a devastating brain disease. Known as amyotrophic lateral sclerosis, or ALS, it left him paralyzed and unable to speak.

But in 2023, a doctor implanted tiny electrodes in the speech center of Harrell's brain. They pick up brainwaves that a computer can convert into words. Today, he can once again converse.

Using recordings of his voice from before his disease, scientists trained an artificial intelligence model. Harrell now "speaks" through an electronic voice synthesizer. And thanks to AI, the voice sounds similar to the natural voice he once had.

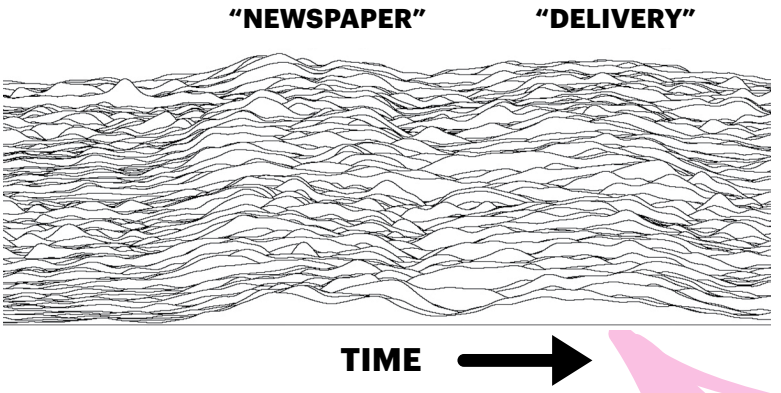
"One of the things that people with my disease suffer from is isolation and depression," Harrell said in a video, using the new technology. These individuals don't feel like they matter anymore, he said. But thanks to this tech, he and others like him might be able to actively participate in society again.

This new technology offers "by far the most accurate speech-decoding ever described," says David Brandman. He's the neurosurgeon with the University of California, Davis Health who implanted the devices in Harrell's brain. His team described how the tech works in the *New England Journal of Medicine*.

This technology isn't a mind reader, Brandman emphasizes. It can't listen to someone's secret thoughts. It only works when the user wants it to — when they are trying to speak.

"There are … thousands of people in the U.S. right now who want to talk but can't," says Brandman. "They are trapped in their own bodies."

One day, this technology might help many of them get their voices back.



Each line shows electrical signals emitted by neurons in Casey Harrell's brain. The brainwaves differ when he was thinking the words "newspaper" and "delivery."

TRANSLATING BRAIN SIGNALS INTO WORDS

Electrical signals from the brain travel along neurons to control your body's every move. They activate the muscles you need to wave your hand, run or smile.

But injury or disease can damage neural pathways. This can keep the electrical signals from reaching the muscles needed to move or speak.

Sergey Stavisky is a neuroscientist at UC Davis. Since 2021, he and Brandman have been working to restore speech through technology known as brain-computer interfaces, or BCIs.

BCIs use implants to tap into brain signals. A computer learns to interpret what the brain signals mean.

Their work is part of a long-running study known as BrainGate. Harrell decided to take part.

In July 2023, Brandman surgically placed four tiny devices into the part of Harrell's brain that controls speech. Each device has 64 metal prongs that help it detect electrical signals being relayed by neurons in his brain.

After Harrell recovered from surgery, the researchers turned on the BCI. It took the system a few minutes to learn how to decode Harrell's brain signals as he tried to speak. Then, it began turning those brain signals into words.

As we speak, our brain breaks down each word into small bites of sound. Each sound bite is known as a phoneme. For example, "moose" is made from three sound bites: the "m," the "oo" and the "ss."

Each phoneme produces a unique electrical signal in the brain. It's like a fingerprint. Math can tell the technology how to turn those signals into the actual words someone is trying to say. Then words appear on a computer screen and are "spoken" out loud by a computer's speaker.

On the second day of using the system, Harrell was able to speak with his young daughter. It was the first time she could remember hearing him speak.

Over 32 weeks, this tech correctly interpreted what Harrell wanted to say about 97 percent of the time. That means it got 49 out of every 50 words right, Brandman explains. And its accuracy is still improving.

Harrell can now have conversations using the technology. He can share his thoughts, needs and wants — and show his sense of humor. Today, he uses the tech up to 12 hours a day to talk with family, friends and coworkers. He still works as a climate activist.

