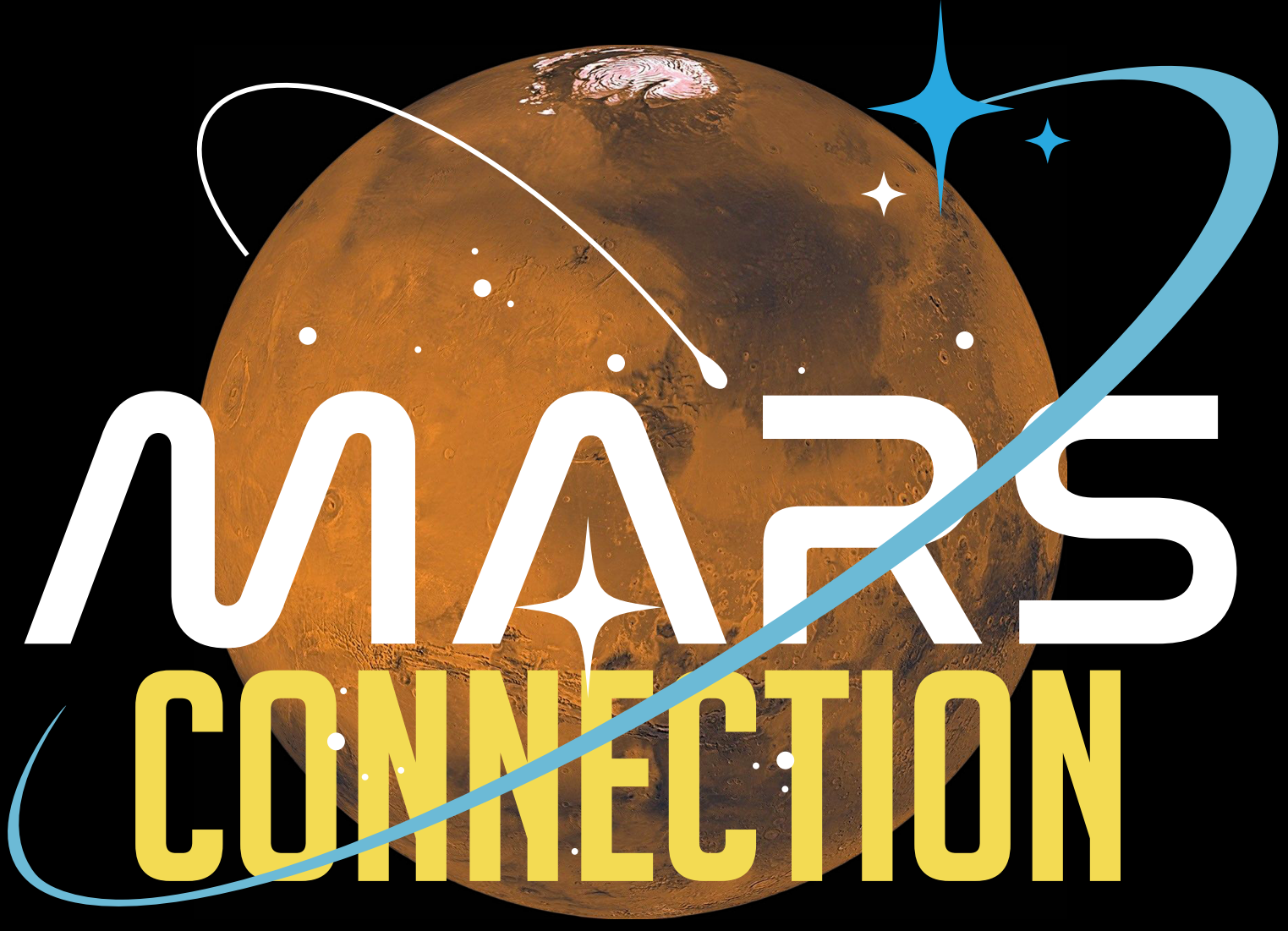
ScienceNews Explores
February 2025

YOU'RE TOO DISTRACTED

WHAT IS THE INTERNET?
P28



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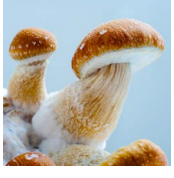

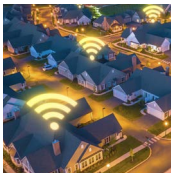

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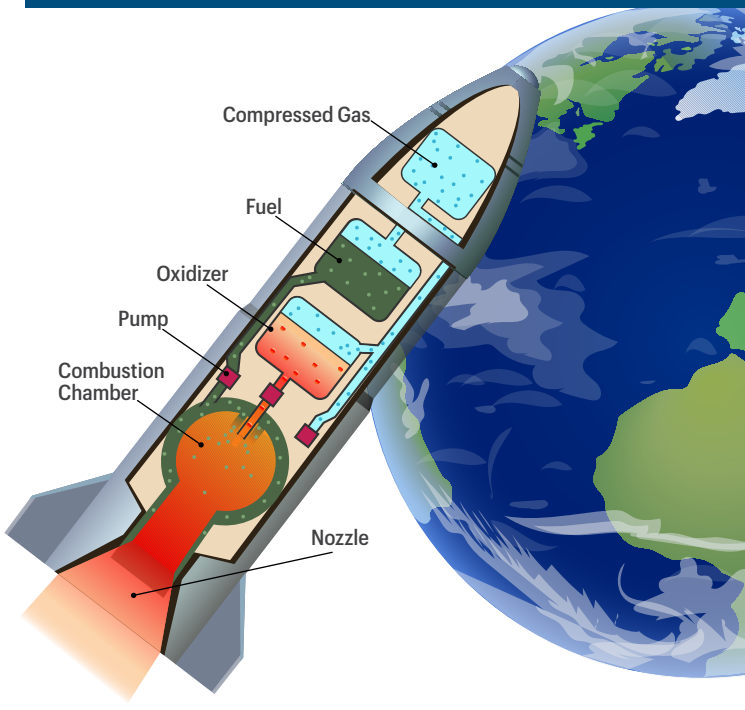
Q How is rocket fuel made?

— Hudson T.

A "We have a whole array of different fuels that we use," which are made different ways, says Stephen Heister. He's an aerospace engineer at Purdue University in West Lafayette, Ind. First, there are the fuels that help launch rockets into space, such as liquid hydrogen. This fuel is created by deep-freezing hydrogen gas in a machine like "a monstrous refrigerator," Heister says. Another common launch fuel is liquid methane, which is drawn from natural gas. Then there are the fuels that spacecraft carry onboard to power them through their missions. One of these so-called storable fuels is kerosene, which is similar to the gas we put in our cars. "It's obtained from part of the oil that's pumped out of the ground," Heister says. Another storable fuel is hydrazine — an extremely dangerous, toxic substance that can cause cancer and is made by experts at special chemical plants.



Q How are we made of stardust, chemically?

— Janice H.

A Nearly all of the elements making up our bodies come from imploding stars. This happened through a process called nucleosynthesis, says Ashley King. A planetary scientist at the Natural History Museum in London, England, King studies the early solar system. The first stars formed from collapsing clouds made mostly of the elements hydrogen and helium. The cores of these stars began to combust, rapidly fusing these elements into heavier ones. Once those stars ran out of fuel, they imploded. The resulting explosions, called supernovae, swept the stars' innards into space at nearly 50,000 kilometers per hour (30,000 miles per hour). This "seed[ed] interstellar space with fresh elements," says King, leading to new stars capable of fusing even heavier elements. Over billions of years, these elements combined in all sorts of ways, leading to the formation of planets, water and, eventually, us.

FIND OUT MORE USING THE QR CODES.

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

Sarah Zielinski
Editor, *Science News Explores*

CORRECTION

In the December 2024/January 2025 story "How volcanoes erupt" (p. 28), Christy Till's affiliation was incorrect. She is a volcanologist at Arizona State University in Tempe. We apologize for the error.

ZAPORIZHZHIA VECTOR/SHUTTERSTOCK

ANIMALS

Metal gives Komodo dragons super strong teeth

The tips and cutting edges are coated with iron

Despite growing to up to 3 meters (almost 10 feet) in length, these large lizards don't have to eat often — sometimes just once a month. An iron coating on their teeth (inset) helps them tear through animal flesh.

Komodo dragon teeth are ironclad. For real. These animals — the largest living lizards — have razor-sharp teeth. What's more, a layer of iron lines the tips and sawlike edges of these chompers. That's the finding of a study in *Nature Ecology & Evolution*.

That metal coating may strengthen each tooth. It could help the Indonesian lizards safely tear through the flesh of deer, water buffalo and other prey. (Indonesia is a nation of many islands in Southeast Asia.)

Iron teeth aren't unique to Komodo dragons, notes Aaron LeBlanc. Beaver teeth get their toughness from iron-infused enamel. But in Komodo dragons, the iron is piped on top of the enamel. "Sort of like icing on a cake," he says. LeBlanc is a paleontologist in England at King's College London.

He was part of an international team that wanted to know what made meat-eating dinosaurs' teeth so good at cutting. The group turned to Komodo dragons as a modern-day stand-in. Small, blade-shaped teeth fill the dragons' mouths. Under a microscope, the team saw orange stains on the tips and edges of their teeth.

Chemical and structural analyses revealed a layer of iron as the source of that orange tinge.

