ScienceNews Explores
October 2023

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GETTING THE GLOBE ONLINE

# WHAT'S THE FUN IN FEAR?

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T. MANGIOK

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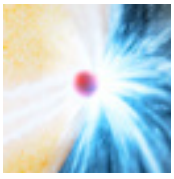










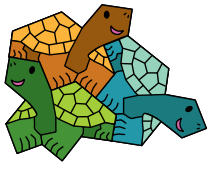









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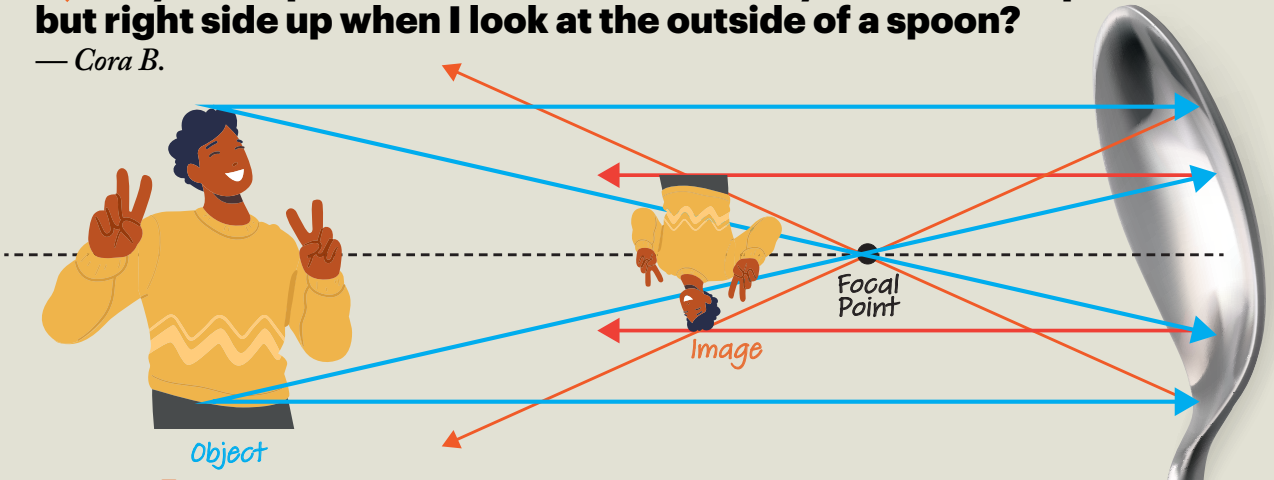
## Q Why am I upside down when I look at myself inside a spoon but right side up when I look at the outside of a spoon?

*— Cora B.*




**A** This quirky illusion happens because of the way light bounces off a curved surface. Light travels in straight lines, says Darren Bly. He is a physicist at Shenandoah University in Winchester, Va. When you look at a flat mirror, light travels from your face to the mirror and bounces off. Some of that light then makes it back to your eyes in a straight line, and you see yourself right side up. The inside of a spoon is concave. Any incoming light bounces back at different angles. Rays hitting the top of the curve get reflected downward while those reflected off the bottom bounce up. These different rays meet at what's called the focal point. Anyone behind this focal point will see an upside-down reflection. The outside of a spoon, though, is convex. Light also bounces off it at different angles, but its focal point is behind the mirror. So the image appears right side up but smaller.

## Q How come some planets have moons and some do not?

*— Regina D.*

**A** Most planets form moons from impacts with large objects or by grabbing nearby asteroids, says geophysicist Ana-Catalina Plesa. At the Institute of Planetary Research in Berlin, Germany, she studies the insides of rocky planets and icy moons. Our own moon may have formed from debris ejected by a massive collision billions of years ago. But whether a planet can have moons depends on its position in the solar system, says Plesa. Near the sun, gravity is too strong for moons to form. So planets like Mercury and Venus can't gather moons. Farther out, the sun's gravity plays less of a role. And gas giants like Jupiter and Saturn are so big that their gravity is much stronger than that of the smaller inner planets. This makes them more likely to hold onto debris from impacts and pull passing asteroids into their orbits.

## Q How do we get scared?

*— Emily Z.*

**A** "There's a little part of our brain called the amygdala that keeps us ready to fight or run away from dangerous things," says Coltan Scrivner. This behavioral scientist studies fear at Aarhus University in Denmark. "When we look at — or even think about! — something bad, the amygdala gets to work," he says. "It tells our heart to pump faster so that our muscles can have enough oxygen to work harder. It tells our eyes to open wide so we can clearly see anything that is dangerous. It also tells the rest of our mind to be on alert." Altogether, this creates the sensation of being scared.

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**Sarah Zielinski**
Editor, *Science News Explores*

SPACE

# Telescopes caught a star gobbling up a planet

## Only dusty scraps were left behind

For the first time, scientists have spotted a star eating a planet. The planet was probably about 10 times the mass of Jupiter and orbited a star about 10,000 light-years away. The stellar meal gave off a burst of light captured by telescopes on Earth and in space.

Stars were long suspected to eat their own planets, says Kishalay De. But no one knew how often this happened. He's an astrophysicist at MIT who led the research.

De was hunting for pairs of stars that orbit each other. One cosmic event from 2020 caught his eye. A spot of light in the sky quickly got about 100 times as bright as it was before — maybe two stars merging?

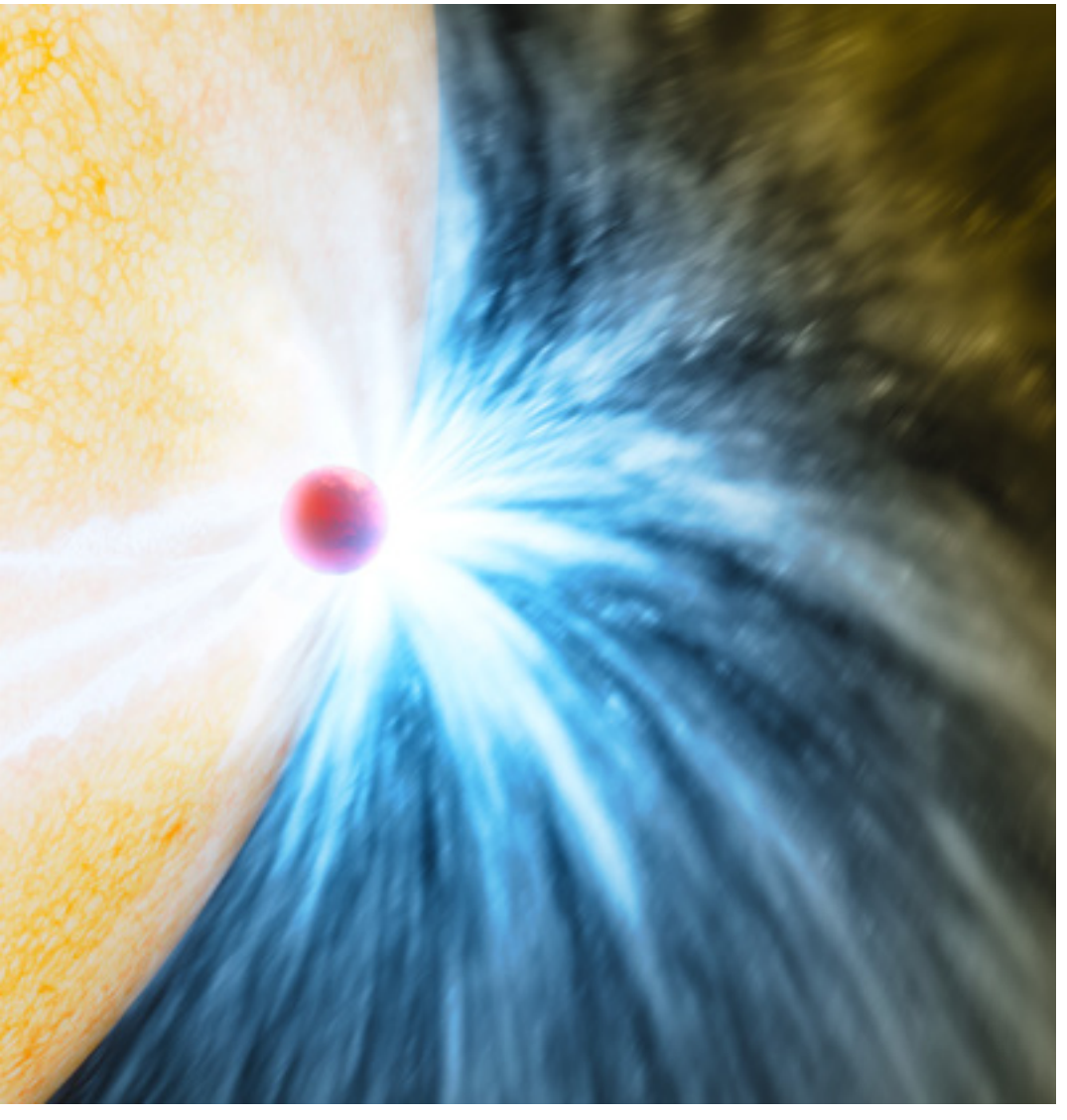
But a closer look revealed one one-thousandth of the energy that would be expected from merging stars. Plus, the area lacked the hot plasma De expected from a star collision. Instead, it was full of chilly dust.

If the flash was from two objects smashing into each other, he determined, they weren't both stars. One was probably a giant planet. As the star chowed down on the planet, a stream of cold dust sailed away like cosmic breadcrumbs. His team shared the discovery in *Nature*.

Planet-devouring stars are probably pretty common, says Smadar Naoz. She is an astrophysicist at the University of California, Los Angeles. A young star might chomp a planet that wanders too close. Or a dying star will swell up to become a supersized star called a red giant. In the process, that star might swallow up a planet in its orbit. The planet-eating star in this study is turning into a red giant. But it's still early in its transformation.

This dramatic end may give a glimpse of Earth's future. Our sun will eventually evolve into a red giant, consuming Earth — in about 5 billion years.

— *James Riordon*



**In this artist's illustration, dust blasts into space as a star swallows a planet up to 10 times as massive as Jupiter.**

K. MILLER AND R. HURT/IPAC/CALTECH

ANIMALS

# How to tell if a catfight is real or just play

## Tell-*tail* behaviors could signal if cats get along

Two cats together may chase and hiss at each other. They might yowl and puff up their tails. They could pounce or even wrestle. Are the cats play-fighting — or fighting *fur* real?

Pouncing and wrestling might be friendly play. But chasing or yowling could be tell-*tail* signs that the cats aren't getting along, one study shows. The results could help cat owners figure out if their pets are playmates or if they stress each other out.