Roya Salehzadeh did not work on the BrainGate technology. But she says work like this could help other researchers. At Lawrence Technological University in Southfield, Mich., she works on BCIs and human-robot interactions. BCIs could help someone drive their wheelchair using information from their brain, she says. Or BCIs could detect emotions or stress, including in people who can't communicate.

How long until these systems become widely available? Brandman thinks doctors may be able to prescribe a BCI like the one Harrell uses within the next five to 10 years.

— *Jennifer Junghans*

UC DAVIS HEALTH

This model of Casey Harrell's brain shows in orange where David Brandman surgically implanted microelectrode arrays to pick up brain signals that could be translated into words.

PLANTS

Trees on the move

Trees grow and forests migrate toward the most comfortable conditions

In the second *The Lord of the Rings* movie, treelike creatures called Ents slowly march to war. Once they arrive at Saruman's fortress, they unleash destruction. The Ents hurl giant boulders, climb over walls and even rip open a dam to wipe out their enemy.

For trees, the Ents are quite athletic.

Such active trees can be found throughout science fiction and fantasy — from the treelike alien Groot in *Guardians of the Galaxy* to *Harry Potter*'s Whomping Willow. It can be hard to find the similarities between such agile fictional trees and the seemingly still forests we see in real life. But science has shown us that trees and forests do move. They're just really, really slow.

SEARCHING FOR LIGHT

All trees move as their seeds grow into saplings, stretching up toward the sun. But when they sprout in a place where the sun is blocked by shade, trees have to work to find light.

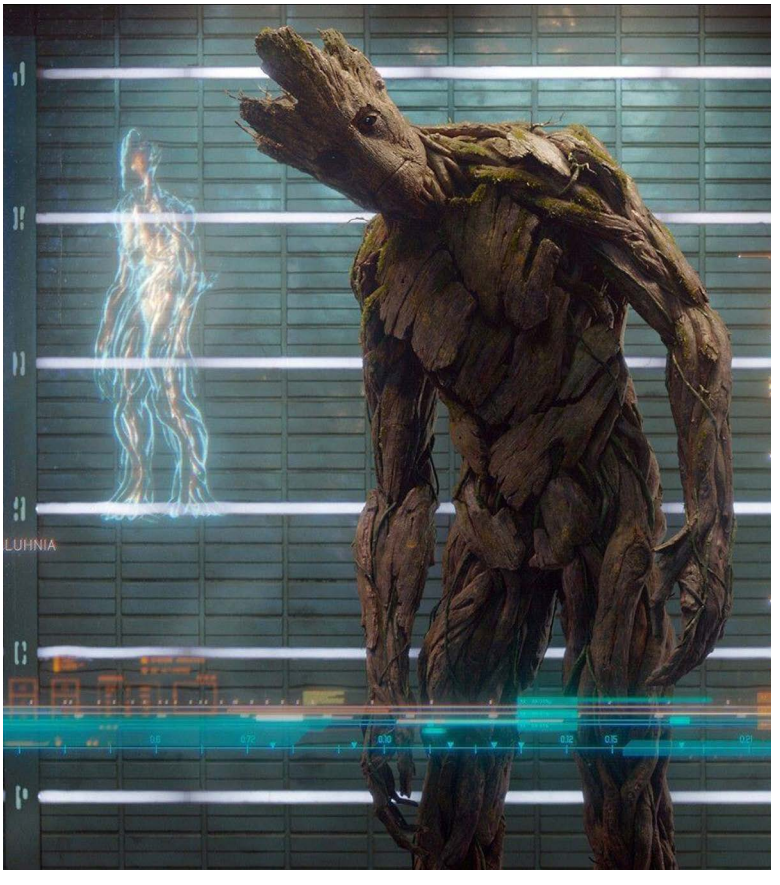
A tree "needs to find enough food. In this case, solar energy," says Gerardo Avalos. He's a plant physiologist at the University of Costa Rica, in the province of San José. By slowly stretching their branches in a sunny direction, trees can orient themselves to get the most "food" possible. This light-chasing phenomenon is called phototropism.

No one comes up and whispers to a tree about where to find sunshine. Instead, a tree's hormones send messages to encourage growth when the tree needs more light.