Some modern meat-eating reptiles — including alligators and crocodiles — also have a thin layer of the metal on their teeth. But the iron along their chompers' cutting edges isn't always visible.

As for dinos, it's still unclear whether their teeth had an iron shield.

Iron is "just everywhere" in the ground, LeBlanc says. So "if you bury a dinosaur tooth underground for tens of millions of years," he says, "iron is going to seep in."

— *Erin Garcia de Jesús*

A.R.H. LEBLANC *ET AL/NATURE ECOLOGY & EVOLUTION* 2024; IMAGEBROKER.COM GMBH & CO. KG/ALAMY STOCK PHOTO

PHYSICS

Weirdly, mayo can help study conditions ripe for nuclear fusion

Sandwich spread provides insight into the behavior of gloopy materials

Sometimes mayo is elastic, sometimes it's plastic. Other times, it's just tasty. Or gross, depending who you ask!

XPIXEL/SHUTTERSTOCK

You might expect mayonnaise in sandwiches or potato salad. But in the lab? Turns out, it's surprisingly useful for studying nuclear fusion.

Mayonnaise can behave in a few different ways. If jiggled gently, it returns to its original shape. That's called elastic behavior — like how an elastic hair band will return to its original shape after you stretch it. But fling the mayo forcefully and it takes on plastic behavior. That means it permanently changes its shape or can even break apart. (The plastic found in water bottles is named after its ability to be molded and shaped.)

This elastic-to-plastic shift also can also take place in tests that use lasers to kick off nuclear fusion. That's the process where slamming two lightweight atoms together hard enough can make them merge, or fuse. The mass of this combo is less than the sum of the starting atoms. That's because some of that mass is converted into energy. So the process releases energy.

If scientists can learn how to control fusion, one day it might be used to generate electricity.

Teams of scientists have been working to ignite a fusion reaction in the lab that releases more energy than went into it. In December 2022, one succeeded. Researchers at Lawrence Livermore National Laboratory in California beamed 192 lasers at a small chamber containing fuel. The pressure and temperature inside the fuel got so high the nuclei of its atoms fused. And those fusion reactions released more energy than had been needed to set them off.

But it's difficult to study how materials behave under the extreme conditions required for fusion. That's where the mayonnaise comes in.

The fuel capsule in fusion experiments, it turns out, acts a lot like mayonnaise. The capsule is a metal or other material that contains a gas (the fuel). When lasers hit the capsule, it melts.

The molten capsule can switch from elastic to plastic. Like gloopy mayo, it doesn't flow on its own. Under enough force, however, it can break apart. If the capsule becomes plastic before fusion occurs, the gas could escape and prevent the reaction.

Two mechanical engineers at Lehigh University in Bethlehem, Pa., wanted to understand that better. Aren Boyaci and Arindam Banerjee spun a wheel into which they'd dropped dollops of mayo. The force of the spinning wheel mixed the mayo with air. Here, the mayo acts like the melted capsule, and the air acts like the gaseous fuel.

The scientists observed the glob while the wheel was spinning. They looked at it again after it stopped. They checked whether the mayo had returned to its original form, changed shape or broken apart. This determined the border between its elastic and plastic behaviors, they explain in *Physical Review E*.

Working with mayo does have one drawback. When you show up in the supermarket checkout line with 48 containers of mayo, you're bound to attract attention. "We sometimes get a lot of questions from the grocery stores," Banerjee says, asking "why we are buying that much mayonnaise."

— *Emily Conover*

ARCHAEOLOGY

A silent 'scream' hints at a mummy's violent death

Her open mouth could be from a rare type of muscle stiffening

Eek! A horrible death could explain the horrified look on one Egyptian mummy's face.

Her remains were unearthed in the 1930s in the ancient Egyptian city of Thebes. They'd been found in a burial chamber from roughly 3,500 years ago. The woman's mummy — nicknamed the "Screaming Woman" — seems to wear an open-mouthed look of pain or fear.

Now research suggests that her expression resulted from a rare muscle reaction at death. It's called a cadaveric spasm. This is a sudden stiffening of muscles in someone who dies a violent death under extreme physical and emotional stress.

Sahar Saleem and Samia El-Merghani shared these findings in *Frontiers in Medicine*.

Saleem is a radiologist. She works at Cairo University in Egypt. El-Merghani is an anthropologist, also based in Cairo. She's a mummy conservator at Egypt's Ministry of Tourism and Antiquities.

The Screaming Woman's cause of death remains a mystery. So researchers cannot be sure a cadaveric spasm caused her fearful look. But new evidence shows that mummifying her body took care and cost. This hints that the embalmers who preserved her did not simply forget to close her mouth.

CT scans showed that the woman's internal organs had not been removed. That's unusual in Egyptian embalming. The researchers looked at samples of the mummy's skin, hair and wig under a microscope.

They also analyzed chemicals in those samples. This revealed imported juniper resin and frankincense on the mummy's skin. Such treatment would have kept the body well-preserved. Embalmers took further care to dye the woman's hair with juniper resin and henna.

S. SALEEM

This Egyptian mummy is known as the "Screaming Woman." Her permanently open mouth was likely caused by a rare muscle spasm when she died.

The mummy also wore a braided wig. It was made from date palm fibers that had been dyed black. (The color black represented youth in ancient Egypt.)

This all suggests that if the embalmers who worked on this mummy could have closed her mouth, they would have. So her silent "scream" was likely frozen in place when she died.

— *Bruce Bower*

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

YOU'RE TOO

By **Alison Pearce Stevens**

SURYADI SUYAMTINA/SHUTTERSTOCK

DISTRACTED

But better screen time, sleep, diet and exercise habits can help you regain your focus >>

I have a confession. Every time I sat down to work on this article, I got distracted.

The dogs wanted attention, so I petted them. My phone would ding when a text came in, so I got up to check. I was tired, so I took a nap. And I might have gotten sucked into some extended time scrolling through Instagram. It was remarkably difficult to focus on writing about distractions because, well, I was too busy being distracted.

Distraction is a tricky thing. Often, we don't feel like we're distracted. In fact, we think we're paying attention, often to multiple things at once.

But science has shown that we aren't truly capable of multitasking. Our brains evolved to stay focused on one or two things at a time. When we multitask, our brains actually quickly switch from one task to another. It feels seamless. But it's not. It comes with major consequences for our ability to pay attention and think deeply about things.

I'm hardly alone in being easily distracted. People generally have become more distracted than ever before. But don't despair! There are steps we all can take to reduce distractions and boost focus. These include changes in screen time, sleep, diet and exercise. Making a few changes can make you a safer driver. They also can make you a more attentive friend — and even help you do better in school.

Your phone can be a big distraction. If you can't avoid the temptation, turn off notifications or the phone itself.

Set new screen habits

For many of us, phones are one of the biggest distractors in our lives — and that's no accident. Our phones have trained us to be on constant alert, says Gloria Mark. She studies digital distraction at the University of California, Irvine. "We pick up our phones when we see them," she says. Try it sometime: Walk by your phone without checking it. How hard is it to leave the phone untouched?

STONEPICTURES/SHUTTERSTOCK

That pull to constantly check for notifications isn't accidental. The people who create social media software use algorithms to figure out when to send those little reminders.

"Notifications can distract us because they use information to elicit emotional responses," Mark explains. "We can't help but respond when an ad or notification brings out an emotion in us, like surprise or fear." That's why it's so hard to resist checking for new content.

A 2018 survey found that adults check their phones about 58 times a day. Many of those checks are for just a few seconds. Still, they add up in a big way. That's because it takes time for our brains to return to what we were doing before the interruption. That delay can have a real impact on how well we focus on the next task.

For people old enough to drive, such distractions are downright dangerous. One in three teens admits to using their phone while driving. Eyes that are on a phone aren't looking at the road. And this slows reaction times. In fact, teen drivers who are texting are 23 times as likely to crash as their non-messaging peers. That's according to the U.S. National Highway Traffic Safety Administration.

But it's not just when you're behind the wheel that phone distractions can have serious impacts.

"Social media can be super fun," says Teun Siebers. He studies social media and teen behavior at the University of Amsterdam in the Netherlands. Checking your social media can "also make it tricky to focus on important stuff like schoolwork," he notes.

Imagine you're super focused on a project with a great idea for what to do next. Then your friend sends you a funny video. When you get back to the assignment, you've lost track of what you were doing. "It takes a while to get back into the work," Siebers says. "And you might forget some of your good ideas."

In one 2022 study of 383 seventh and eighth graders, Siebers found a strong link between social media use and how distracted people felt. Teens in the study installed an app on their phones. Several times a day, the app prompted them to answer questions. These focused on social media use and distraction during the previous hour. Teens who reported spending more time on social media said they generally were more distracted.

What's more, teens reported feeling less distracted at times of day when they were not using social media. As they spent more time on their phones, their distraction climbed. That was true for a whopping 83 percent of participants.

Curiously, teens who used social media the most said they felt less distracted. It's probably not that they *were* less distracted. More likely, they didn't recognize distractions for what they are, Siebers says. "They might not even realize that messages from social media are distractions because they're using it so much."

Need help overcoming the temptations of social media? Turn off notifications, Siebers says — or just turn off your phone. Is the off button too much? Put your phone in a different room while you work or put it in the glove box while driving. "If you're spending too much time on, say, TikTok or YouTube, you can delete the app from your phone," he adds, "and only use it on the computer."