Scientists have studied cats' social relationships — both with other cats and humans. But it can be tricky to tell whether two cats are playing or fighting, says Noema Gajdoš-Kmecová. She's a veterinarian who studies cat behavior at the University of Veterinary Medicine and Pharmacy in Košice, Slovakia.

Sometimes cat owners miss the signs of a tense relationship. Humans might think their pets are just playing when in fact they don't get along at all. Living with another cat they don't like can make some animals ill and stressed, Gajdoš-Kmecová explains. Other times, people may assume their pets were fighting — when the cats were really friends.

Gajdoš-Kmecová and her colleagues watched about 100 cat videos. Each video had a different pair of cats interacting. After viewing around a third of the videos, Gajdoš-Kmecová noted six main types of behaviors. These included wrestling, chasing, making noises and staying still. She then watched all of the videos. She tallied how often and how long each cat showed one of the six behaviors. Analyses of these behaviors revealed three types of interactions between cats: playful, aggressive and in-between.

Next, other members of the research team watched the videos. They, too, labeled each interaction style to confirm the results.

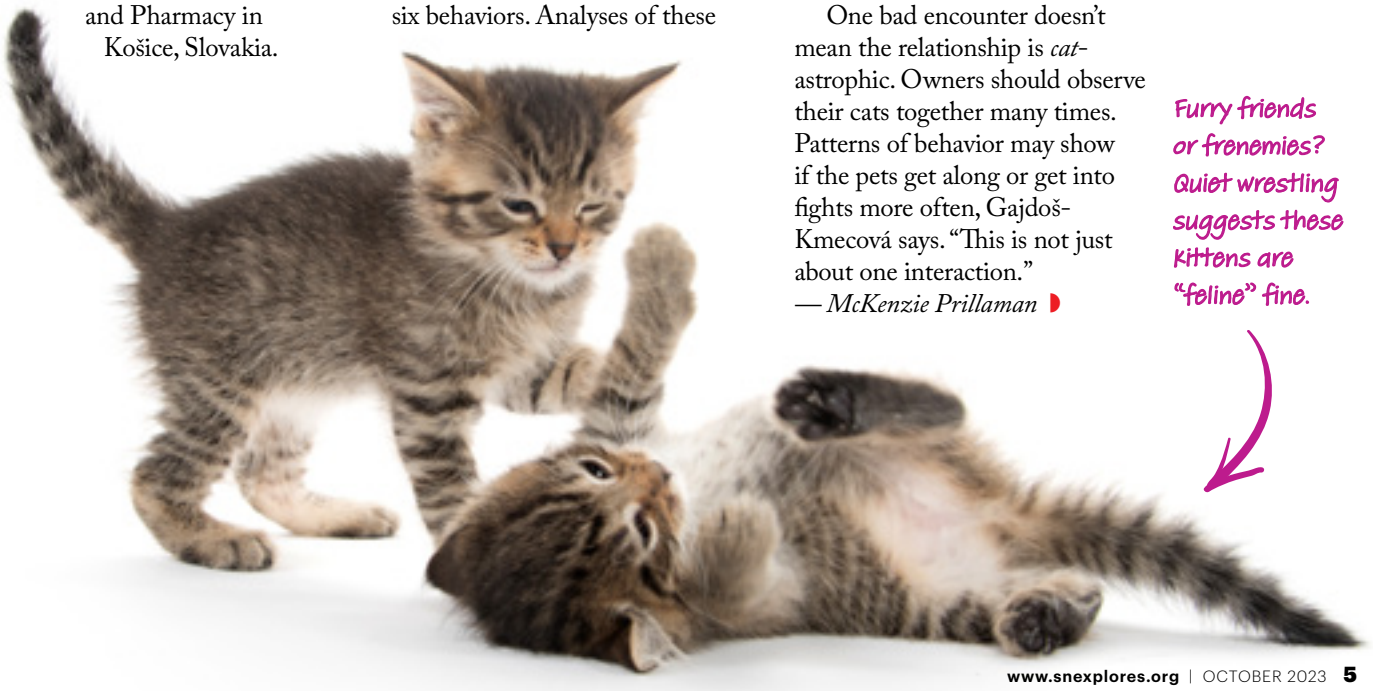
Clear connections emerged. Quiet wrestling between two cats suggested playtime. Chasing and sounds like growling, hissing or yowling implied aggressive encounters.

The in-between behaviors could be a little playful and a little aggressive. They also often included one cat moving toward the other. It might pounce on or groom its fellow feline. These actions could hint that one cat wants to keep playing while the other doesn't. The more playful cat gently nudges to see if its partner wants to continue, the authors say. They published their findings in the journal *Scientific Reports*.

This work provides a good first look at how cats get along, Gajdoš-Kmecová says. But it's just the start. In the future, she plans to study more subtle behaviors like ear twitches and tail swishes.

One bad encounter doesn't mean the relationship is *cat*-astrophic. Owners should observe their cats together many times. Patterns of behavior may show if the pets get along or get into fights more often, Gajdoš-Kmecová says. "This is not just about one interaction."

— *McKenzie Prillaman*



Furry friends or frenemies? Quiet wrestling suggests these kittens are "feline" fine.

TONY CAMPBELL/SHUTTERSTOCK

ANIMALS

# *T. rex's* famously toothy grin may have featured lips

## Fossil evidence suggests a different look for the dino




**Clues from teeth and bones (A) call into question whether *Tyrannosaurus* had a lipless crocodile-like grin (B) or lizardlike lips (C) that extended beyond the tips of the teeth (D).**

MARK P. WITTON

In movies and TV shows, *Tyrannosaurus rex* almost always has its big, sharp teeth on display. But in real life, these dinosaurs may have kept their pearly whites mostly tucked behind lips.

Almost all modern land animals with backbones have liplike coverings over their teeth. But *T. rex's* closest living relatives with teeth are crocodiles and alligators, which lack lips. Plus, *T. rex*'s teeth tended to be large — maybe too big to fit in the mouth. So one might assume that their chompers were exposed.

Thomas Cullen and his colleagues compared fossilized and modern reptile skulls and teeth. Cullen is a paleontologist at Auburn University in Alabama. The bones and teeth suggest that *T. rex* and its kin probably had lots of soft tissue around the mouth. That tissue could have functioned as lips. The findings, reported in *Science*, challenge common toothy portrayals of these dinos.

One hint came from small holes through the jaw bones. These passages can route blood vessels and nerves to soft tissue around the mouth. In lipless crocodilians, they are scattered across the jaw. But *Tyrannosaurus* fossils show jaw pores more like those seen in lipped reptiles.

The tooth enamel also yielded clues. When enamel dries out, it wears down more easily. The exposed side of alligator teeth erodes more than the wetter side that faces the inside of the mouth. *T. rex* teeth are more evenly worn down on both sides. This suggests that their teeth were kept covered and moist by lips.

Not all paleontologists buy the new results. Thomas Carr calls them "completely unconvincing." He has studied tyrannosaurs at Carthage College in Kenosha, Wis.

Carr's research has shown that the jaw bones of tyrannosaurs had a rough, wrinkled texture. Lipless crocodilians have this same bone texture. But the new research did not account for the texture of facial bones.

Discovering a mummified tyrannosaur with preserved facial tissues, Carr says, could settle who had lips and who didn't.

— *Jake Buehler*

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

# WHAT'S THE FUN IN FEAR?

## Science explores the appeal of scary movies

By **Maria Temming**

DEN ROZHNOVSKY, STASIA04, VWORLD/SHUTTERSTOCK

*A woman slides a tape into a VHS player and a black-and-white video flickers on the TV. An eerie hum fills the room as a ring of light glows on-screen. The TV fuzzes over with static. Then the image of the ring is replaced by a flurry of other scenes. A burning tree. A writhing mass of maggots. A box full of twitching severed fingers.*

*The TV cuts to static again. Across the room, a phone rings. Trembling, the young woman picks it up. "Seven days," a voice whispers — confirming that the legend of the tape is true. Anyone who watches it is doomed to die exactly one week later.*

So begins the 2002 horror film *The Ring*. For some people, movies like this are too frightening to be fun. But other people relish a good fear-fest.

Mathias Clasen is one of these people. He became fascinated with scary movies as a teen, he says, "even though I knew that there was a price." That price might be checking for monsters under the bed. Or sleeping with the lights on. "But, like for many other people, it's a price I'm willing to pay," Clasen says. "I was always curious about that weird fascination — what's often called the paradox of horror."

The paradox is this: Horror movies are designed to provoke seemingly bad emotions. Dread. Shock. Fright. Disgust. Yet many people want to sit through films stalked by creepy clowns, bloodthirsty monsters and mad murderers. Why?

Today, Clasen directs the Recreational Fear Lab at Aarhus University in Denmark. There, he and others are shedding light on the appeal of dark media. New research is just starting to untangle who likes horror and why. The findings may not only help explain a curious quirk of human behavior. They may also reveal how scary media helps people face real-life fears.

## The hype about horror

*A teen sets off across a cornfield in the dead of night. On the way, he shoulder-checks a scarecrow hung crooked on its post. A few minutes later, he seems to pass the scarecrow again. Confused, the boy walks on. But he soon stops a second time. Here, on the side of the path, stands the scarecrow's post. The scarecrow is gone.*

The question of why people find enjoyment in scenes like this — from *Scary Stories to Tell in the Dark* (2019) — has no simple answer.

"There are a lot of different reasons," says Margee Kerr. She's a sociologist at the University of Pittsburgh in Pennsylvania. The focus of her research is fear. Recreational fear, she says, "does increase all of this activity in our nervous system that — in the absence of a real threat — can be experienced more like excitement and make

**Films like *The Ring* (left) and *Scary Stories to Tell in the Dark* (right) are designed to spook viewers.**

RGR COLLECTION, ALBUM/ALAMY

ILLUSTRATION: THENATCHDL/SHUTTERSTOCK; PICTURELUX/THE HOLLYWOOD ARCHIVE/ALAMY

**In *Haunted Mansion*, a woman and her son recruit supernatural experts to rid their home of ghosts.**

us feel good." Plus, "there is that sense of accomplishment" in making it through a real nail-biter of a film.

Clasen's team identified this range of motives when it surveyed more than 250 American horror fans about why they enjoyed the genre. Survey responses broadly revealed three types of fans. There were "adrenaline junkies," who enjoyed the suspense and adrenaline rush of scary movies. The "white knucklers" often reported being stressed while watching horror, sometimes even having nightmares after — but sought those films out anyway. And the "dark copers" seemed to use horror to deal with bad feelings and events in real life.