Tree roots move too. When they sense moisture in surrounding soil, trees push their roots toward the likely water source. While searching for water underground, roots have found wells, plumbing and pipes. "Sometimes they get into people's toilets," says Avalos.

Funky looking roots have also inspired folklore. Some scientists and tour guides tell of a walking tree in the tropical forests of South and Central America. This walking palm tree (*Socratea exorrhiza*) can supposedly travel up to 20 meters (about 70 feet) a year. The palm has roots that grow above ground and look similar to octopus tentacles. Some people have hypothesized that the tree uses these roots to search for light across the shady forest floor. Images of walking palms seemingly sliding down steep hills have inspired some of the folklore, explains Avalos.

"They say that the palm was walking," he says. "Crossing creeks, going up and down the slopes." But the notion of a tree



The treelike alien Groot, from the *Guardians of the Galaxy* movies, can run, fight and even dance. But real trees move much more slowly.

CINEMATIC/ALAMY STOCK PHOTO

The walking palm tree can supposedly travel up to 20 meters (some 70 feet) per year, but there's no scientific evidence to support this.

getting up and walking in real life is "pretty ridiculous," Avalos says. There's no concrete scientific evidence this happens.

FORESTS ON THE MOVE

While individual trees can't cross rivers and climb mountains, entire forests can. Forests migrate to compensate for long-term changes in their habitats.

"Trees have been migrating forever," says Leslie Brandt. She's an ecologist with the U.S. Forest Service in St. Paul, Minn. During the last ice age, when the Laurentide Ice Sheet covered most of Canada and the northern United States, many tree species took refuge in warmer, southern climates. They didn't walk or fly there. Instead, forests moved over the course of many generations, through spreading seeds and new tree growth.

"There are seeds, like acorns, that squirrels will pick up and move around," says Brandt. Maple tree seeds are encased in tiny "helicopters" that help them soar with the wind. Berries contain seeds that birds eat and poop out. These features can spread seeds out in all directions. But seeds don't have equally good chances of growing in all places.

As northern habitats got colder during ice ages, for instance, it was likely easier for seeds to thrive toward the warmer south. As a result, more new trees started growing on the southern edges of forests, while older trees up north died out. Slowly, forests migrated, moving around 100 to 500 meters (about 300 to 1,600 feet) a year, Brandt says.

Now, human-caused climate change is changing habitats faster than forests are prepared to move. Warmer temperatures in Canada, for instance, are making it difficult for white spruce to grow. And pinyon pines are struggling with drier climates in the American southwest.

"Trees just cannot keep up," says Brandt. "Their habitats are changing faster than they can migrate. So, humans are helping them out by moving them."

Scientists are planting new seeds in areas with favorable conditions. This is called assisted migration. Sometimes, assisting migration can even mean replacing species that are no longer equipped to handle a changed landscape with species better suited to the new conditions.

Minnesota's Superior National Forest just created an assisted migration plan — a guidebook to help forest managers prepare for climate change. Because trees can hold cultural significance, the team has been working with scientists, Minnesota residents and local Indigenous tribes to make sure the forest migration plan aligns with community needs.

Even though forests need to adapt in order to survive climate change, "we don't want to completely change the forest," Brandt says. People "rely on those trees."

— *Sophie Hartley*

WAGNER CAMPELO, AARON J HILL, SCOTT MIRROR, MARTIN FOWLER/SHUTTERSTOCK

While trees can't walk around on their roots, entire forests can migrate when the wind, or animals like squirrels and birds, drop seeds in new places.

ANIMALS

What is a dinosaur?

This group of reptiles has been around for more than 200 million years

***Brachiosaurus*, *Triceratops* and ankylosaurs were definitely dinosaurs. But other ancient reptiles, such as pterosaurs, were not. Scientists have to look at hip and leg bones to determine which fossils came from dinos and which did not.**

The word "dinosaur" is often used as a catch-all term for any scaly, prehistoric giant. But it actually refers to a specific group of reptiles.

"There's kind of a misconception that any big extinct thing was a dinosaur," says Nathan Smith. He should know. He's director and curator in California at the Dinosaur Institute. It's part of the Natural History Museum of Los Angeles.

Dinosaurs have been around continuously for more than 200 million years. They include everything that's descended from the earliest common ancestor of avian (birds) and nonavian dinosaurs, Smith explains.