One last suggestion: Get rid of the mindset that you have to be available around the clock. Let your friends know you're not always able to respond right away. That will make it easier to limit how often you check in.

Get up and move

Personal devices can affect our attention in indirect ways, too. For instance, they can make it harder to fall asleep. Smartphone and computer screens emit blue light, which prevents the brain from releasing melatonin. That's a hormone that makes us sleepy. And lack of sleep makes us more easily distracted.

When we sleep at night, the fluid that surrounds the brain and spinal cord washes over these organs. It removes chemical wastes that built up in them during the day. We also go through different stages of sleep. These stages allow our brains to make sense of information we encountered the previous day. We need both the cleaning and the full set of sleep cycles to function fully the next day.

For teens, that usually means about nine hours of sleep (though few get that much). Not getting enough sleep leaves us cranky and groggy, which can make it hard to pay attention.

One obvious solution is to put screens away earlier and get more sleep. Another is to increase the amount of exercise we get. Exercise improves the quality of our sleep, and it's good for our bodies. But "being physically active, even for a short time, is also good for the mind," says Peter Gröpel. He is a sport psychologist at the University of Vienna in Austria.

He and Wolfgang Altermann set out to see if certain types of exercise were better at boosting attention. They worked with 80 high school students, ages 15 to 18. Each was randomly assigned to one of four groups. Three of the groups did different types of exercises. The last group read a book.

Before their session, each student completed an attention test, which involved searching for specific patterns on papers full of letters. They then spent 25 minutes doing their assigned activities.

At the end of the session, everyone repeated the attention test. The reading group did no better on the second test. But all three exercise groups improved. It didn't matter which exercise they did; their improvement was the same.

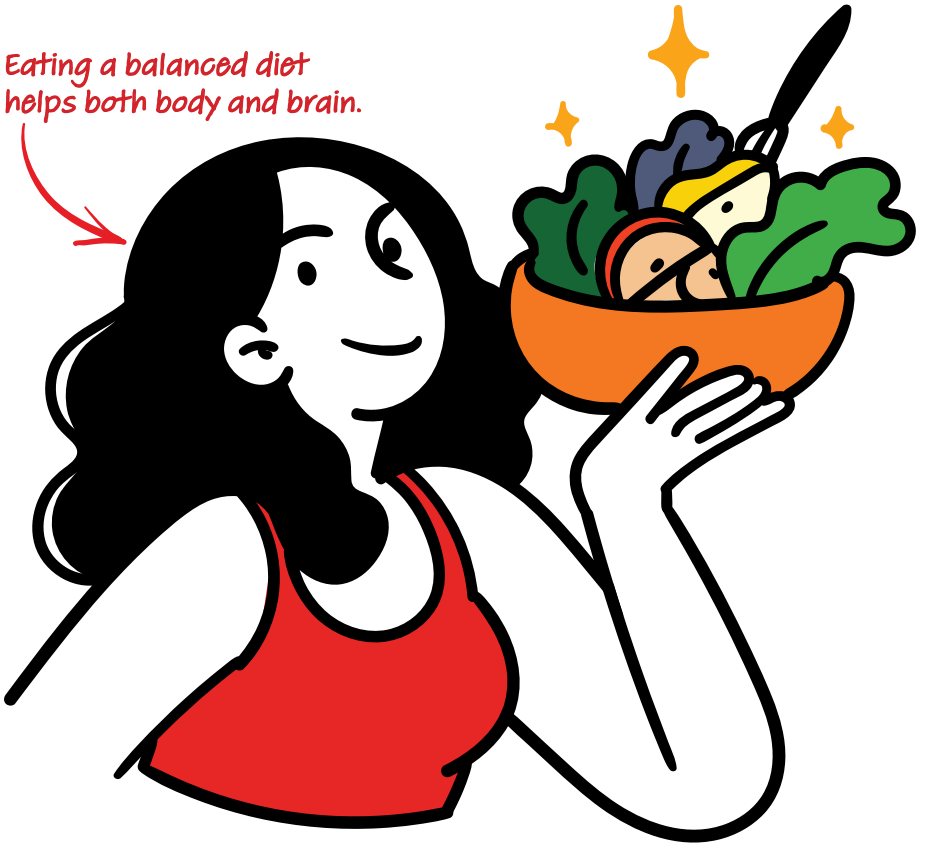
Exercise "brings more oxygen into the brain," Gröpel says. This is helpful for thinking clearly. In the long run, keeping your body active also "helps to develop the brain structures necessary for paying attention." A single session of exercise can improve our ability to focus. Longer exercise programs provide even more powerful effects.

"Regular exercise is highly beneficial for cognitive [brain] development," Gröpel says. And that helps us stay focused longer.

The food connection

What you eat plays a big role in brain function, too. That's why eating a balanced diet can boost focus.

A good diet contains plenty of fiber and protein, with limited sugars and fats. Carbohydrates — sugars and starches (such as whole grains) — are especially important for our brains. A steady supply of the sugar glucose helps the brain stay on task.



But many people — especially kids and teens — eat too many refined carbs. These include the sugars found in soft drinks, candy and other sweets. They also include the refined flour used in many baked goods. Chowing down on refined carbs gives the brain a sudden flood of energy. Once it's been used up, we tend to crash, making it hard to focus.

But it's not just sugar that causes problems with attention. Some food dyes can, too. Food dyes give candies and fruit drinks their bright colors. They're found in other types of foods as well, notes Mark Miller. He's a pediatrician at California's Office of Environmental Health Hazard Assessment in Oakland. Miller and the toxicologists he works with study substances to determine if they are harmful to people or the environment.

In 2022, Miller was part of a team that reviewed research on whether food dyes could impact kids' behavior. The researchers found strong evidence that synthetic, or human-made, food dyes can cause attention issues in kids. After consuming them, some kids had a harder time staying focused.

Not all the kids did, though. "You're likely to be more sensitive to the effect of the food dyes if you have this certain underlying genetic risk factor," Miller says. That risk factor is a form of a gene that alters the effect of histamine — a chemical that brain cells use to "talk" to each other.

Some synthetic food dyes increase brain cells' release of histamine. For some people, that's OK. After these chemicals have sent their messages to other brain cells, an enzyme breaks them down. But in people with a specific form of one gene, the enzyme that breaks down histamine works too slowly. That lets the chemical stick around too long. It sends its message over and over again. The result can be hyperactivity and high levels of distraction.

Food dyes that make us more distracted also make it harder to learn. So avoiding these dyes can go a long way toward improving focus — at least in sensitive people.

Miller's research was part of what the state of California used in October 2023 to justify a ban on red dye #3. (It will go into effect in January 2027.) The U.S. Food and Drug Administration is considering a ban as well. There's some evidence that other dyes, including red #40 and yellow #5, may cause similar problems. But it will be years before all troublesome food dyes are removed from grocery store shelves.

Until then, you can help protect your ability to focus by checking ingredient lists on food packaging. Food dyes are usually listed at the end with a color and number.

If you have trouble with distraction, consider limiting your intake of foods that contain those problem dyes. And replace sugary foods with more complex carbohydrates, such as whole grains or fruit.

This combination should power your brain for longer, allowing you to keep your focus throughout the day. Add in some changes in phone use, sleep and a bit of exercise, and you've got yourself a recipe to reduce the distractions in your life.

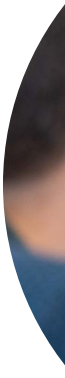
STONEPICTURES/SHUTTERSTOCK

This neuroscientist wants to understand how the brain plans for the future

By studying eye movements, Freek van Ede is exploring how the brain sorts information

A cyclist pedals down the street, signs and trees whipping by. As they travel, their brain takes in information from what they've perceived but can no longer see. There are all sorts of info — the color, shape and text on signs, for example. The cyclist's brain sorts through it all and selects what is most important. Based on that, the biker takes the correct turn and continues on.

Freek van Ede uses a lot of bicycling metaphors. This makes sense for a researcher in the Netherlands. Bicycling is very popular there. A cognitive neuroscientist at Vrije Universiteit Amsterdam, van Ede studies attention.



COURTESY OF F. VAN EDE; PETER VALCKX/VRIJE UNIVERSITEIT AMSTERDAM

His focus is not on external attention. That's what someone is looking at or attending to in the moment. Instead, van Ede is trying to understand internal attention. This is how the brain focuses on and grabs exactly what it needs from vast amounts of incoming information to guide future behavior.

Van Ede thinks of the brain as an organ of anticipation. Think about when you're riding a bike. You use your recent experience to guide upcoming actions. This is a process our brains are performing at all times when we are awake. "It's really at the core of cognition," van Ede says.

This process depends on working memory. That's the ability to store information short-term. But the process also requires attention. That's because we have to select from that stored information to translate it into action. "It's really a fundamental process. ... And I want to understand how it works," van Ede says.

Paying attention to time

Van Ede attended Utrecht University in the Netherlands for his undergraduate studies. There, he was thrilled to find out that he could continue studying and learning for his whole career. All he had to do was become a scientist.

At the time, most cognitive neuroscientists were looking at attention in terms of space. Van Ede's eventual postdoctoral advisor, Kia Nobre, however, was interested in how time might play a role. Nobre is now at Yale University in New Haven, Conn.