The same researchers also surveyed about 250 visitors to a haunted house in Denmark and found the same three types of horror fans. After the haunt, those fans reported how they felt, whether they'd learned anything about themselves or if they'd grown as a person by braving the haunt.

Adrenaline junkies felt great. But they didn't necessarily think they'd learned or had grown. White knucklers were the opposite. "They didn't really have a mood boost," says Coltan Scrivner, a behavioral scientist who works with Clasen. "But they were much more likely to report feeling like they had learned something about themselves and developed as a person." Dark copers felt great and thought they had learned and grown.

Kerr found similar results among some 260 adults who visited a haunted house in Pittsburgh. Half of the visitors were in a better mood after the haunt — especially people who said they challenged their fears. Together, the two haunted-house surveys suggest people can revel in both the thrill and the challenge of horror. Kerr also suspects that horror fans would report similar benefits after scary movies. But future studies will need to confirm that.

## Who likes horror?

*The door to a young girl's bedroom swings open. Three haunted-house investigators peer in from the hall, aghast. A violent whirlwind flings books, music records and other objects around the room. A cackling clown doll whips round and round on a spinning bed. But the little girl is nowhere to be seen. She has already been swallowed up by the evil spirits infesting the house.*

Just as there are different types of horror fans, there are those who don't like the genre at all. Such people never want to watch a scene like this, from the 1982 movie *Poltergeist*, or a vampire or human-hunting alien. Data from Clasen's group backs this up. The team surveyed nearly 1,100 American adults. Some of them liked horror. Others really didn't.

"We didn't find as clear of a personality profile of the horror fan as I had been expecting," Clasen says.


The differences between horror fans and horror-phobes tended to be small. But the survey did unmask some interesting trends.

People higher in a personality trait called thrill-seeking tended to watch and enjoy horror more. (Thrill seekers often seek out new and intense experiences.) Men also seemed to be slightly bigger horror fans than women. People who really liked horror also tended to be younger than those who really disliked it.

Those findings echo trends seen in past studies. But Scrivner and Kerr caution that these results should be viewed with caution.

Take the apparent gender divide. In several studies, women have reported liking horror less than men do. But does that really mean women are bigger fraidy cats than men? Kerr thinks not. "It comes down to, I think, the way questions are asked," she says, "and stereotypes." Men may feel more pressure to appear tough. So they may be less likely to admit in surveys if they don't like horror.

Likewise, Scrivner thinks it's unfair to paint all horror fans as thrill seekers. His research on different types of horror fans shows "there's this huge portion of people that it's simply not true for," he says.

Another decades-old idea about horror fans that may need to be rethought is that people who like this genre must be low in empathy. That is, they must be less affected by seeing others suffer. One survey of about 170 young adults found empathy was not related to overall enjoyment of scary movies. But it did seem to affect how people responded to certain aspects of scary movies. Those higher in empathy found it harder to watch characters suffer. But more empathetic people also delighted more in danger and excitement.

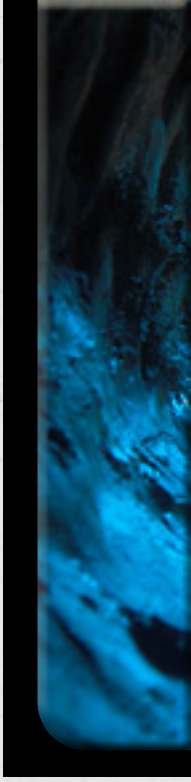
So empathy may enhance or impair someone's enjoyment of horror, depending on the film.

## Real-world effects of fictional fright

*A young woman smiles serenely as she treads water during a sunset dip in the sea. Suddenly, she's jerked downward. Her head disappears beneath the water. When she breaks the surface again, she screams. She tries to paddle away, but it's no use. Something under water has her in its grip. And no amount of thrashing will break her free.*

A scene like this from the 1975 movie *Jaws* might give you nightmares. It might even make you nervous about swimming in the ocean. But a film that freaks you out is not likely to have a long-term impact on your mental health, says Christopher Ferguson. And watching violent films does not seem to make people more violent. Ferguson is a psychologist at Stetson University in DeLand, Fla., who studies the effects of media violence.

Watching horror may actually help some people become more resilient in real life. That's because horror movies let people practice feeling negative emotions in a safe setting, Scrivner says. You're



**A bloodthirsty shark terrorizes beachgoers in the film *Jaws*, but real-life shark attacks are rare.**

FROM LEFT: ANTON_IVANOV/SHUTTERSTOCK; PICTORIAL PRESS LTD, FLIXPIX/ALAMY; MARTIN PROCHAZKACZ/SHUTTERSTOCK; ILLUSTRATION: THENATCHDL/SHUTTERSTOCK

PHOTO 12, ALBUM/ALAMY

**In *Coraline* (left), a young girl explores a sinister alternate reality. In *Jurassic Park* (right), two kids run for their lives from dinosaurs. Both films are hair-raising in their own ways.**

not learning how to escape axe murderers or alien monsters. "What you're learning is how to deal with feelings of fear," Scrivner says. That way, when it comes to scary situations in real life, "you kind of have this toolkit that you implicitly learned, that you might deploy in order to calm yourself down."

People may also draw other lessons from horror. For instance, the chaos of a fictional zombie apocalypse may in some ways be similar to the chaos following a real disaster. Watching such chaos unfold on screen may help people do mental dress rehearsals for navigating real crises.

Scrivner, Clasen and their colleagues found evidence for this in a survey of more than 300 people in the United States. Participants were recruited in April 2020. The researchers asked them how much they were a fan of different TV and movie genres. They also asked about how much distress people felt during the COVID-19 pandemic and how prepared they were for it.

Horror fans reported lower levels of distress during the pandemic. What's more, fans of zombie or other apocalypse movies said they were more prepared, such as knowing what to stock up on for a lockdown. This is "the most direct evidence that we have so far" that horror helps people brace for real-world threats, Clasen says.

It's important to note that this study alone is not proof. People who have the emotional endurance to sit through scary movies may just happen to be better at weathering the stress of a pandemic. But Clasen is intrigued by the possibility that horror movies could work like a "fear vaccine" to help someone become more resilient in real life.

## Tips for trying out horror

*A horde of zombies throws itself against the wall safeguarding a city. The monsters crawl over each other, piling higher and higher — until those at the top can fling themselves over the wall. On the ground below, screaming humans scatter. Undead bodies crumple as they land on the street, but the impact only slows them down. Fallen zombies simply wrench their limbs back into place and continue their vicious pursuit of human flesh.*

Benefits or not, scary movies aren't for everyone. And that's okay.

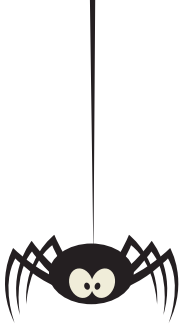
"No one should ever be made to feel bad about themselves for not liking [scary films]," Kerr says. But some self-identified scaredy cats may still be intrigued by horror films and want to try watching one. For them, Kerr has some advice.

"Go into it without any judgment or expectations about what [your] reaction will be," she says. And if you feel you need to leave, then leave. This can offer someone the opportunity to learn about themselves and their fears.

"Monster movies are good," she adds, "because you know that they're not real." If a scene like the one above from 2013's *World War Z* freaks you out, you can remind yourself that a zombie apocalypse is not actually possible.

If you're not ready to watch a horror movie — even through your fingers with the lights on — there are still other ways to stress-test yourself, Kerr says. One is writing your own horror-movie script. "If you write a story about something that you're afraid of, you are taking control over it," she explains. "You're taking a sense of power in this arena … and that can be really helpful."

# This scientist knows how to frighten you



## Sociologist Margee Kerr looks to empower others through haunted attractions

Margee Kerr has been thinking about how zombies can help people overcome their fears.

Kerr is a sociologist. This type of scientist investigates aspects of human society. At the University of Pittsburgh in Pennsylvania, Kerr studies our fears, collecting data on how and why people seek out frightening situations. Haunted attractions use her findings to make their exhibits spookier and more fun. Kerr's love for everything scary has led to trips all around the world in search of the perfect scare. She wrote about her experiences in her book *Scream: Chilling Adventures in the Science of Fear*.

People often see fear as something to be avoided, says Kerr. But fear can be used to help people lead happier and more empowered lives, she contends. Her latest project looks at how virtual reality can make treatments for intense fears, or phobias, less intimidating. In this interview, Kerr shares her experiences with *Science News Explores*. (This interview has been edited for content and readability.) — *Aaron Tremper*

**Q What inspired you to pursue your career?**

**A** In my work for my PhD, I looked at why some parent groups are organized around the idea that vaccines cause autism. [Vaccines do not cause autism.] I studied how and why fear was useful for inspiring large groups of people.

During that time, I had days where I was just so "in my head" from work on a computer all day. So to take a break and have some fun, I looked for haunted houses. I had a lightbulb moment. I had spent all my time thinking about fear as this negative thing. Yet here I was lining up to spend money and my time to be scared. That's when my path shifted. I wanted to explore why people want to engage with things we usually see as negative and scary.

**Q How do you get your best ideas?**

**A** Through reading a lot of articles and science. I love to use research to learn about how people react and their ideas about what is normal. I'll then take that and change it into something that can be used for a really fun scare. For example, I researched how our senses process so much without our awareness. I used those findings to develop jumpscares, like things tickling your ankles or strobing lights.

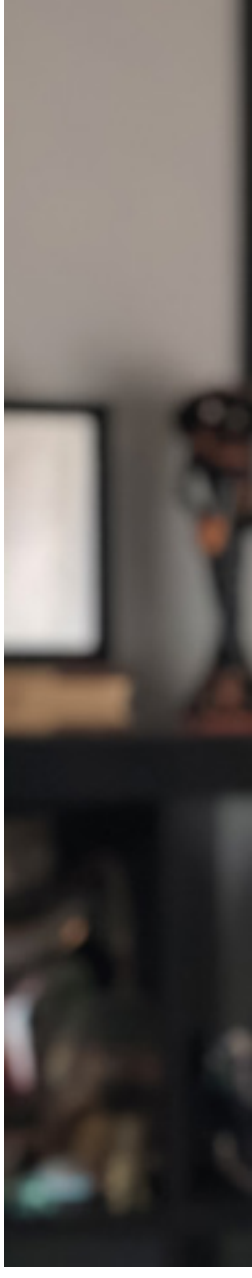
A lot of haunted attractions think that they just have to continue to make their attractions scarier by adding more blood and violence. But research shows that we find new and unusual experiences more engaging, fun and scary.