Over tens of millions of years, dinosaurs evolved a dizzying array of sizes, shapes and adaptations. The most classic dino features have to do with how they moved, Smith explains.

"These are animals that are bringing their limbs underneath their body," he says. "That involves changes in the hip bones and the leg bones."

The top of their thigh bones — or femurs — turn inward to attach to the hip socket. Their pelvis features a unique hole where the femur attaches. Other prehistoric reptiles didn't have this opening in their hip.

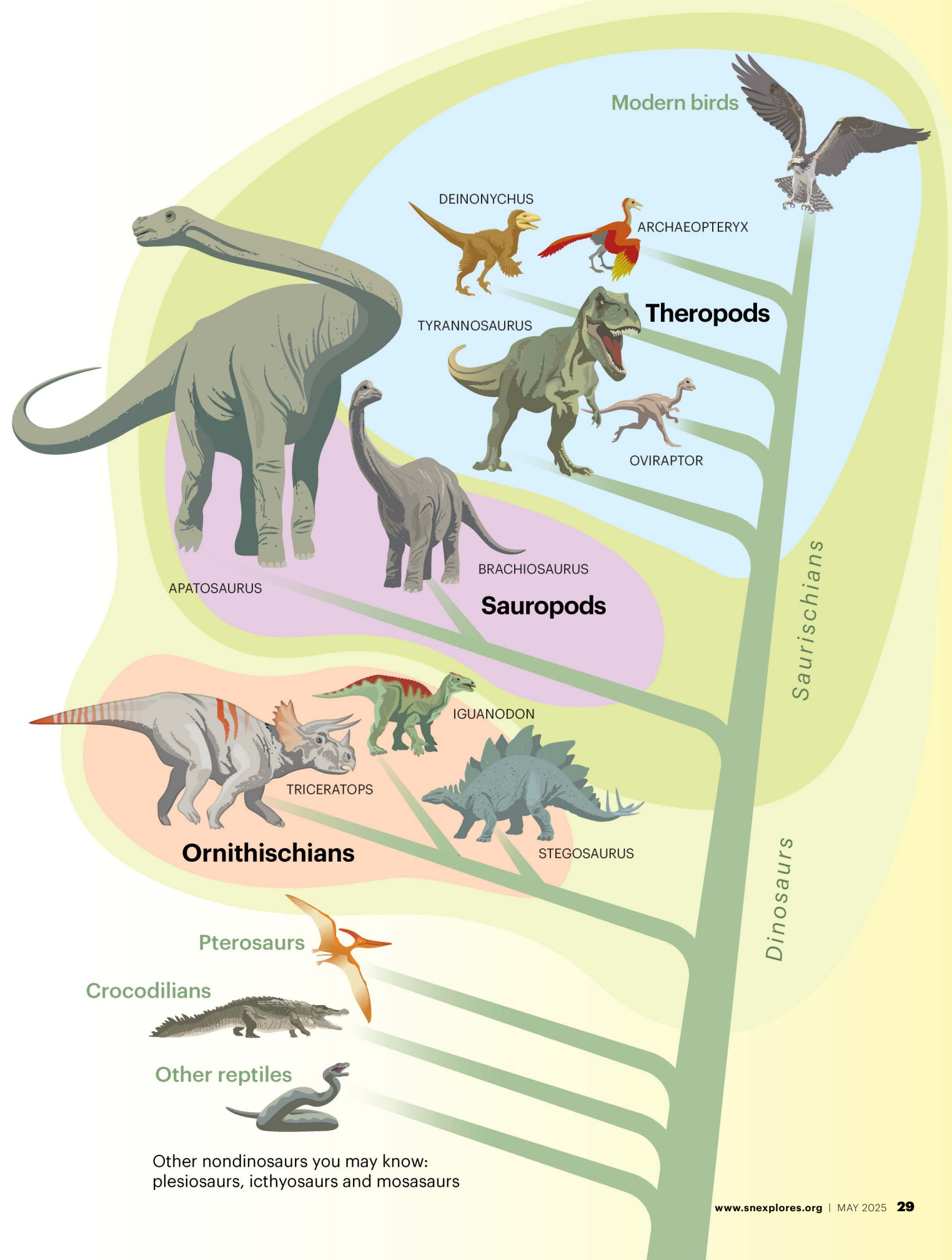
These traits gave dinosaurs an upright stance, with their legs placed under their bodies. It allowed them to spend less energy while moving. And it helped support the weight of the biggest dinosaurs.