Van Ede began thinking about the question of time, too. After all, we don't spend our lives frozen in time. We move through the world and see things in sequence. "When we perform a dance, or even ride a bike or anything we do," van Ede says, "our movements are carefully orchestrated in time."

Getting a more real-world picture means measuring brain activity in real time. So van Ede uses electroencephalography, or EEG. "It's kind of remarkable that we can put an electrode on somebody's skull … and we can measure electrical activity emitted by the brain," he says.

The eyes have it

At first, van Ede and his colleagues paired EEG with eye-tracking data. "One day, I decided to actually dive in and explore the eye data," van Ede says. "I think out of curiosity really."

He found that when someone was asked to recall something about an object that had been on-screen, their eyes made a tiny movement toward where the object had been. That flicking was detectable as microsaccades. These are tiny unconscious twitches that your eyes make multiple times per second.

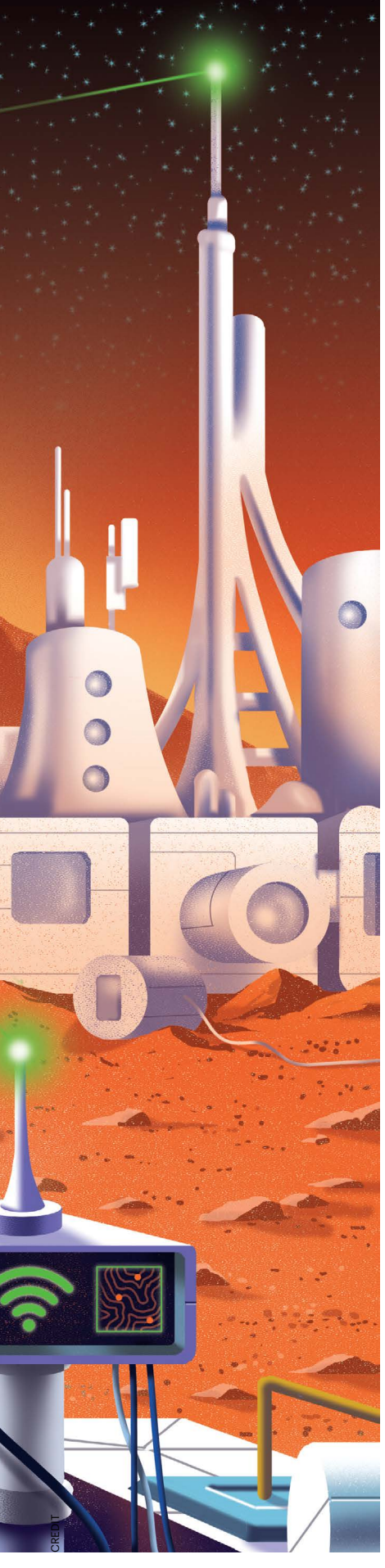
> [W]hen preparing for the future, the brain doesn't wait to make a plan. Instead, it plans possible actions as each piece of information comes in.

Freek van Ede studies how the brain prioritizes information. He has focused on tiny eye movements called microsaccades (left inset, reviewing a video of a study participant). His team has also watched people's brains in real time through electroencephalography (middle) and had people walk through virtual worlds (right).

"We soon realized this discovery also opened new opportunities for 'tracking the mind's eye,'" van Ede says. And that let his team decipher what information the brain is using to plan future action. His lab has shown that when preparing for the future, the brain doesn't wait to make a plan. Instead, it plans possible actions as each piece of information comes in.

Van Ede and his colleagues are now looking at microsaccades while people play in virtual reality. They track the tiny eye movements to see how people's brains are using the information they recently encountered to make a plan. It's one step closer to biking through the streets of Amsterdam.
— *Bethany Brookshire*

GLENN HARVEY; CHAKRART/SHUTTERSTOCK



By **Payal Dhar**

MARS CONNECTION

VISITORS TO THE RED PLANET WILL NEED AN INTERNET — HERE'S HOW WE MIGHT BUILD IT

When the first astronauts land on Mars, maybe in a couple of decades, they'll need some way to communicate. They'll need to talk with each other — and mission control back on Earth — using equipment on and around Mars.

Plus, they'll no doubt want to email loved ones, keep their playlists up-to-date or stream new episodes of their favorite shows. And setting up a Wi-Fi connection to Earth's internet won't be an option. Earth is simply too far from Mars. >>

The distance between the two planets depends on where they are in their orbits around the sun. In fact, this can range from around 55 million to 400 million kilometers (34 million to 250 million miles). So even data traveling at the speed of light would take four to 24 minutes to make a one-way trip.

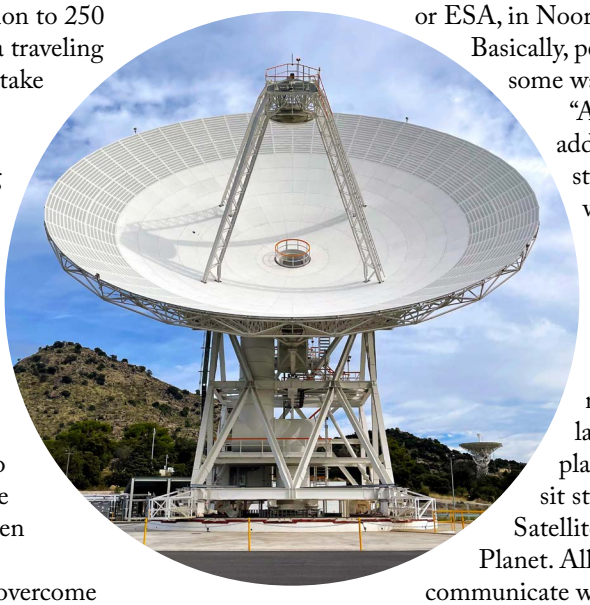
That means a quick ping from Mars to mission control on Earth is out of the question. And a WhatsApp call home? Forget about it.

There's also a problem when Earth and Mars are on opposite sides of the sun. This happens every two years or so. At that time, the sun blocks all signals between the two planets.

No known strategy can overcome the time lag in signals traveling between Earth and Mars. Or make it possible to send messages through the sun.

But researchers are working on ways to make communication on the Red Planet more like it is on Earth. And at least one team has wondered: What if Mars had its own internet?

A good communications setup is crucial for human missions to Mars, says Claire Parfitt. She's a systems engineer with the European Space Agency, or ESA, in Noordwijk, the Netherlands. Basically, people on Mars will need some way to get online, she says. "At the moment," she adds, "we're in the early stages of working out what that means."



A global array of radio telescopes, including the one above in Madrid, Spain, make up the Deep Space Network. These radio receivers listen for signals from spacecraft across the solar system.

NASA/JPL-CALTECH

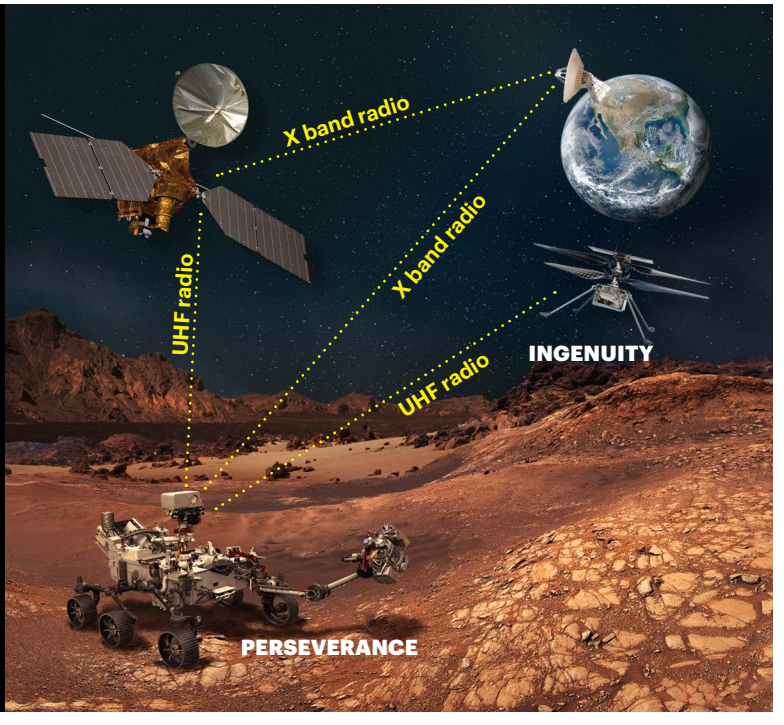
How Mars 'chats' work today

Several space agencies have spacecraft on or near Mars. There are landers and rovers on the planet's surface. (Landers sit still; rovers move around.) Satellites also orbit the Red Planet. All of these machines have to communicate with Earth.

Consider NASA's Perseverance, or Percy, rover. It sends and receives two types of data. One is called "command and telemetry." That's where operators on Earth tell a rover what to do, receive responses from it and then decide what to do next. Percy typically gets more than 1,000 commands from Earth every day.

CALLING EARTH

Perseverance and other Mars rovers get most commands directly from Earth via "X band" radio waves. Percy can send small amounts of data back to Earth directly. But it often uses "ultrahigh-frequency," or UHF, radio waves to relay data to some orbiter in the Mars Relay Network. Those spacecraft have big antennas for sending data to Earth. When the helicopter Ingenuity was exploring Mars, Percy also communicated with it through UHF radio waves.