**Q What is one of your biggest successes in your career?**

**A** Definitely the publication of my book on the science of fear. It continues to be such a meaningful accomplishment for me. It's pretty popular among middle-schoolers. A handful of teachers have reached out to me saying they teach this book. They find that it's a way to introduce kids to this growing field.

**Q What do you like to do in your spare time?**

**A** I am really into kayaking. I also do a lot of hiking and outdoor activities. I'm trying to push myself. It's important to keep pushing our boundaries as we age. So I try and do things that are a little scary. And, of course, I'm all about decorating, dressing up and going out to local attractions when it's Halloween season.



**As a kid, Margee Kerr wondered what brought people together and what separated them. That led her to the field of sociology and, eventually, to studying our fears.**

Kerr's book Scream takes readers to some of the scariest places on Earth to explore the science of fear. She now helps design haunted houses.


TOP: M. KERR; BOOK: PUBLICAFFAIRS; SPECIAL VIEW/SHUTTERSTOCK

# GETTING THE GLOBE ONLINE

This place, Ivujivik, takes its name for the local word for "place where ice accumulates because of strong currents." Its residents are mostly Inuit. These people endured many years of oppression. Thomassie Mangiok hopes access to more technology will help restore some of the independence that was taken from them.

## Will the internet soon reach the one-third of people without it?

By **Kathryn Hulick**

T. MANGIOK

Welcome to Ivujivik. No roads lead here. The only way in or out is via airplane or boat. Thomassie Mangiok calls this northernmost town in Quebec, Canada, home. It's where he runs a company, Pirnoma Technologies Inc., that builds apps. It also provides graphic design and IT support. Oh, and Mangiok is a director at Nuvviti, the local school, too. >>

"I depend on the internet," says Mangiok. Unfortunately, internet access in northern Canada's remote towns often is slow, unreliable and expensive. "It's hard for us to get what we need up here and to give what we have," he says.

Mangiok isn't alone. All around the world — especially in rural areas — people have trouble going online. For some, high-speed internet simply isn't available where they live. Other people lack devices, training or electricity.

Jane Munga grew up in Nyeri, a rural town in Kenya. She notes that internet service providers cover most parts of Africa. Yet two-thirds of Africans still can't or don't use the internet. Around the globe, some 2.9 billion of 8 billion people are not connected. Connected and non-connected people sit on two sides of a so-called digital divide. This is a big problem.

In very remote places like Ivujivik, there may be no local health specialists, banks or sources of world news. High-speed internet is the best way to share these essential services. Other people may need high-speed internet to run a business or get an education. And many new technologies, such as Zoom, only work well with high-speed internet.

Back in 2016, the United Nations declared internet access to be a basic human right. "The internet is an equalizer," says Munga. She works on technology policy at the Carnegie Endowment for International Peace in Washington, D.C.

Several new technologies are helping to bring good internet access to those who don't yet have it. But technology alone won't fix the digital divide. Education, funding from governments or nonprofit groups, and community-led efforts can help bring the internet to people who lack it. To get everyone online, tech companies and these other groups must all work together.

## Building highways

Everything on the internet — a text to your friend, a TikTok video, even many video games — travels from device to device in chunks of data. Those chunks are called packets. Packets need a way to get around. "Think of the internet as kind of like roads or highways," says Stephen Hampton. He works in Canada at Telesat, a satellite internet company in Ottawa, Ontario.

Someone can travel faster and more smoothly on a highway than a dirt road. Similarly, packets travel better in some ways than others. Back when the internet was new, most people connected via landline telephone wires. This was the dirt road of the internet world. Packets travel slowly as electrical signals along these wires. Fiber-optic cables are the internet's highways. Laid underground or hung from telephone poles, these cables carry packets extremely quickly, as bursts of light.

Of course, highways don't reach every corner of the globe. Neither do fiber-optic cables. To build a fiber-optic connection to a remote town, workers must dig into the ground or build poles. Then they lay new cables reaching from a nearby town or city that already has high-speed internet. That can get incredibly costly, especially over very long distances. It's also tricky when mountains, rivers or other obstacles get in the way. It's no surprise that many rural areas lack this kind of connectivity.

Yet high-speed internet is so important that cables are finally reaching out to some remote areas. In 2021, a project began to bring fiber optics to Ivujivik and many other towns in the area. "Boats are going along the coast, laying long lines of cable [underwater]," says Rob McMahon. He studies digital media and technology in Canada at the University of Alberta in Edmonton.

This brand-new, high-speed internet reached Mangiok's town during the summer of 2022. His kids can now watch Netflix and YouTube. These streaming platforms hadn't worked before. Munga's hometown of Nyeri, Kenya, got a brand-new fiber-optic connection around the same time. "I saw them putting up telephone poles," says Munga. When she worked in Nyeri, she used to use her phone as a hot spot. Now, she can tap into the town's high-speed internet.

## Towers and TV channels

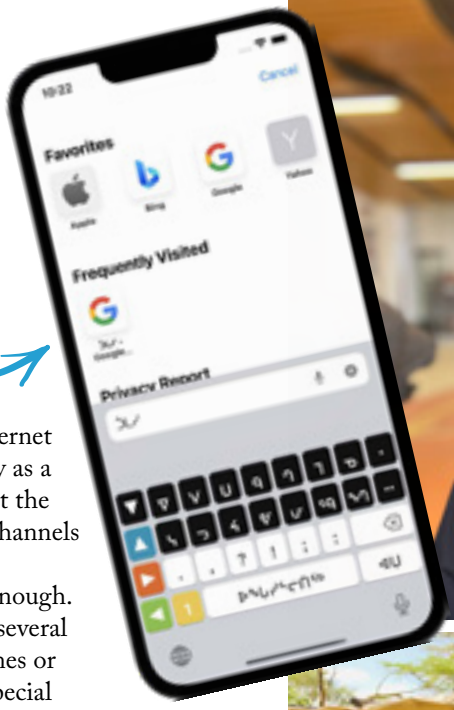
In places that lack a fiber-optic link, people may access the internet only through cell phone signals. These signals bounce packets to and from cell towers. It's how cell phones connect to the internet even when there's no Wi-Fi available.

These technologies can supply internet speeds comparable to fiber-optic cables. However, the tech that provides the fastest speeds cannot reach far. Trees, mountains or rain can block these signals, causing delays. So you need to be fairly close to a tower for these connections to work well. Since it costs less than fiber-optic cables, though, many places choose this wireless option anyway.

Another old-school technology might be a better fit for rural areas: television.

TV signals can travel farther and through more obstacles than a cellular signal. The problem with television is that most of its frequencies now carry

Thomassie Mangiok (top right) builds apps in his native language, Inuktitut. "We wanted there to be apps for Inuit to use," he says. "The foundation of our beliefs, of our views, are from our language." One project is an Inuktitut keyboard for smartphones.




television shows. Sending internet packets at the same frequency as a TV broadcast would interrupt the show. The key is to find TV channels no one is using.

One empty channel isn't enough. Internet providers must find several unused frequencies. And homes or communities would need a special receiver to convert this TV signal into Wi-Fi or some other form of internet service.

Could there be even better ways to expand access to the internet? Engineers are working on some futuristic approaches. Bring on the satellites and lasers!

## Satellites on parade

Before new high-speed cables came to town, Ivujivik's citizens connected to the internet via a geostationary satellite. Such a satellite remains directly over a single spot on the planet's surface at about 36,000 kilometers (22,000 miles) high. It sends packets back and forth as radio signals to satellite dishes on the ground.

But sending packets that far out into space and back takes time — typically around two-thirds of a second. That's more than 10 times slower than a fiber-optic cable link. The only way to speed up the link, says Hampton, is to "bring satellites closer to Earth." Satellites in low Earth orbit — or LEO — zip around the planet at heights of 160 to 2,000 kilometers (100 to 1,200 miles). They can now match the connection speed of fiber-optic cables.

These LEO satellites don't stay put over the same spot on Earth. So it takes a parade of them to provide a steady internet connection. But that gives LEO satellites one other advantage over geostationary ones. A single bad storm is unlikely to block the signals between all LEO satellites in that parade and the ground.

Telesat plans to launch 200 LEO satellites to create a planet-wide network called Telesat Lightspeed. Other companies, including SpaceX and Amazon, are launching their own LEO networks.

Jane Munga met this group of schoolgirls on a trip to Lake Oloiden in rural Kenya (bottom right). Their teacher had let them use her tablet during their free time.

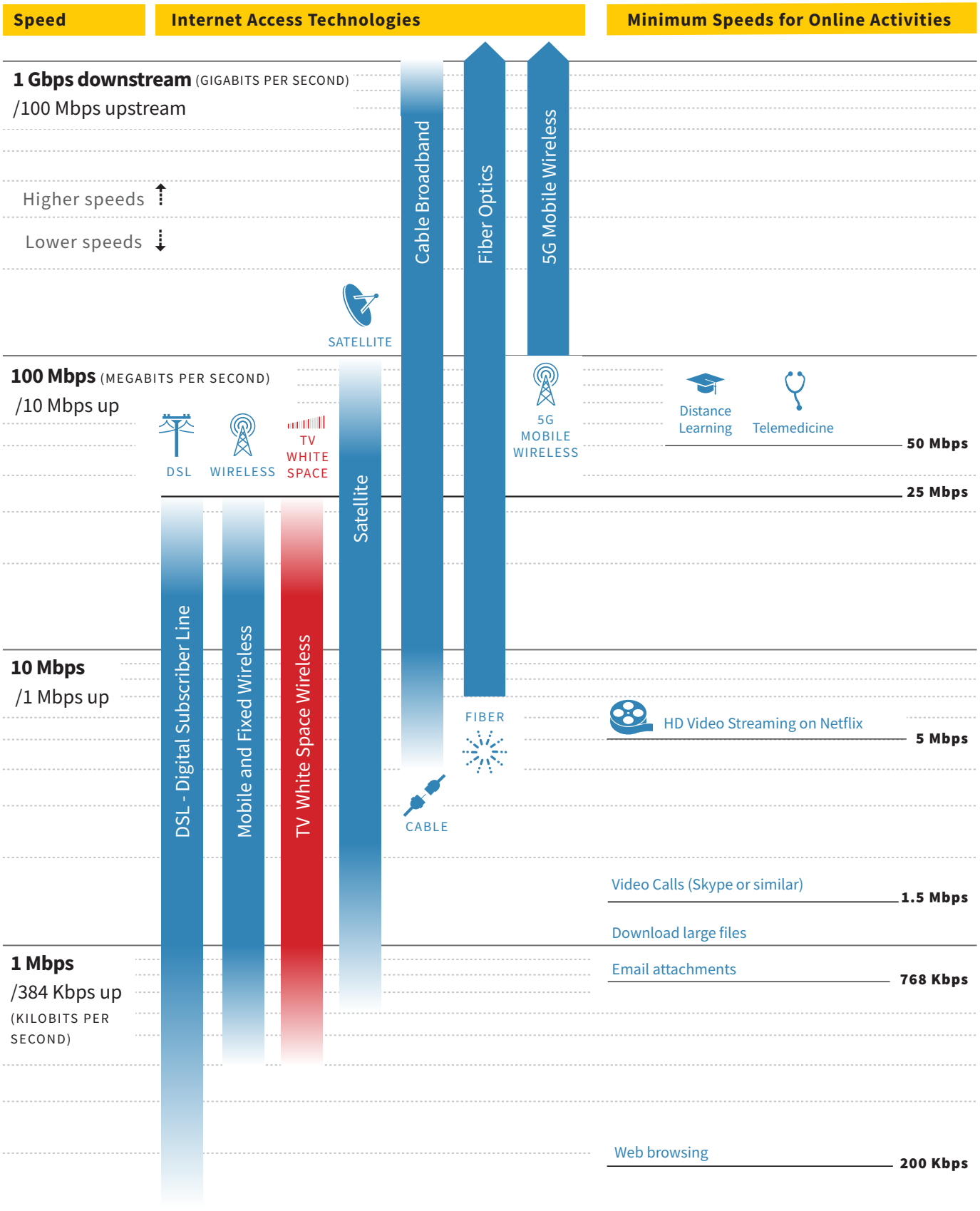
Some have already sent thousands of satellites into orbit. (The number needed to cover the whole Earth depends on their distance from the planet.)