Scientists coined the term "dinosaur" in 1842. Back then, only a few species were known. Researchers assumed these ancient reptiles were clumsy, sluggish giants. Since then, science has turned up about 1,000 nonavian species of this group. And some scientists suspect these represent only a fraction of all that ever lived. New species continue to be named each year.

Their fossil remains have turned up on every continent. Understanding them is helping science better understand how these animals dominated most ecosystems for about 165 million years.

— *Aaron Tremper*

ORLA/SHUTTERSTOCK; ILLUSTRATION BY STEVE MCCRACKEN



Other nondinosaurs you may know: plesiosaurs, icthyosaurs and mosasaurs

EARTH

Smartphones map Earth's ionosphere

Tracking this layer of the atmosphere could help improve GPS

Smartphones are helping chart an erratic region of Earth's atmosphere that can mess with navigation systems.

That region is the ionosphere — a sea of charged particles on the edge of outer space. There, the sun's radiation cooks gases in the air. This rips electrons off neutral atoms and molecules, creating free-roaming charged particles.

Levels of these charged particles shift with changing sunlight and solar activity. So the ionosphere over any part of the planet will look different during day and night. Earth's weather and space weather can also make a stir in the ionosphere.

These changes can disrupt radio signals traveling through the atmosphere. For instance, they can distort GPS signals traveling between satellites and the ground, causing navigation errors.

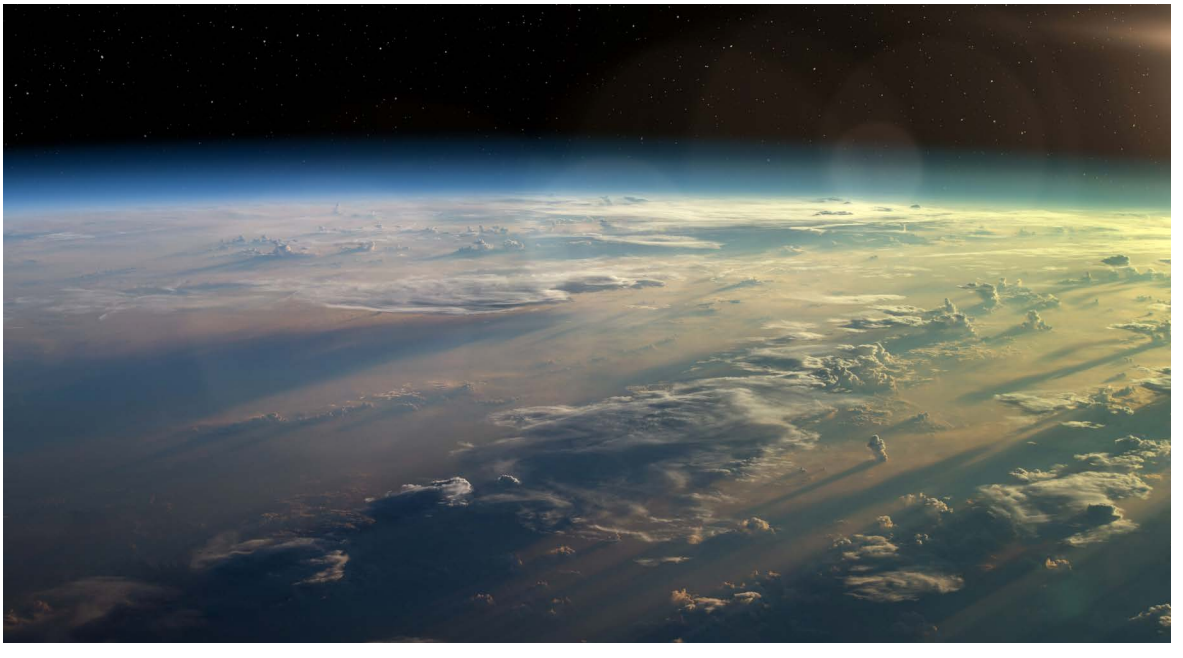
For that reason, it's vital to keep tabs on how the ionosphere is changing in different places. A network of ground-based monitors — run by universities, research centers and other groups — does keep tabs on the ionosphere. But these stations are expensive to build and run. And existing ones can't see the ionosphere over the whole globe.