MRO AND EARTH: NASA; DSN ANTENNA: ANITA GOULD/FLICKR (CC BY-NC 2.0 DEED); INGENUITY: JPL-CALTECH/NASA; MARS SURFACE AND PERSEVERANCE: ANTEROVIUM/SHUTTERSTOCK

Percy and Earth also share science data. Percy takes pictures of Martian rocks and collects other kinds of data about its surroundings. It then sends those findings back to Earth.

Orbiters circling Mars likewise send science data back home. These robotic scouts include NASA's Mars Odyssey and Mars Reconnaissance Orbiter, or MRO. There's also ESA's Trace Gas Orbiter, or TGO. They send their own observations back to Earth. They also help send home data collected by other machines on the planet's surface.

A lot of messages to and from Mars are routed through the Mars Relay Network. It's made up of five orbiters around Mars: the three mentioned above, plus NASA's MAVEN and ESA's Mars Express orbiters. All five have antennas pointed toward Earth to send data home. It's "a tightly choreographed dance," NASA says.

Say a rover needs to send its latest observations home. It first passes those data to one of the orbiters in the Mars Relay Network using radio waves. That orbiter may or may not have a clear view of Earth at the time. If it does, it can beam the data home straight away, also using radio waves. If not, the orbiter can hold on to the rover's data until Earth is in its line of sight.

Once an orbiter broadcasts its data, powerful radio antennas on Earth pick those signals up. A global network of radio receivers, such as NASA's Deep Space Network, is always listening for pings from deep space.

This whole setup works pretty well for robots on Mars. But once a human crew lands there, this system will not be good enough.

Mars communication renovations

Vincent Chan studies fiber-optic and satellite communications at the Massachusetts Institute of Technology in Cambridge. He doesn't foresee local, on-the-ground communication as a challenge for future Mars explorers.

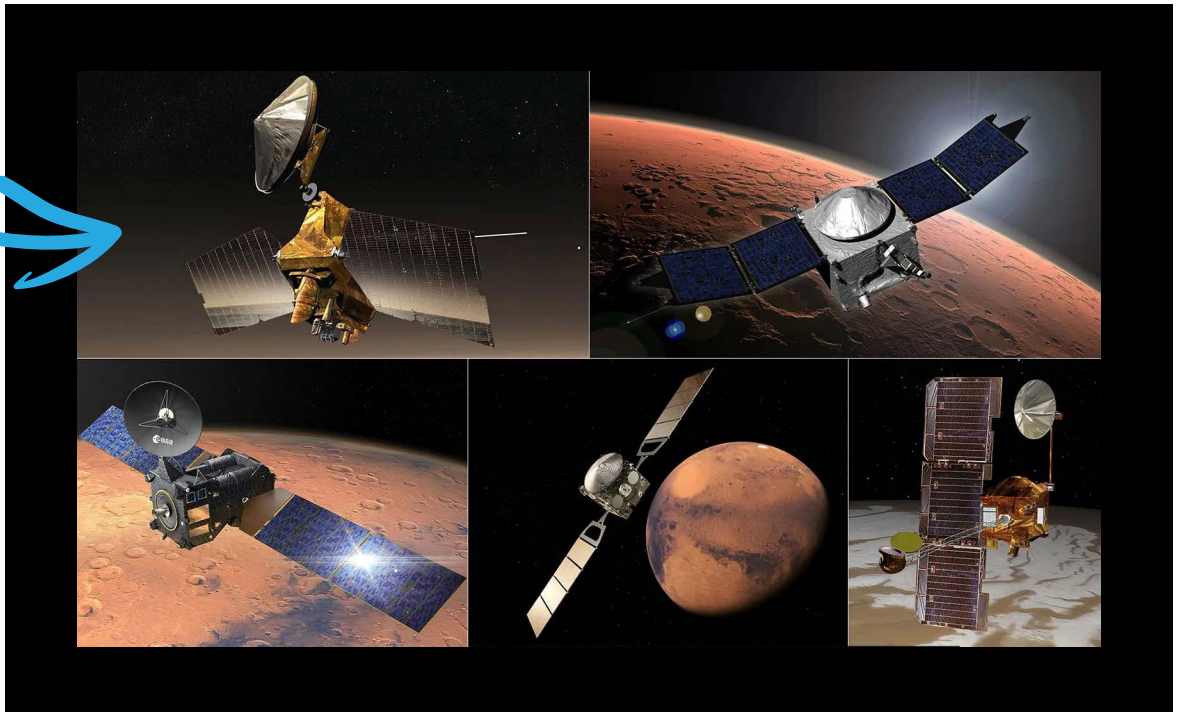
A crew could interact using existing wireless tech that sends messages through radio waves, Chan says. Two mini cell towers would be enough when the astronauts are close together. When they're far apart, some device that picks up radio waves and passes them along could help bridge the gap between astronauts. People living in remote places on Earth already connect in a similar way.

"Those services are already in play," Chan says. What's more, he adds, they're "very economical."

A big antenna on the crew's landing vehicle could point toward Earth. That antenna would probably be the very first thing Martian explorers would set up, Chan says. It would route all communications to and from Earth.

When that antenna doesn't have a direct line of sight to Earth, orbiters similar to the Mars Relay Network could step in. The spacecraft would then relay the data between other orbiters to reach one

In addition to sending data back to Earth, the Mars Reconnaissance Orbiter is looking for water on the Red Planet.

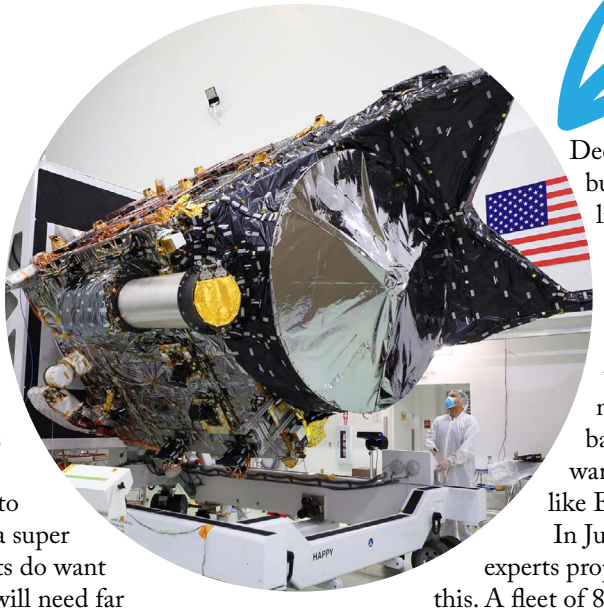


Five satellites currently make up the Mars Relay Network. They are (clockwise from top left): NASA's Mars Reconnaissance Orbiter (MRO), Mars Atmospheric and Volatile EvolutioN (MAVEN) and Mars Odyssey, and ESA's Mars Express and Trace Gas Orbiter (TGO).

NASA/JPL-CALTECH, ESA

with a clear view of Earth. Several orbiters would be needed for round-the-clock coverage. They'd also need to be equipped to handle a lot of data.

So far, spacecraft on and around Mars have mostly communicated using radio waves. This has been fine for non-human explorers. They don't need to send or receive tons of data super fast. But if future astronauts do want to move lots of data, they will need far higher rates of data transfer. For this, they might turn to lasers.



NASA's Deep Space Optical Communications technology is testing laser communication from beyond the moon.

Laser communication in space

Laser light is made up of optical waves that have much higher frequencies than radio waves. That is, the crests and troughs of optical waves are much closer together in space than those of radio waves. As a result, optical waves can densely pack in a lot more data than radio waves can. In fact, lasers could carry 10 to 100 times as much data as radio waves in the same amount of time.

But laser-based messaging in deep space must be tested first.

NASA's Psyche mission is helping here. Its main job is to explore an asteroid between Mars and Jupiter. But the spacecraft also carries NASA's Deep Space Optical Communications tech. This is letting it test long-distance laser communications through space.

Laser signaling had never been tested from distances farther than the moon. But in November 2023, Psyche beamed data to Earth from a distance of 16 million kilometers (10 million miles). That's 40 times farther from Earth than the moon is. A month later, it sent a video of a cat named Taters from 31 million kilometers (19 million miles) away.

Despite its benefits, laser communication has its drawbacks. For one thing, it requires super-precise aim. Radio waves fan out as they travel through space. This allows radio receivers to net these signals easily from multiple locations. But laser signals travel in narrow beams. That means a laser has to point exactly at the receiver. Miss it and the message is gone.

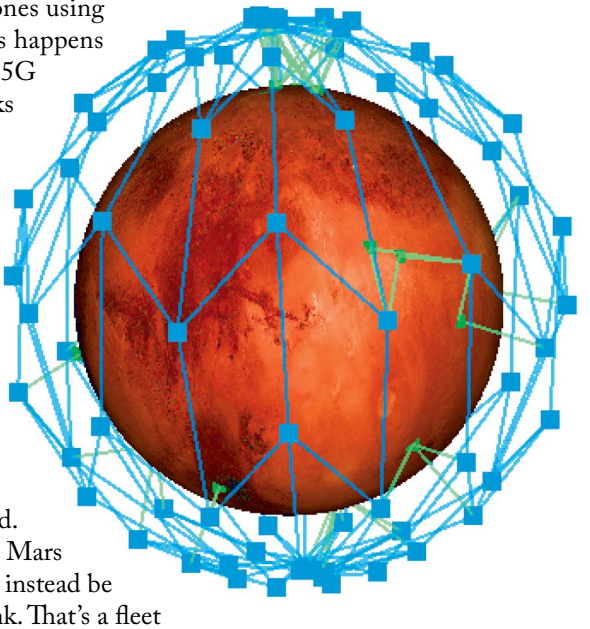
What's more, clouds and atmospheric effects also mess with laser signals. And using lasers would require upgrading existing radio antennas in the Deep Space Network. Or building new receivers to listen for laser signals from deep space.