To access such a network, some people will have to pay to install a dish or antenna on their home or business. That can be quite costly. Telesat has a different approach. "We're doing community connectivity," says Hampton. This works especially well in remote areas.

For this approach, one antenna in a central area talks to the satellite parade. From there, the internet spreads out to the rest of town via cables or a wireless signal. Many remote towns already have some sort of existing network in place. Feeding a new, high-speed connection into such an existing network makes the upgrade cheaper.

ILLUSTRATION: KINGLINE/SHUTTERSTOCK; TOP: T. MANGIOK; BOTTOM: J. MUNGA

# BROADBAND INTERNET ACCESS SPEEDS




**NOTE:** *"Satellite" on this chart is a geostationary satellite. LEO satellites and WOC are not included in the graphic.*

GEOFF MCGHEE/BILL LANE CENTER FOR THE AMERICAN WEST

On a trip to Ghana, Vickie Robinson visited a shopkeeper (right) who had recently begun selling online, thanks to a new wireless connection. "It was amazing to see what connectivity did for that shop owner," says Robinson.

## From balloons to lasers

One group tried to provide internet to remote areas with high-flying balloons. This Project Loon proved to be too difficult to make reliable, but the attempt wasn't all in vain. Along the way, "the team had to figure out how to send data reliably between balloons," says Mahesh Krishnaswamy. Its solution was a technology now called wireless optical communications, or WOC.

Krishnaswamy works at a Mountain View, Calif., company owned by Google. It's known as X, the moonshot factory. He founded and now leads its Project Taara, which uses WOC to zap packets in beams of laser light between small terminals mounted on poles up to 20 kilometers (12 miles) apart.

Like fiber optics, beams of light travel extremely quickly through the air. The tricky part is that just about anything can block these signals. Krishnaswamy points to fog, heavy rain, birds — even "a curious monkey" during one test in India. But his team has found creative ways to adapt to changes in the environment in real time.

In 2021, Project Taara used WOC in Africa to beam internet across the Congo River, the deepest river in the world, says Krishnaswamy. It would be too hard and costly to span a fiber-optic cable connection across the river. But the distance isn't that far. Here, WOC is a great solution that can be set up quickly.

## 'Internet by the people, for the people'

New technologies are exciting, says Munga. "But I have mixed feelings about them." A new group of satellites or cell tower isn't a magic solution, she says.

Vickie Robinson in Washington, D.C., agrees. "Just because you build it doesn't mean they're going to come," says this leader of the global Airband Initiative at Microsoft. Airband's goal is to connect as many people as possible to technology.

It isn't enough to just make sure internet is available to an area. People have to be able to afford it. Plus, people need the right skills, Wi-Fi routers and devices to get connected. They also need electricity. In many rural parts of Kenya, Munga points out, people lack electricity at home. So when their phone batteries run down, they pay a small fee to charge them all day at a local shopping center.

At its heart, the digital divide separates the world unfairly. Certain communities are more likely than others to lack reliable, high-speed internet, says Robinson. Among these are the elderly, people of color, women, girls, people who are part of the disability community and people who lack a secure income. Many projects support these different groups and their efforts to get online.

Munga notes that several groups in Kenya are forming community networks for internet access. It is "internet by the people, for the people," she says.

New tech can definitely help expand internet access. But often the best solutions arise when the people in a community lead the way. Mangiok is doing this in Ivujivik. Whenever he shows kids and students his apps, he's hoping they'll go out and build their own tech. "I made this, and you can make your own thing," he tells them.

Creative solutions of all kinds and in all places — from Ivujivik to Nyeri and beyond — are crucial to making sure everyone can access the internet.

# READ MORE

***The Phone Book:* Stay Safe, Be Smart, and Make the World Better with the Powerful Device in Your Hand**
*—by Jessica Speer, illustrated by Lesley Imgart*

**Ever hear of nomophobia?**

**It's the fear of losing or not having your phone. Learn more tech facts and online safety tips in this handy guide.**


TOP: MICROSOFT CORP.; BOOK: FAMILIUS

GEOLOGY

# Create a candy mystery and solve it with science

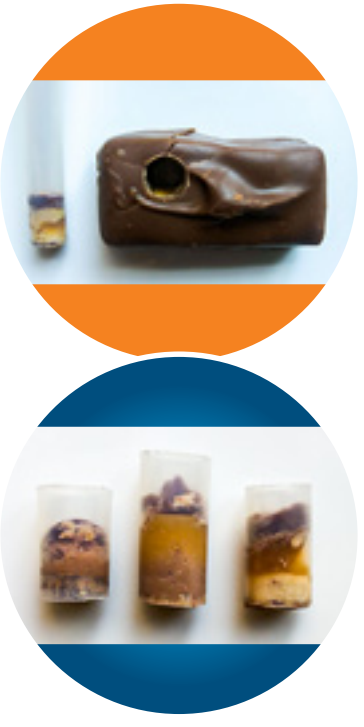
## Drill 'core samples' with a straw

By Science Buddies

Core samples are cylindrical pieces drilled from soil and rock. These samples allow scientists to study the properties and geological history of the Earth — or the moon or other planets. In this activity, make your own "core samples" from candy bars, and see if you can identify what type of candy you're looking at just from studying samples.


### OBJECTIVE

*Act like a geologist by drilling "core samples" from candy bars using a straw*



Use a straw to take a core from a candy bar (top) and then see if a friend can identify your samples (bottom).

### EXPERIMENTAL PROCEDURE

1. Unwrap a candy bar and put it on a plate.
2. Poke a clear straw through the top of the candy bar, all the way to the bottom.
3. Gently pull the straw back out of the candy bar.
4. Use a damp paper towel to wipe off the outside of the straw.
5. Use scissors to cut the straw just above the candy inside
6. Place your core sample next to the wrapper for the candy it came from.
7. Repeat steps 1–6 for at least one other type of candy bar.
8. Have a friend take a core sample without showing you which candy they used.
9. See if you can guess which type of candy your friend's core came from by comparing it to your own samples.

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

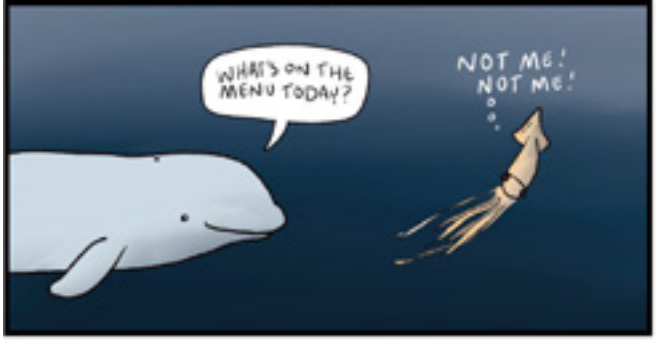
SCIENCE BUDDIES

M. TEMMING

# How toothed whales make noises with their noses

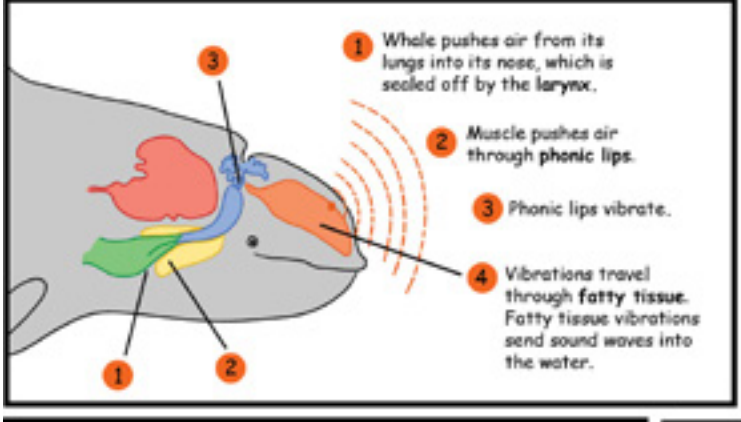
Written by Maria Temming
Illustrated by JoAnna Wendel

Toothed whales are total chatterboxes. They chirp out clicks for echolocation, which helps them hunt in the deep, dark sea, and they grunt or whistle at each other to team up for hunting, finding mates and more.

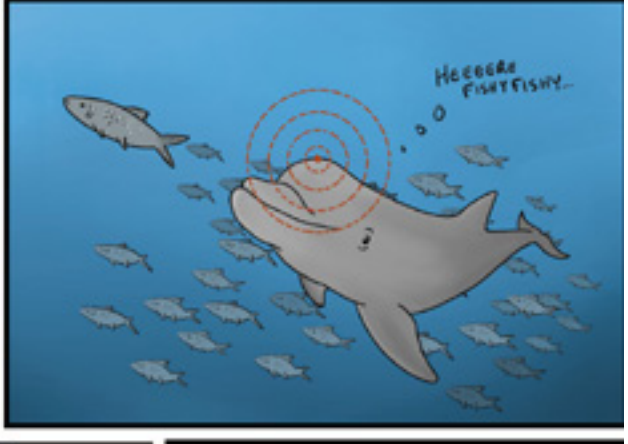



To find out how whales make these sounds, scientists used cameras to peer into the open blowholes of trained dolphins and porpoises. This revealed how tissue moved inside the animals' noses as they chattered away.