Smartphones receive signals from GPS and other satellites. These signals, captured by sensors in phones, are used for navigation. Researchers looked at a huge batch of those signals for clues about how the ionosphere can mess with radio signals. That allowed the researchers to fill in poorly mapped patches of the ionosphere.

The team compared ionosphere maps for two months in 2023. These maps either used data from millions of smartphones or from thousands of monitoring systems. Phone data doubled the coverage across our planet's surface. The researchers shared their findings in *Nature*.

The new maps picked up features of the ionosphere that can wreak havoc on radio signals. In October 2023, maps showed bubbles of charged gas over India. The team also saw a higher density of charged particles whipped up by a solar storm. This pocket of particles hovered over North America in May 2024.

Better maps of the ionosphere could improve the location accuracy of GPS systems for cars, airplanes and more. And they might even help scientists make new discoveries about this tumultuous part of our atmosphere. — *Carolyn Wilke*

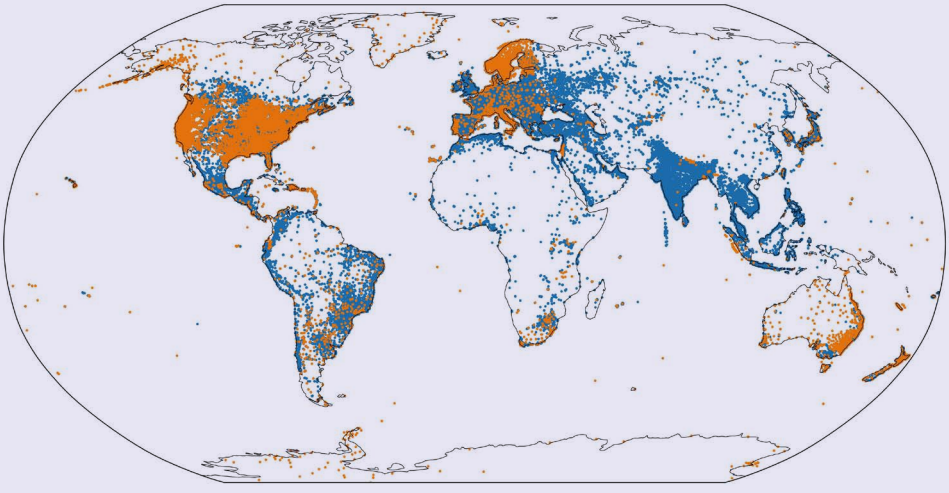


BURADAKI/SHUTTERSTOCK

The ionosphere is a layer of charged particles in the upper atmosphere that can mess with GPS and other satellite signals.