An internet on Mars

Future Mars residents will likely want to do more than send messages back and forth. They'll want to set up something like Earth's internet.

In June 2023, two computing experts proposed how to achieve this. A fleet of 81 satellites orbiting Mars, they said, could provide the Red Planet with its own offshoot internet. Those researchers, Tobias Pfandzelter and David Bermbach, both work at Technische Universität Berlin in Germany.

Most of us here on Earth access the internet through our phones using radio waves. This happens on either 4G or 5G wireless networks or Wi-Fi routers. These connections are linked by fiber-optic cables. Such cables are buried underground, hang from poles and snake across seafloors around the world.



A network of 81 satellites in orbit around Mars, depicted in blue, could offer planetwide internet coverage, one research team has suggested. Green points show Mars landing sites as of 2018.

NASA/BEN SMEGELSKY; T. PFANDZELTER AND D. BERMBACH/SATCOM 2023

The proposed Mars "internet" would instead be similar to Starlink. That's a fleet of satellites in low Earth orbit run by the company SpaceX. On Earth, connecting to the internet by satellite is expensive. But on Mars, such a system might be cheaper and easier than building a fiber-optic cable network on the ground.

Imagine that an astronaut on Mars is trying to catch up on a Netflix show. "If you were to stream it from Earth, you would have to first wait 10, 15 or even 40 minutes," Pfandzelter says. That's just to connect. It would be a frustrating stop-and-start affair to get through an episode. If another astronaut on Mars wanted to watch the same

show, they would have to go through the same process all over.

The 81 satellites around Mars could instead offer local data storage. A movie could be slowly uploaded from Earth to the satellite system once and then stored there. When astronauts on Mars want to stream that flick, they could then retrieve that data instantly from the Mars satellite fleet.

"You could just have the same experience that you have on Earth because all your data is locally copied," Pfandzelter says. Meanwhile, other uploads and downloads to and from Earth, such as science data, could continue in the background.

Putting internet satellites into orbit around Mars wouldn't require landing a lot of stuff on the surface. That's a good thing. Landing things on another world can be very costly. "It would be much cheaper to just send a bunch of networking satellites to Mars," says Pfandzelter. Those satellites could use radio waves — or optical waves, if laser tech is ready.

Learning from the moon

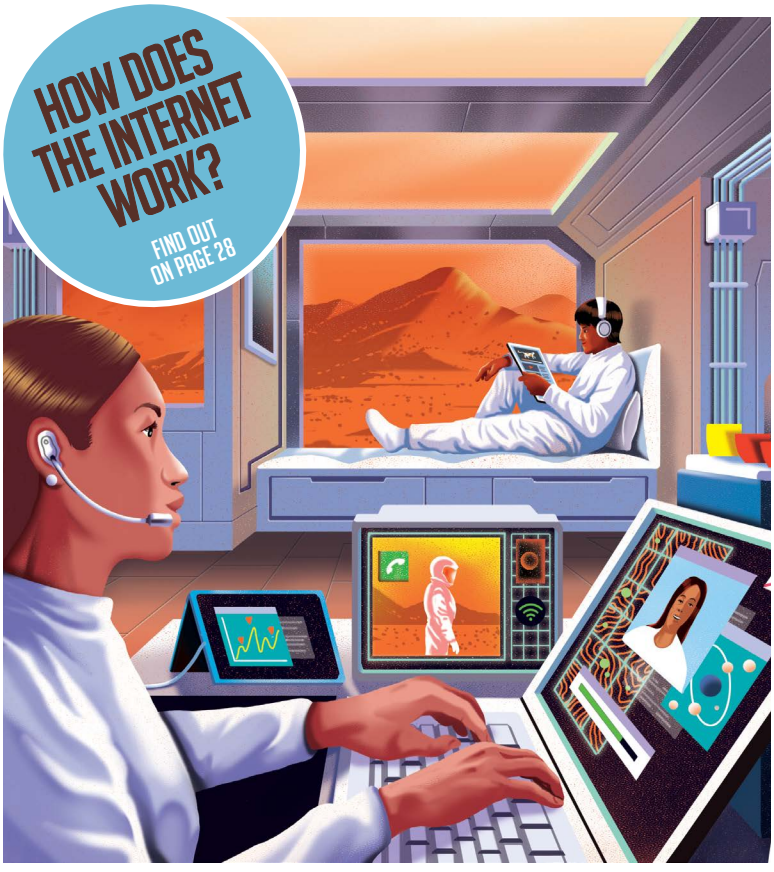
Missions to the moon could offer lessons for setting up an internet on Mars. NASA's Artemis program, for instance, aims to return humans to the moon. As part of that effort, NASA has arranged for private companies to set up a 4G network for the moon — one based on radio waves. It would include installing antennas and base stations that can withstand the harsh lunar landscape. They'd relay transmissions on the moon.

ESA has a related program called Moonlight. It invites private space companies to set up satellites around the moon. These spacecraft would allow people on the far side of the moon, which never faces Earth, to reach people at home. The first phase of the program includes the launch of the Lunar Pathfinder orbiter in 2026.

"Everything that is being done for the moon, it's got the objective of taking humans and missions to Mars," explains Tomas Navarro. He's a future projects engineer with ESA in Didcot, England.

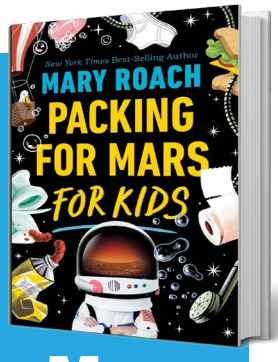
Even if human missions to Mars are decades away, Parfitt says, it's not too soon to start planning. And tackling these challenges may not only benefit future astronauts on Mars. It also may help convince space agencies that human crews are ready to take on the Red Planet.

If future Mars astronauts tried to stream TV shows directly from Earth, they'd suffer a lot of long buffering. But if the data came from spacecraft orbiting the Red Planet, they might have an experience more like viewers back home.



GLENN HARVEY; NORTON YOUNG READERS

READ MORE



Packing for Mars for Kids

By Mary Roach

Modern life on Mars will require some sort of internet for research and communication. But what else will it be like? Check out this book to learn more about the daily challenges of life in space.

CHEMISTRY

What makes ice melt fastest?

Answering this chemistry question can help keep roads safe during winter

By Science Buddies

During the winter, you might see trucks spreading salt on the streets after a snowfall. This keeps ice from building up on the pavement, because salt lowers the freezing point of water. That means ice can melt even when it's colder than 0° Celsius (32° Fahrenheit) outside. But other materials can lower the freezing point of water, too. Let's see how different substances affect how fast ice cubes melt.

OBJECTIVE

Determine which material will make ice melt fastest

Spreading salt on pavement after a snowfall can prevent ice buildup, making roads safer to drive on.

EXPERIMENTAL PROCEDURE

1. Place three ice cubes into each of four bowls.
2. Sprinkle ½ teaspoon of salt over one bowl, ½ teaspoon of sugar over another and ½ teaspoon of sand over a third. The fourth will just be ice.
3. Put all bowls in the refrigerator.
4. When the ice in one bowl is at least half melted, remove all bowls from the refrigerator.
5. Pour the water from one bowl into a graduated cylinder and record the amount.
6. Clean out and dry the graduated cylinder.
7. Repeat steps 5 and 6 with the other three bowls.
8. Let the ice cubes melt completely, then repeat steps 5, 6 and 7.
9. Calculate the total amount of water originally in ice cube form in each bowl.
10. Calculate the percentage of ice that was melted in each bowl when you first took the bowls out of the refrigerator.
11. Repeat all steps at least two more times for at least three trials total.
12. Did any of the substances consistently speed up the melting of ice, compared with the melting rate of plain ice cubes?