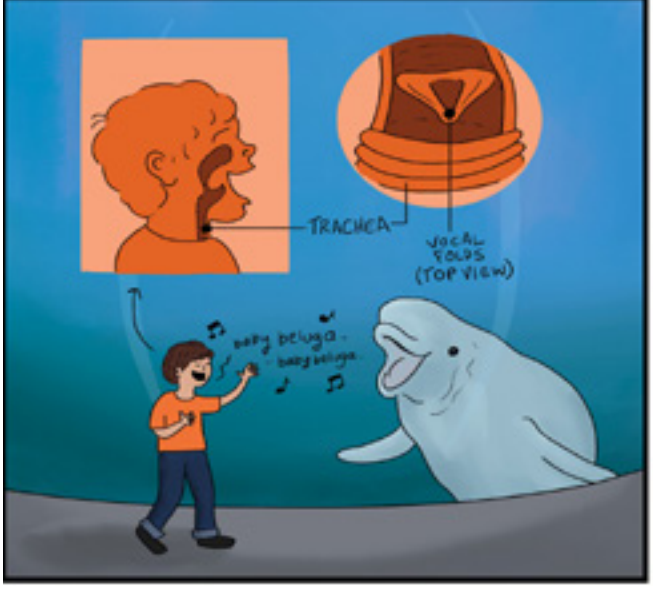

Toothed whales, they found, use their nasal passages to make noise. "It's a completely new structure," says Coen Elemans, a biologist at the University of Southern Denmark in Odense. "No other animal has it."




Whales' communication noises spread out in all directions. The clicks they make for hunting travel one way, like the beam of a flashlight.




Toothed whales' sound-making setup is similar to the way people talk or sing. We just blow air through vocal folds in our throats instead.



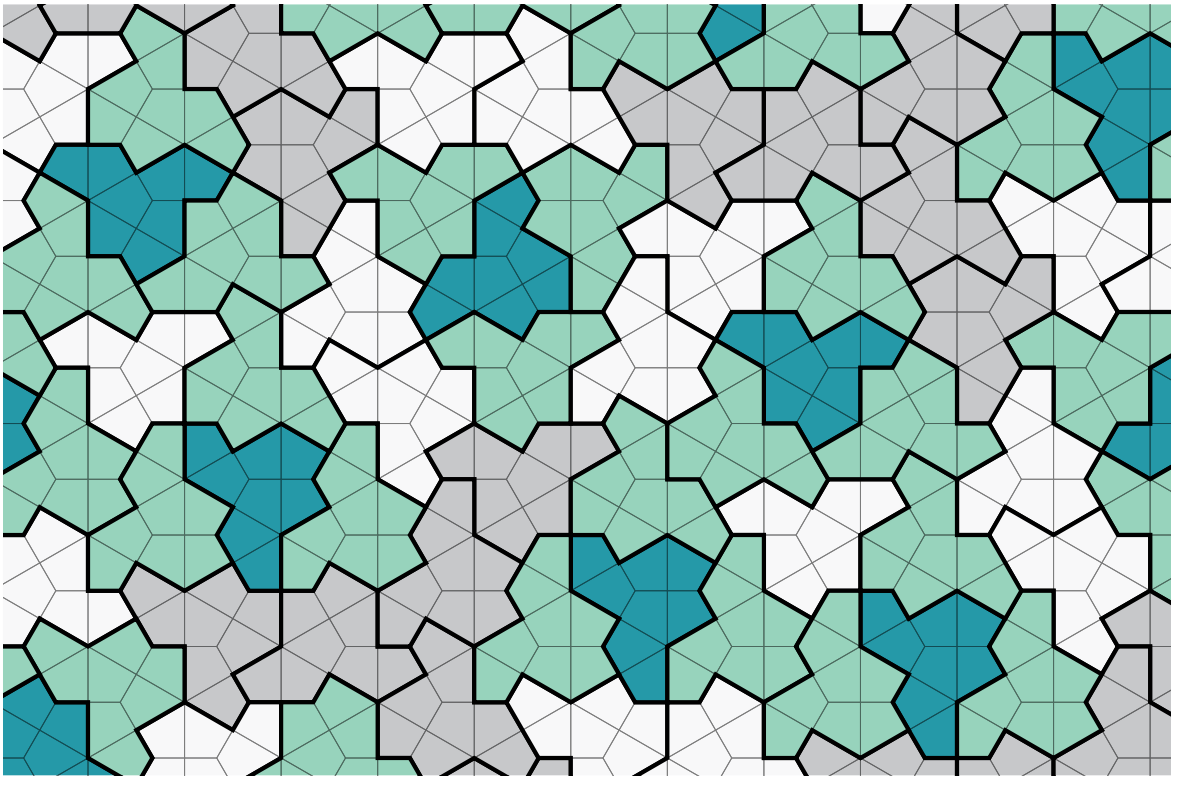

Elemans' group also found that toothed whales use their nasal voice box to make sounds in "vocal registers," such as vocal fry and falsetto, just like people. So far, humans and crows are the only other animals known to use vocal registers.

Elemans hopes this new similarity between people and toothed whales "may create some more sympathy for these animals that were close to being wiped out by us and are luckily slowly recovering."

MATH

# ‘Einstein’ tile finally found

## This strange shape eluded scientists for 50 years



The 13-sided “hat” tile can cover an infinite plane in a pattern that never repeats. Each “hat” is made up of eight smaller kite shapes.

D. SMITH, J.S. MYERS, C.S. KAPLAN AND C. GOODMAN-STRAUSS (CC BY 4.0)

To find a new, special type of shape, mathematicians put on their thinking caps.

A group of researchers recently reported finding a 13-sided shape that looks like a hat. This hat was the first true example of an “einstein.” That’s the name for a special type of shape that can tile a plane. Like bathroom floor tile, such a shape can cover an entire surface with no gaps or overlaps. It can even tile a plane that’s infinitely big. But an einstein tile does so with a pattern that never repeats.

“Everybody is astonished and is delighted,” says Marjorie Senechal. She’s a mathematician at Smith College in Northampton, Mass. She was not involved with the work. The hat’s discovery ends a 50-year search for such a shape. “It wasn’t even clear that such a thing could exist,” Senechal says.

The name “einstein” doesn’t refer to the famous physicist, Albert Einstein. In German, *ein Stein* means “one stone.” That refers to using a single tile shape.

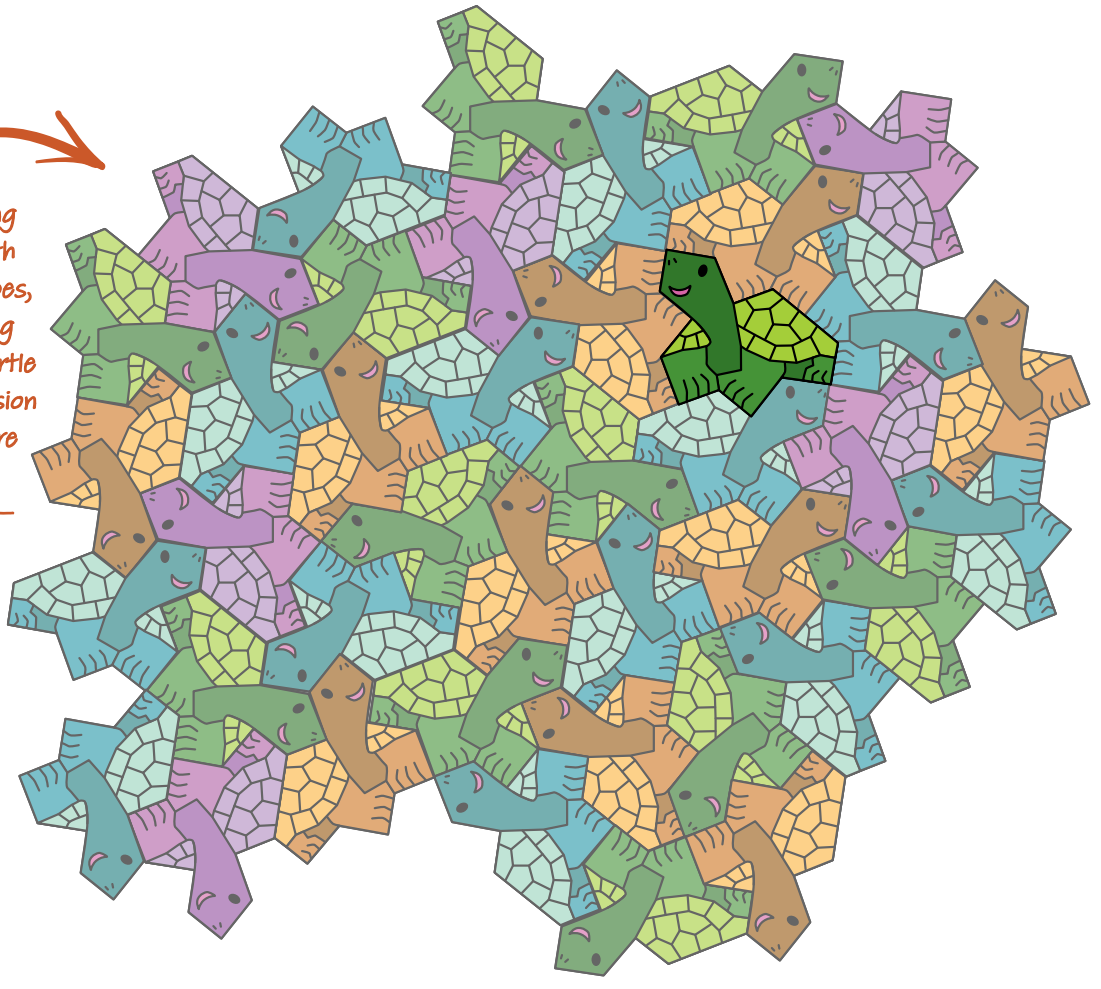
### INFINITE WITHOUT REPEATING

Think about tiled floors. The simplest ones are made with one shape that fits together neatly with others like itself, with no gaps and no overlaps. Squares or triangles work well. These floor tiles typically create a repeating pattern. You could shift the tiles over by one row and your bathroom floor would look exactly the same.

The hat could also cover an infinitely large floor. But it won’t form a pattern that repeats, no matter how hard you try.

David Smith identified the hat. He does math as a hobby, not as his job. He describes himself as an “imaginative tinkerer of shapes.” He was part of a team of researchers that reported the hat in a paper posted in March at arXiv.org.