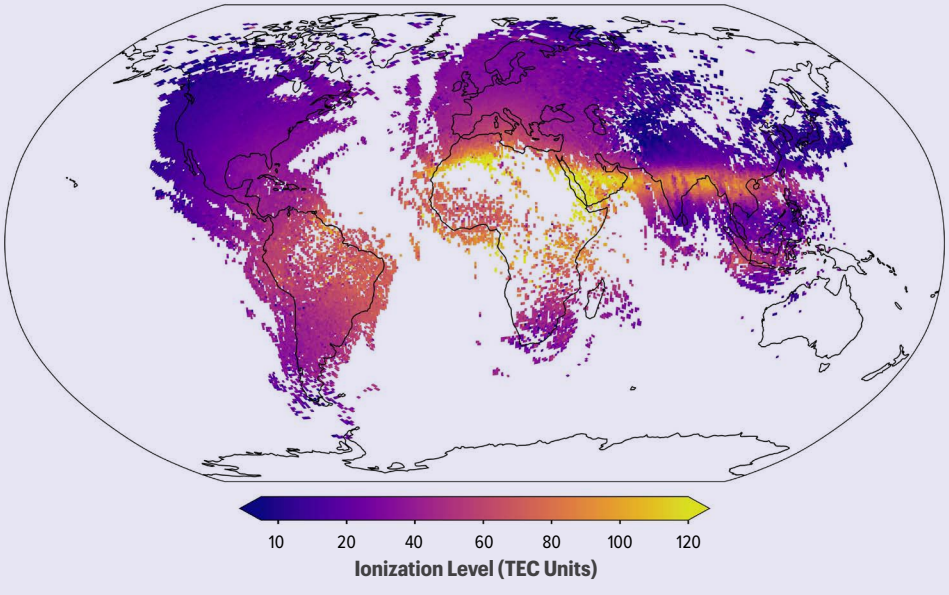
PHONE COVERAGE

FIGURE A



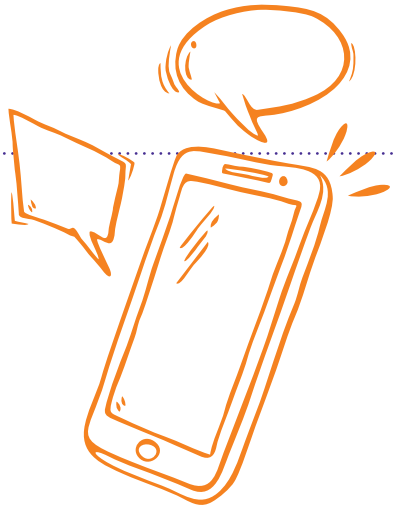
Researchers compared maps made with measurements from phones and monitoring stations. They used data from some 9,000 monitoring stations (orange dots). At around 100,000 locations, there was enough data from smartphones to map the ionosphere (blue dots).

FIGURE B



Researchers made this map of the ionosphere using 10 minutes of phone data from October 12, 2023. It shows levels of ionization, or how much charge is hanging around. Ionization is measured in TEC, or total electron count, units. TEC units describe the number of electrons not attached to atoms in a square meter of the atmosphere. Higher levels of TEC units correspond to greater ionization. The map shows what's called the equatorial anomaly. This is a band of more intense ionization around the equator that dips south over South America.

GOOGLE



DATA DIVE

1. Look at Figure A. Which areas of Earth have the highest and lowest density of monitoring stations?

2. Which areas of Earth have much higher coverage using phone measurements of the ionosphere than using station measurements?

3. Are there any areas of Earth that have better coverage from monitoring stations than from phones?

4. Look at Figure B. What is the range of the ionization level over South America?

5. Which regions have the highest ionization level?

6. Not enough data was captured at nighttime to fill in the map in some areas. Where do you think it was nighttime when researchers took their data?

ANSWER

Flour-based nanofibers break record for world's thinnest pasta

The fibers are a two-hundredth of the thickness of a human hair

The world record for thinnest pasta has been shattered. Researchers made starchy nanofibers from white flour. The threads are about 370 nanometers thick. That's about one two-hundredth the thickness of a human hair. But these nano-noodles won't be found on any dinner table. Instead, they may be used in biodegradable bandages.