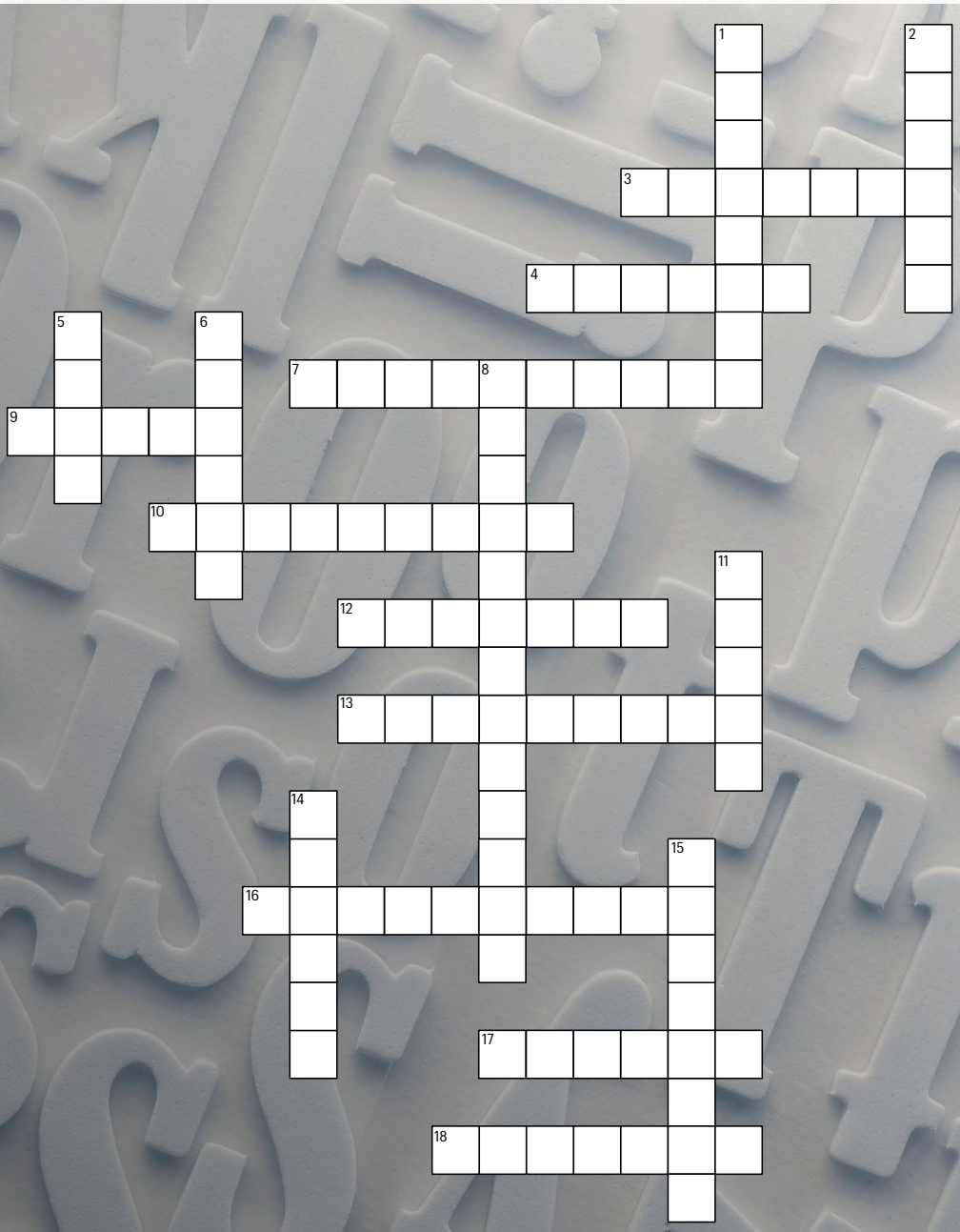
Find the full activity, including how to analyze your data, at snexplores.org/meltingice. This activity is brought to you in partnership with Science Buddies.

SCIENCE BUDDIES

KRASULA/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.



BART SADOWSKI PL/SHUTTERSTOCK

ACROSS

3. Skipping or fast-forwarding videos seems to increase this

4. New plant-machine hybrids use wind to make this type of electricity

7. A condiment useful for studying nuclear fusion

9. Fiber-optic cables ferry data in the form of light with this material

10. Blue light prevents the brain from releasing this sleepy chemical

12. Five of these devices make up the Mars Relay Network

13. A method to preserve mummies used by ancient Egyptians

16. Explosions that seeded space with the elements in our bodies

17. This snake's fangs inspired a new shoulder injury treatment

18. The first device that astronauts would probably set up on Mars

DOWN

1. This helps bring more oxygen to the brain for clear thinking

2. Iron coats this material in a Komodo dragon's teeth

5. Trucks spread this on streets to keep them from freezing over

6. A newfound type of octopus is named after this ghost

8. Muting these phone pings can help reduce distractions

11. New robots use these organisms for sensing their surroundings

14. A device that directs data at internet "intersections"

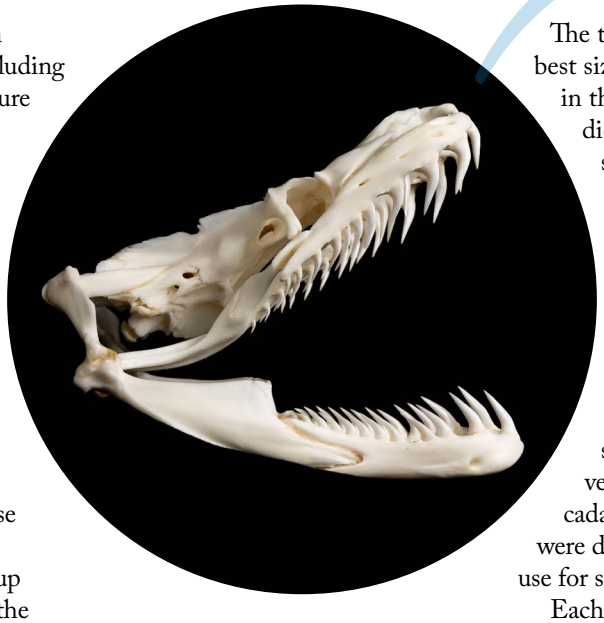
15. An underwater mountain

HEALTH

Python fangs inspired a fix for common sports injuries

Curved teeth could better grip fragile shoulder tendons

Each year, 2 million Americans — including many teens — injure their shoulder's rotator cuff. Often, this happens while participating in sports, such as baseball, volleyball and swimming. Many of these injuries are hard to treat. Only about 30 percent get surgical fixes. But a new type of device — inspired by snake teeth — might help more of those surgeries succeed.



The rotator cuff is a group of muscles and tendons in the shoulder. Injuries here can include tears and inflammation that cause pain and limit use of the joint. Surgical repairs are meant to fix a torn tendon, often reattaching it to the head of the arm bone. But sutures, or stitches, are anchored at only a few points in the tissue. That puts a lot of force on each point. That pulling can often retear the already fragile tendon.

With the likelihood of retearing, doctors sometimes decide not to operate. And even when they do, the treatments don't always work. Rotator cuff surgeries fail between 20 and 94 percent of the time.

Stavros Thomopoulos is a biomedical engineer at Columbia University in New York City. He's part of a team that designed a device to overcome this problem. It uses rows of small, pointed "teeth" that latch onto the tendon and bone. All those extra points of attachment spread and lessen the force on each part of the damaged tissue. Used along with standard sutures, this device should lessen the risk of tearing. And that should improve treatment outcomes, researchers report in *Science Advances*.

A BETTER GRIP FOR SHOULDERS

What inspired the new system? A predator with a strong grip.

Unlike teeth designed to cut — like a shark's razor-sharp triangles — a python's fangs are made to hold on tight. They curve inward. This means they dig deeper when an animal pulls or struggles. "This was kind of a lightbulb moment," recalls Thomopoulos.

The team first calculated the best size and shape for teeth in the new device. They did this using computer simulations and math. They 3-D printed the teeth, both singly and in sets. Then they ran tests with the device to figure out the best tooth placement and grip.

Afterward, the engineers partnered with surgeons. This team tested versions of the teeth on cadavers. (These human bodies were donated after death to use for science.)

Each body got rotator cuff tears in both shoulders. The team fixed one shoulder with only sutures. The other, they repaired with sutures and the new device.

"We mechanically tested the strength that the device was adding," says Iden Kurtaliaj. A bioengineer on the team, she works at the Icahn School of Medicine. It's at Mount Sinai in New York City. Shoulders repaired with their device had twice the holding strength as those without, their data show.