The hat is a surprisingly simple shape, says Chaim Goodman-Strauss. Before this work, if you’d asked him what an einstein would look like, he says, “I would’ve drawn some crazy, squiggly,



Math lovers are having fun making tilings with the new einstein shapes, including these smiling turtles. The darker turtle is a mirror-image version of the shape. Two more reflected turtles are hiding in the picture — can you find them?

YOSHIAKI ARAKI

nasty thing." Goodman-Strauss is a mathematician. He works at the National Museum of Mathematics in New York City. He teamed up with Smith and others to study the hat.

Mathematicians previously knew of tile patterns that couldn't repeat. But all used two shapes or more. "It was natural to wonder, could there be a single tile that does this?" says Casey Mann. He's a mathematician at the University of Washington Bothell. He was not involved with the discovery. He calls the hat finding "huge."

## FROM HAT TO VAMPIRE

The researchers proved that the hat was an einstein in two ways.

One came from noticing that the hats arrange themselves into larger clusters. Those clusters are called metatiles. Metatiles then arrange into even larger supertiles, and so on. This revealed that the hat tiling could fill an entire infinite plane. And it showed that its pattern would never repeat.

The second proof relied on the fact that if you gradually change the relative lengths of the sides of the hat, you can find other tiles that take on the same nonrepeating pattern.

The work has yet to be peer-reviewed. That's the process in which other experts in a field read and critique the work. But the experts interviewed for this article think that the result will likely hold up.

In May, the same team made another announcement. They found a new type of einstein shape. This one is even more special. The researchers shared it in another paper at arXiv.org.

The first einstein made a pattern that involved both the tile and its mirror image. The new tile also makes a pattern that never repeats but without its reflection. Because the shape isn't paired with its reflection, you might call it a "vampire einstein," the researchers say. They found a whole family of vampire einsteins that they're calling "spectres."

"I would never have predicted that we'd stumble upon a shape that solves this [vampire-einstein problem] so quickly," says team member Craig Kaplan. He's a computer scientist at the University of Waterloo in Canada.

Researchers should continue the hunt for einsteins, he says. "Now that we've unlocked the door, hopefully other new shapes will come along."

— *Emily Conover*

ANIMALS

# How Godzilla might get his atomic breath

## The movie monster could be gorging on radioactive gravel

Meet Godzilla, a kaiju. This colossal dinosaur-like monster walks on two legs. He has thick, scaly skin. His mouth is full of sharp teeth. And he has a grudge to settle. Godzilla was once a peaceful prehistoric sea creature. But nuclear bomb tests polluted his underwater home with massive amounts of radiation.

Newly mutated and furious, Godzilla rose from the ocean off Japan's coast. He walked ashore, heading for Tokyo. There, he unleashed a rampage. He toppled buildings. And he blasted the city with deadly radioactive beams that shot from his mouth as he roared. After the attack, most of the city was destroyed, on fire or both.

Many of the people in Godzilla's way were now dead. Any survivors were suffering.

For someone exposed to Godzilla's fire, the immediate danger would be the burns, says Alex Wellerstein. He is a historian of nuclear weapons at the Stevens Institute of Technology in Hoboken, N.J. Survivors of the initial blast would have to worry about radiation sickness. This happens when exposure to high-energy radioactive particles damages or kills cells in the body. Symptoms include nausea, headache and feeling dizzy and disoriented. It can cause hair loss, internal bleeding and infections. And depending on the radioactive substance and its half-life — how long that substance sticks around — health risks could persist for decades, Wellerstein says. Often, radiation sickness is fatal.

Godzilla first tore across screens in the 1954 Japanese movie *Godzilla*. Since then, he's had many different forms in films and books. But most Godzilla forms feature his signature power move: atomic breath. This powerful beam of radiation shoots from his mouth as he roars.

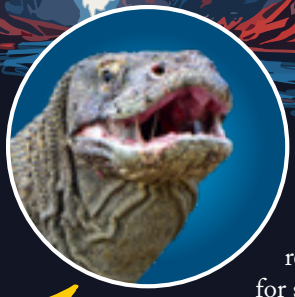
Maybe Godzilla's awe-inspiring atomic breath could be possible. But it would take some special tricks of biology.

### DEADLY BREATH

Godzilla's atomic breath almost always appears as a tightly focused beam. But a blast of pure radiation would, well, radiate — spread out in random directions. Godzilla's atomic breath could be full of steam, water vapor or even spit, notes Wellerstein. Such a medium could carry radioactive particles out in a forceful stream. This version of atomic breath wouldn't look like the atomic breath attacks in recent movies. There, Godzilla shoots laser-like beams. But it would still be deadly.

No matter the shape of the emitted breath, Godzilla would need a source of radiation. And an attack as intense as atomic breath would take an immense

AGUSTIN A/SHUTTERSTOCK



The Komodo dragon, a fierce predator, can get rotting meat stuck in its teeth and could be a model for truly terrifying breath.

SERGEY URYADNIKOV/SHUTTERSTOCK

amount of power. His specialized anatomy includes a bio-nuclear reactor and special organs for storing uranium-235 (see page 28). This is an isotope, or version, of the element uranium that is radioactive. It's usually the fuel in nuclear power plants. "The uranium-235 isotope in our present world is not very abundant," says Wellerstein. It would be challenging to imagine atomic breath evolving naturally on Earth due to the scarcity of uranium-235. But in a different dimension or planet with higher uranium-235 levels, it could be plausible. On Earth, uranium can be found in rocks. In theory, Godzilla's gut could be designed to pull uranium out of rocks, then concentrate and store it.

No lizards are known to eat rocks. But chickens, which are descended from dinosaurs, do eat small rocks. They swallow the rocks whole and store them in their gizzards. This is a special digestive organ unique to birds. Birds lack teeth. So, the gizzard helps grind up their food.

Godzilla could also have a gizzard-like organ for storing and crushing uranium-rich rocks. This could power his bio-nuclear reactor and his atomic breath. But he would need to be constantly eating rocks to replenish his uranium stores. And no matter which version of Godzilla you consider, that's a lot of rocks. (Maybe this is what he does during his non-rampaging downtime.) "You've just got to imagine that biologically, Godzilla works a little differently," says Wellerstein.

## GODZILLA, BRUSH YOUR TEETH

Maybe Godzilla doesn't need to munch on mountains, though. Perhaps the radioactivity is coming from some truly awful breath. "If I was going to think about what's the most noxious breath and lizards, it would probably be a large meat-eating lizard, like a Komodo dragon," says James Stroud. Stroud is a lizard biologist at Georgia Tech in Atlanta.

The Komodo dragon is an apex predator with extremely sharp teeth. It hunts and takes down large prey. It devours carcasses. It often has rotting meat stuck in its teeth and frequently drinks from bacteria-infested water.

Godzilla is an apex predator, too, and a likely carnivore (look at those teeth!). But he is almost never seen chowing down on animal protein. Godzilla could be secretly eating other kaiju off-screen and getting that rotting radioactive material stuck in his teeth. Or, Stroud proposes, "imagine Godzilla eating workers of a radioactive plant … and that meat stays within his teeth. His breath could then emit radioactivity via the rotting pieces of meat in his mouth."

But that blast might be deadly for another reason. Stroud adds, "The breath would smell horrendous."

— *Lillian Steenblik Hwang*

PHYSICS

# The basics of radioactivity

## Some elements shed parts of themselves


Chemical elements can take several forms, called isotopes. All have the same number of protons in their nucleus but different numbers of neutrons. Some of these isotopes are unstable, but they don't want to be unstable. So they morph by shedding one or more subatomic particles. Through this process, they naturally transform into a more stable (and always smaller) element.

The expelled particles and energy are known as radiation. That morphing process is called radioactive decay.

The radiation emitted by that decay can take several forms. Often, it sheds light (a form of energy), an alpha particle (two neutrons bound to two protons) or an electron or a positron. But there are a whole host of other tiny particles that might also be released.

This radiation can damage cells, causing mutations, cancer or even death of an organism.

How long it takes an isotope to decay depends on a lot of factors. But scientists describe the process in terms of its half-life. An isotope's half-life is defined as the amount of time it takes for one-half of the atoms of a radioactive isotope to decay. That half-life is always the same — like an unwritten rule — that is specific to each isotope.

Some isotopes decay very quickly. Take the lab-made isotope lawrencium-257. Its half-life is little more than a half-second. Other isotopes may have a half-life measured in hours, days or years.

Some decays involve an atom's nucleus ejecting a single particle. Other decays may be a complicated multi-step process. For instance, sometimes one isotope ejects energy and a particle, which then results in a new unstable isotope. This interim atom now decays (with a new half-life), again shedding energy and some particles as it seeks to become stable. Still other decay chains can lead one element to morph into two or more different ones on its path to stability. For instance, uranium-238 decays into radioactive isotopes of thorium, radium, radon and bismuth — before ending up as the non-radioactive lead-206.

— *Janet Raloff and Trisha Muro*

OLE.CNX/SHUTTERSTUCK

## DECAY CHAIN OF RADIATION

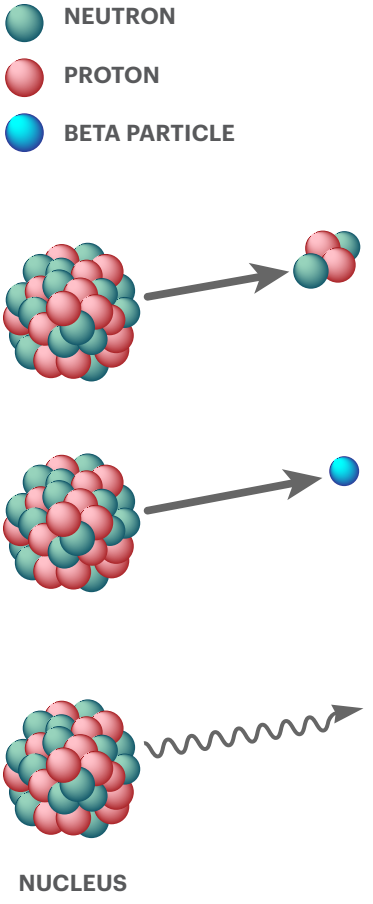
| | HALF LIFE |
|---|---|
| **Uranium-238** | 4.5 x $10^9$ years |
| **Thorium-234** | 24.5 days |
| **Protactinium-234** | 1.14 minutes |
| **Uranium-234** | 2.33 x $10^5$ years |
| **Thorium-230** | 8.3 x $10^4$ years |
| **Radium-226** | 1,590 years |
| **Radon-222** | 3.83 days |
| **Polonium-218** | 3.05 minutes |
| **Lead-214** | 26.8 minutes |
| **Bismuth-214** | 19.7 minutes |
| **Polonium-214** | 1.5 x $10^{-4}$ seconds |
| **Lead-210** | 22 years |
| **Bismuth-210** | 5 days |
| **Polonium-210** | 140 days |
| **Lead-206** | Stable |

Cherenkov radiation causes the fuel in this nuclear reactor to glow blue. This kind of radiation occurs when electrons travel through water faster than light does.