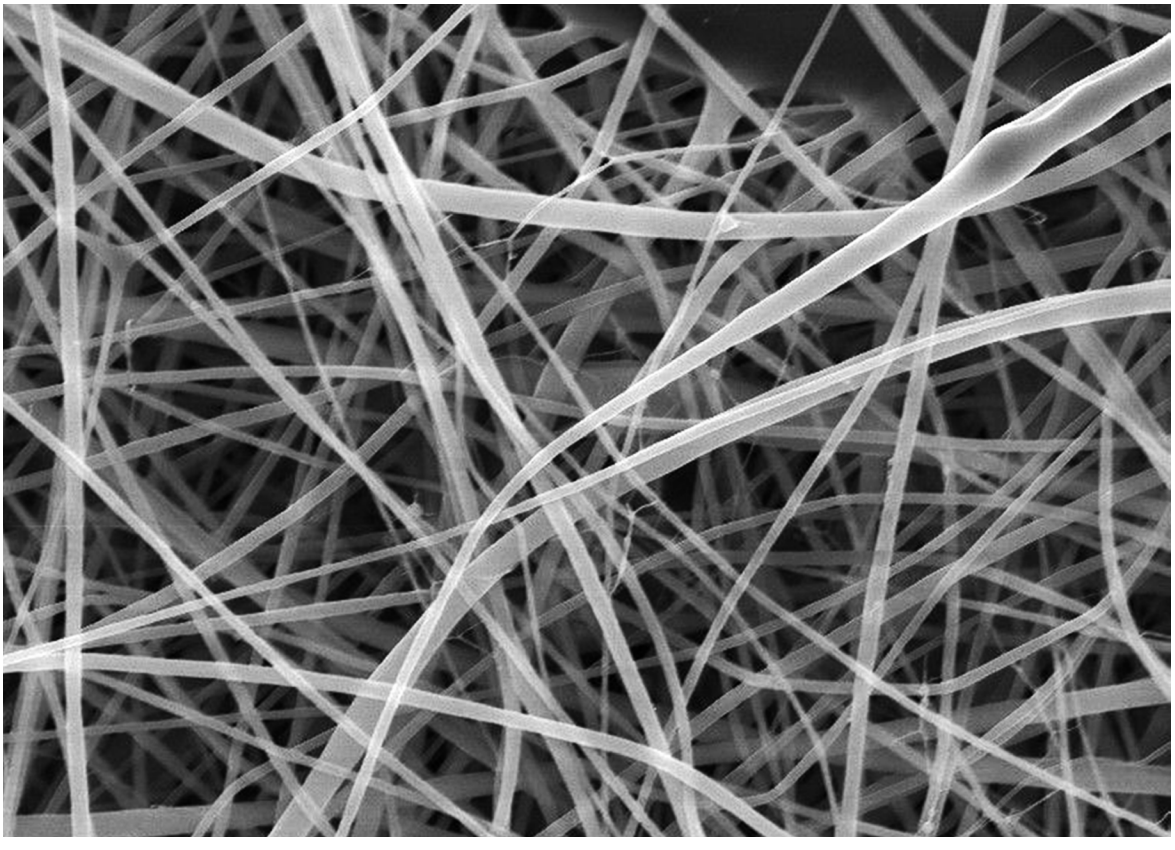
To make the noodle "dough," scientists mixed flour with formic acid. That type of liquid helps uncoil the flour's long molecules of starch. To stretch the dough into tiny noodles, they used a technique called electrospinning.

In this process, an electrical charge pulled the dough through a needle and onto a plate several centimeters away. The starch molecules tangled with each other as they left the needle, forming a jet. As the jet flew through the air, the formic acid evaporated. This left behind a thin fiber. After about 30 minutes, the fiber formed a thin mat on the plate.

Since the fibers are made of dried flour, they count as pasta, the authors say. That makes them the thinnest pasta on record. But are they edible?

"I certainly hope so," says chemist Adam Clancy. He works at University College London in England. Clancy and his colleagues published this study in *Nanoscale Advances*.

— *Skyler Ware*



BEATRICE BRITTON, ADAM CLANCY

These nanofibers (seen under a scanning electron microscope) can be called pasta because they are made from dried flour, the researchers say. That makes them the thinnest noodles ever.

INSIDE THE MIND OF A YOUNG SCIENTIST

A Thermo Fisher Scientific Junior Innovators Challenge award wwinner answers three questions about his science project

Science competitions can be fun and rewarding. But what goes on in the mind of one of these young scientists? **Samvith Mahadevan**, an award winner at the 2024 Thermo Fisher Scientific Junior Innovators Challenge, shares his experience.

Q What's the most important thing you learned in working on your project?

A Samvith designed a sensor that detects food allergens by scent. "You have to be observant all the time and have a curious mind," he says. "Even the smallest things can spur good ideas." He got the idea to use scent for detecting allergens by watching an ant in his kitchen home in on sugar from afar.

Q How did you feel when you first saw your results?

A "It was really exciting because I had to go through a lot of different trial and error, and there were a lot of failures along the way," Samvith says. Seeing his sensor accurately pick out allergens "felt really motivating … because it showed me that this idea has a lot of potential." With further development, he says, "we could save a lot of lives."

Q Any advice for science fair newbies?

A Being completely new to your project area can actually be a good thing, Samvith says. When he started his project, he didn't know that most current allergen sensors work by analyzing the proteins in food. When he came up with the idea to test food smells, "it was in part because I didn't place any imaginary restrictions on myself," Samvith says. "Sometimes inexperience triggers out-of-the-box thinking, and even a complete beginner could come up with the idea of the future."

The Lemelson Foundation Award for Invention

Samvith Mahadevan

Samvith, 14, inspired by his own allergies, used artificial intelligence to create an allergen detector that can sense scent particles in the air with 94 to 97 percent accuracy. Samvith is in the 8th grade at Canyon Vista Middle School in Austin, Texas.

EXPLORE
OUR SOCIAL MEDIA

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