α **ALPHA RADIATION**
This type of radiation emits positively charged alpha particles, which consist of two protons and two neutrons. Due to their large size, alpha particles can cause severe damage to DNA and cells. But they are also relatively slow and have difficulty penetrating very far into matter. They can be blocked by intact skin or a piece of paper.

β **BETA RADIATION**
A beta particle, emitted by this type of radiation, has the same mass as an electron and can carry a negative or positive charge. These particles zip around, traveling farther than alpha particles, but they can be stopped by a thin layer of a metal such as aluminum or even clothing. Inhaled or swallowed, though, these particles can still be hazardous.

**X-RAYS AND GAMMA RADIATION**
Gamma rays are the most energetic form of light. They differ from X-rays only in their source. Both types of this radiation penetrate deeply through most materials. They also can interact with matter along the way. On Earth, many radioactive isotopes (especially those of uranium, thorium and actinium) emit gamma rays as they decay to a stable form. The X-ray form of this radiation is emitted when electrons are beamed at some target or when electrons have been forced to rearrange themselves within some atom.




TOP: GENEVIEVE MARTIN/ORNL/FLICKR; ATOMS: GSTRAUB/SHUTTERSTOCK

MATERIALS

# How to keep warm like a polar bear

## A new fabric absorbs light and traps heat like polar bears' pelts

A new fabric traps heat by mimicking polar bears' pelts.

Polar bears have black skin covered by fur that looks white. But that fur isn't like normal hair, says Trisha Andrew. "It has a very unique structure." A materials engineer, Andrew works at the University of Massachusetts Amherst.

Polar bears' hollow hairs channel infrared light from the sun toward their skin. This light is invisible but can be felt as heat. A dark pigment in the bears' skin — similar to the melanin in human skin — absorbs the infrared light. It also absorbs visible light that passes through the fur.

The layer of fur traps the heat from absorbed light. That can keep a bear warm for a while after the sun goes down, Andrew says.

Andrew and her colleagues designed their material to work in the same way. Nylon, a common material in clothing, forms the bottom layer. It's coated with a polymer called PEDOT, whose molecular arrangement and dark color lets it absorb light like polar bear skin does. On top of that, the team added a lightweight layer of fabric called Agribon AG-19. It has tiny fibers that carry light toward the "skin" layer like polar bear hair does.

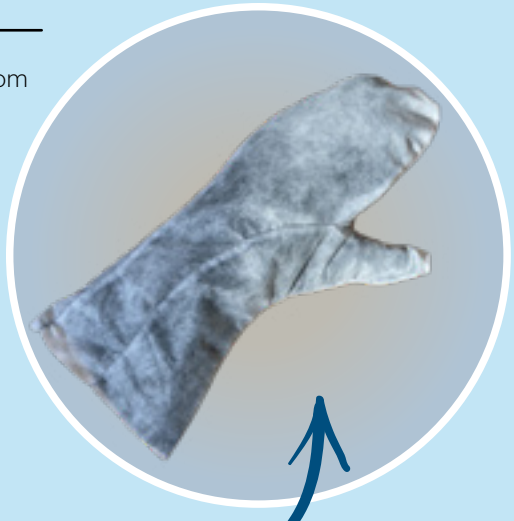
Under light, the new fabric kept a surface beneath it 10 degrees Celsius (18 degrees Fahrenheit) warmer than cotton T-shirt fabric did. The new material also performed better than Omni-Heat fabric, a material currently used to make warm outdoor gear. The researchers shared their results in *ACS Applied Materials & Interfaces*.

"It's washable. It's breathable. You could sew with it," Andrew says of the new fabric. It would feel like a lighter version of fabrics used for curtains and to cover couches, she adds. Used to make clothes or tents, this fabric could keep people cozy in frigid places like the Arctic. — *Carolyn Wilke*

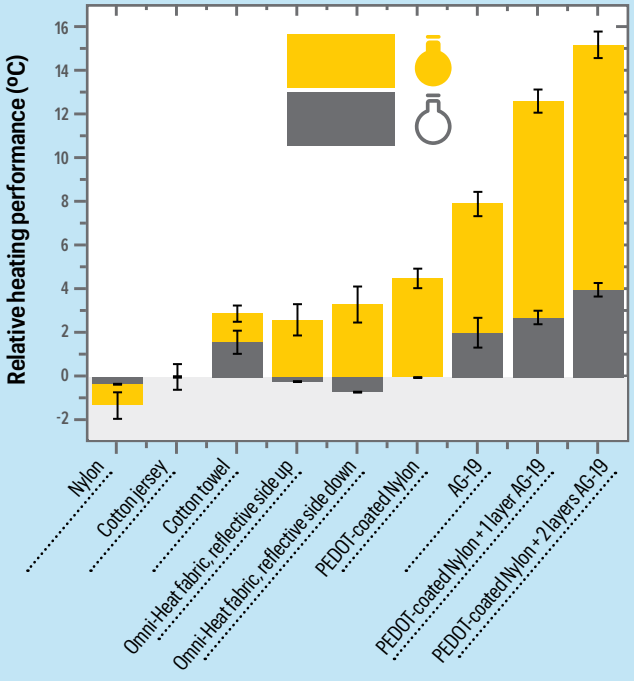
ALEXEY SEAFARER/SHUTTERSTOCK

## HEAT-HOARDING FABRIC

Inside a chamber, researchers placed manila paper that was heated slightly from below. The paper was meant to mimic skin warmed by body heat. On top of this "skin," the researchers placed different fabrics. Then, they measured how hot the chamber needed to be for the "skin" to be a comfy temperature. (The cooler the chamber could be with the skin still comfy, the toastier the fabric.) The scientists did this test in the dark (gray) and under light (yellow). They compared all materials to cotton jersey, which is often used for T-shirts. Materials that kept the skin warmer than cotton jersey appear as bars above zero. Higher bars for the relative heating performance mean that the materials perform better at keeping skin warm. Fabrics that don't keep the skin as warm as cotton jersey appear as bars below zero.



*The new fabric could make clothes like this mitten extra toasty.*




### DATA DIVE

**1.** How do the different materials perform under dark conditions? What is the range — the spread — of values?

**2.** Which material is the warmest in the dark?

**3.** How do the materials perform under light? What is the range of values?

**4.** How do the values under light compare with those in the dark? Why do you think that is?

**5.** Nylon is the bottom layer of the new material. How does its warmth compare with that of PEDOT-coated Nylon?

**6.** AG-19 is the top layer of the new material. How does the heating of PEDOT-coated Nylon compare with PEDOT-coated Nylon + 1 layer of AG-19? What is the benefit of adding another layer of AG-19 (PEDOT-coated Nylon + 2 layers AG-19)?

**7.** What are some ways you might use a heat-trapping material like this new textile?

MITTEN: W. VIOLA/UNIV. OF MASSACHUSETTS AMHERST; GRAPH: W. VIOLA *ET AL/ACS APPL. MATER. INTERFACES* 2023; ADAPTED BY L. STEENBLIK HWANG

ANSWER

# Go ahead, shout into the wind

## It's hard to hear yourself, but people upwind can hear you just fine

To describe something as pointless, people may compare it to shouting into the wind. This saying implies that making noise against the flow of air is very hard. But is it really?

Ville Pulkki studies acoustics at Aalto University in Espoo, Finland. He was part of a team that tested what happens when you shout upwind. Pulkki first tested the effect by hollering with his head out the top of a moving car, surrounded by microphones.

The results were inconclusive. So, Pulkki and his team put a speaker playing multiple tones on top of a moving vehicle. Microphones measured how loud the noise would sound in different spots, including where the yeller's mouth and ears would be.

Sending sounds upwind, against the flow of air, actually makes them louder, the researchers found. This is an effect known as convective amplification. Someone standing in front of you should have no problem hearing you. Sound sent downwind, in contrast, is quieter. When you yell upwind, your ears are downwind of your mouth. So your own voice sounds quieter to you. That makes it seem like other people can't hear you well, even though they can.

The researchers described their findings in *Scientific Reports*.

— *Emily Conover*

Don't try this at home! Researcher Ville Pulkki yelled into the wind from a moving car fitted with a ring of microphones.

COURTESY OF ILKKA HUHTAKALLIO

# INSIDE THE MIND OF A YOUNG SCIENTIST

## A Regeneron International Science and Engineering Fair competitor answers three questions about his science

**Science competitions can be fun and rewarding.** But what goes on in the mind of one of these young scientists? Riccardo López-Cepero Navarro, who competed at the 2023 Regeneron International Science and Engineering Fair (ISEF), shares some of his science inspiration and advice.

**Q What inspired your project?**
**A** One of my teachers and one of my uncles. They suffer from kidney stones, which cause them excruciating pain. They can't afford to get surgery to remove every stone. It's also an invasive process. My teacher mentioned how the pain is with him day and night. It comes and goes. So that motivated me to find a way to help those in need with a totally accessible treatment.


**Q What was the most challenging part of your project?**
**A** Synthesizing the calcium oxalate crystals. [This substance makes up the most common type of kidney stones.] We failed three times before we managed to get the synthesis right.

**Q What advice would you give to other students starting a science project?**
**A** Never give up. It's a lot of work, and hard work. You have to be patient with your experiment. There are many ups and downs, but you cannot limit yourself. One has to battle those adversities in order to achieve their goals. I went into my regional competition thinking I wouldn't win a single award. But deep inside I knew that I had done an amazing job, and that is what matters. Getting my name called up was something I can't describe with words, but it certainly felt fulfilling. I didn't imagine that I would get to that point. The ability to help those in need is something that always propels me to give 110 percent. So to all those students out there: Never give up, and find something to help those that need it the most.

### Translational Medical Science

## Riccardo López-Cepero Navarro

**Many people in Puerto Rico use white broomweed to treat colds, coughs and other conditions. The herb is known for having anti-inflammatory and regenerative abilities. Riccardo, 17, tested whether the herb, brewed as a tea, might also be able to treat kidney stones. He found that, at high concentrations, the herbal tea can dissolve the crystals and concluded that it holds promise as an effective, low-cost treatment for people with kidney stones. Riccardo is a senior at Colegio San Ignacio de Loyola in San Juan, Puerto Rico. He hopes one day to be a doctor.**

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