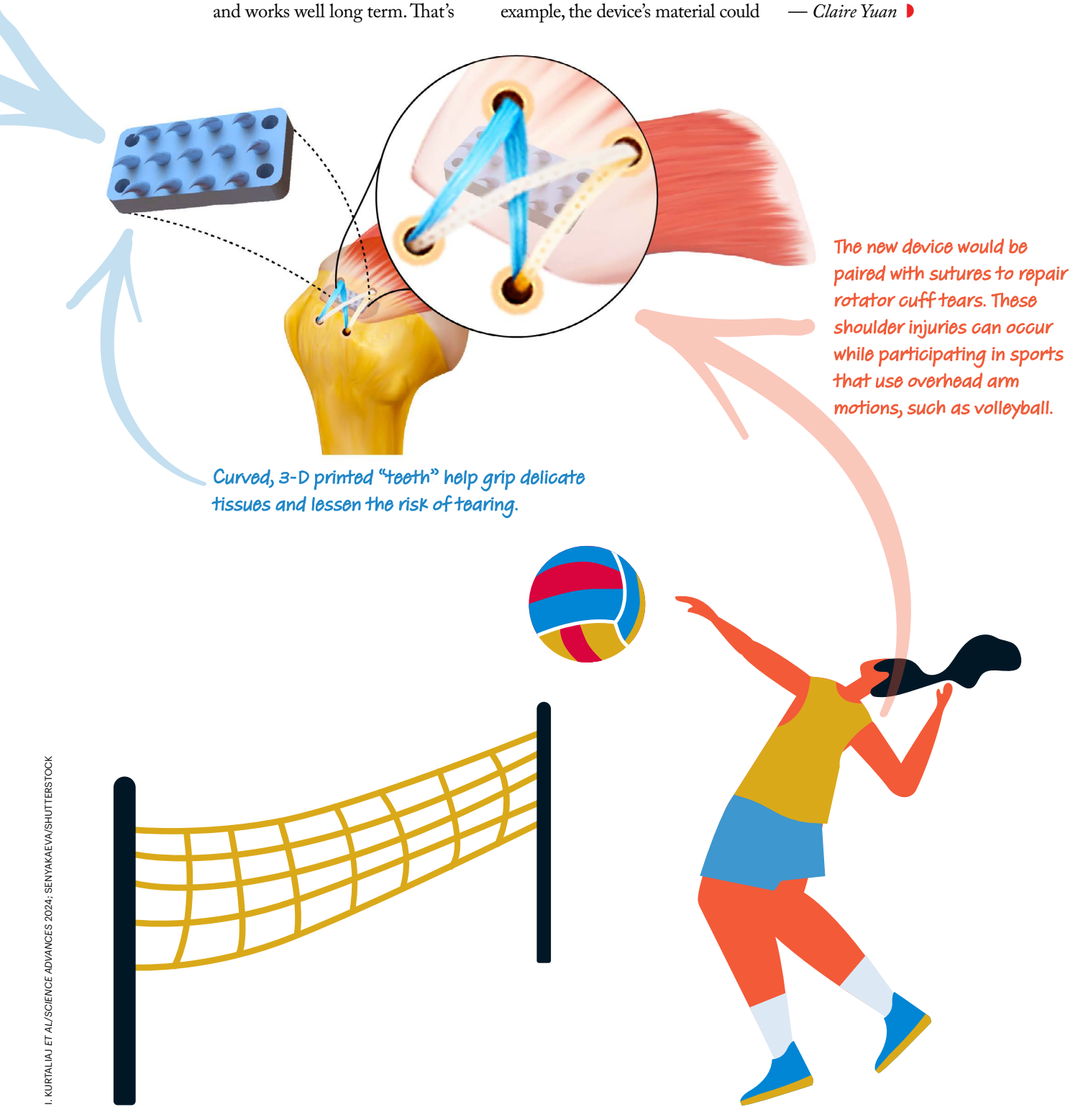
"A device like this is much more elegant than what [doctors] use now," says Eric Nauman. A biomedical engineer at the University of Cincinnati in Ohio, he did not take part in the new work. "Anything you can do for the shoulder right now is a win," he says.

A python's curved fangs (seen here on a skull) grip tighter when prey pulls against them. The fangs provided inspiration for a fix for rotator cuff injuries (opposite page).

KNIGHTPICS PHOTOGRAPHY/ALAMY STOCK PHOTO

More steps are still needed before such a device can be used to treat people.

The design needs to be tested in live animals to see if it's safe and works well long term. That's according to Ghanashyam Acharya. A biomedical researcher who did not take part in the new study, he works at Baylor College of Medicine in Houston. As the body heals, for example, the device's material could break down or injure the tendon, he notes. Still, he says, the concept is promising. He calls it a "significant and innovative first step" toward more effective rotator cuff surgeries. — *Claire Yuan*



I. KURTALIA ET AL/SCIENCE ADVANCES 2024; SENYAKAEVA/SHUTTERSTOCK

TECHNOLOGY

Plant and fungi parts help robots level up

These life forms are giving machines new sensing and self-healing capabilities

In the TV series *Doctor Who*, treeborgs supply fresh air to spaceship passengers. Part tree, part robot, these devices convert starlight into oxygen. In Nnedi Okorafor's novel *Zahrah the Windseeker*, children receive their own "flora computers." These are personal machines made of leaves and vines, grown from CPU seeds and shaped into useful tech.

While these devices may be fictional, flower-powered machines are getting real. This new generation of devices are examples of biohybrid technology. That's a term for any device that merges artificial parts with living tissue.

Engineers have strived to make robots that work like living things. But re-creating the complex functions of, say, a hand or leaf is impossible with synthetic materials, says Anand Mishra. He's an engineer at Cornell University in Ithaca, N.Y. "There is a point where technology limits us."

But using life forms to build machines can overcome the limits of human technology. Researchers like Mishra are looking at how fungi and plants can give machines abilities they couldn't achieve with electronics alone.

FUNGAL FEELINGS

Living tissue has evolved all sorts of ways to scope out its environment. Think of your own body. You can see light, feel warmth, smell and taste the molecules in food. Mishra aims to use living tissue to make robots that are similarly sensitive to their surroundings. But instead of animal tissue, he's using fungi.

Fungi tend to grow faster than animal cells. Some are also quite good at surviving harsh

DEEP ROOTS/SHUTTERSTOCK

conditions such as cold, radiation and salty environments. Animal cells tend to be a lot more sensitive. "To cultivate animal cells, you probably have to be a biologist," says Mishra. Mushrooms are easy to grow at home.

Fungi aren't plants. They're more closely related to animals. But Mishra used one of fungi's most plantlike features, mycelia, to help his bots sense their surroundings. Fungi use these rootlike structures to tunnel through soil for nutrients. Mycelia also detect environmental cues such as light, heat and chemicals.

Mishra's team grew mycelia directly into electrodes attached to two robots. The fungi communicated with the robots through electrical signals called action potentials. These zaps are similar to those produced by hearts and nerve cells.

Mycelia produce spontaneous action potentials. These random bursts of electricity triggered the biobots to walk and roll around. But when flashed with ultraviolet light, the mycelia produced stronger electrical zaps. This changed the robots' gait, showing that they could respond to their environment.

Using fungi in biohybrid robots is still "pretty new," Mishra says. His team now hopes to test how such tech responds to other cues, such as gases and chemicals. One day, their robots' sensory superpowers might help out in agriculture. Future shroom bots may walk through crop fields, testing soil health and other conditions as they go.

PLANT PERSISTENCE

While fungi may help robots better interact with the world, plant powers could help devices better survive it.

"Many artificial [technologies] have a shelf life," says Fabian Meder. This materials scientist works at the Sant'Anna School of Advanced Studies in Pisa, Italy. Electronics start to break down in a few years. Yet the oldest living trees can stand tall for thousands of years. When it comes to longevity, this makes plants the clear winner, says Meder. And while broken electronics require repairs, plants can recover from damage.

In his own research, Meder has witnessed firsthand the difference in durability between plants and electronic parts. Meder has designed artificial leaves that tap an unlikely energy source: static electricity. This type of electric charge is created when two objects touch, then separate.

To harvest static electricity created by wind, Meder places artificial leaves on plants. The fake leaves include a layer of rubber — a material good at building up static charge. When wind rustles one of these bionic plants, the artificial leaves bump into real leaves. This creates static charges that pass into the inner tissue of the real plant leaf, producing a current. This energy can be harvested through electrodes placed in the plant leaf. Meder's studies have shown that such devices can light up LED lights.

Working with living materials does pose some extra design challenges. For one thing, it requires keeping those living parts alive, says Meder. Like fungi, plants need certain resources to stay healthy. "Photosynthesis is a big part of that." To accommodate that need, engineers might use transparent materials to make parts that would otherwise block out sunlight. Or they might use lighter materials that don't weigh leaves down.

Certain plants would work better with Meder's system than others. Evergreen trees, which keep their leaves throughout the year, are more ideal than deciduous plants that lose their leaves during winter. But Meder is excited about this new way to tap a new potential energy source. "It's always about harvesting [these] crumbs of energy which we otherwise would just lose."

Almost like those *Doctor Who* treeborgs surviving on the light of faraway stars.

— *Aaron Tremper*

A fungus-powered robot (top) and plant-based energy harvester (bottom) are two real-world examples of devices that combine natural and human-made components.

A. MISHRA; F. MEDER

COMPUTERS

What is the internet?

It's a network of computers where people can share information

The internet is a massive structure, with components that crisscross the globe. Cables snake below your feet. Wireless signals fly over your head. Numerous devices hide within your community.

Fiber-optic cables are the roads of the internet. These cables contain glass filaments that transfer data in the form of light. Just as roads have different numbers of lanes, these cables also come in different sizes. Bigger cables with more filaments carry more data at once. *Bandwidth* is the rate of data passing through every second.

Devices called *routers* exist anywhere that internet cables come together, much like intersections where roads meet. These devices direct data toward a final destination. *Internet service providers* (ISPs) are companies or governments that manage networks of connected cables and routers.

For the internet to reach the whole world, ISPs have to link their networks. This happens at *internet exchange points* (IXPs). Here, data switch from one network to another. Some IXPs are located inside ordinary buildings in towns and cities.

Data that you upload to the internet end up in a building called a *data center*. This is a bit like a parking garage. Content waits on computers called *servers* until someone else asks for it. Servers also store the programs required to run many of the apps and software that you use.

Unlike cars, internet data don't need a road to follow. These data can fly through the air in the form of *radio signals*. A simple home *Wi-Fi network* has one router with an antenna. It sends and receives radio signals from all the devices in the home. If you are outside without any Wi-Fi, you might connect to the *cellular network*. This network uses tall structures called *cell towers* to send and receive radio signals. Wi-Fi routers and cell towers have cables that connect them to the rest of the network.

Most people today access the internet via wireless networks and cellular networks that connect to the fiber-optic network. But some places connect using phone lines, electrical lines or satellites.

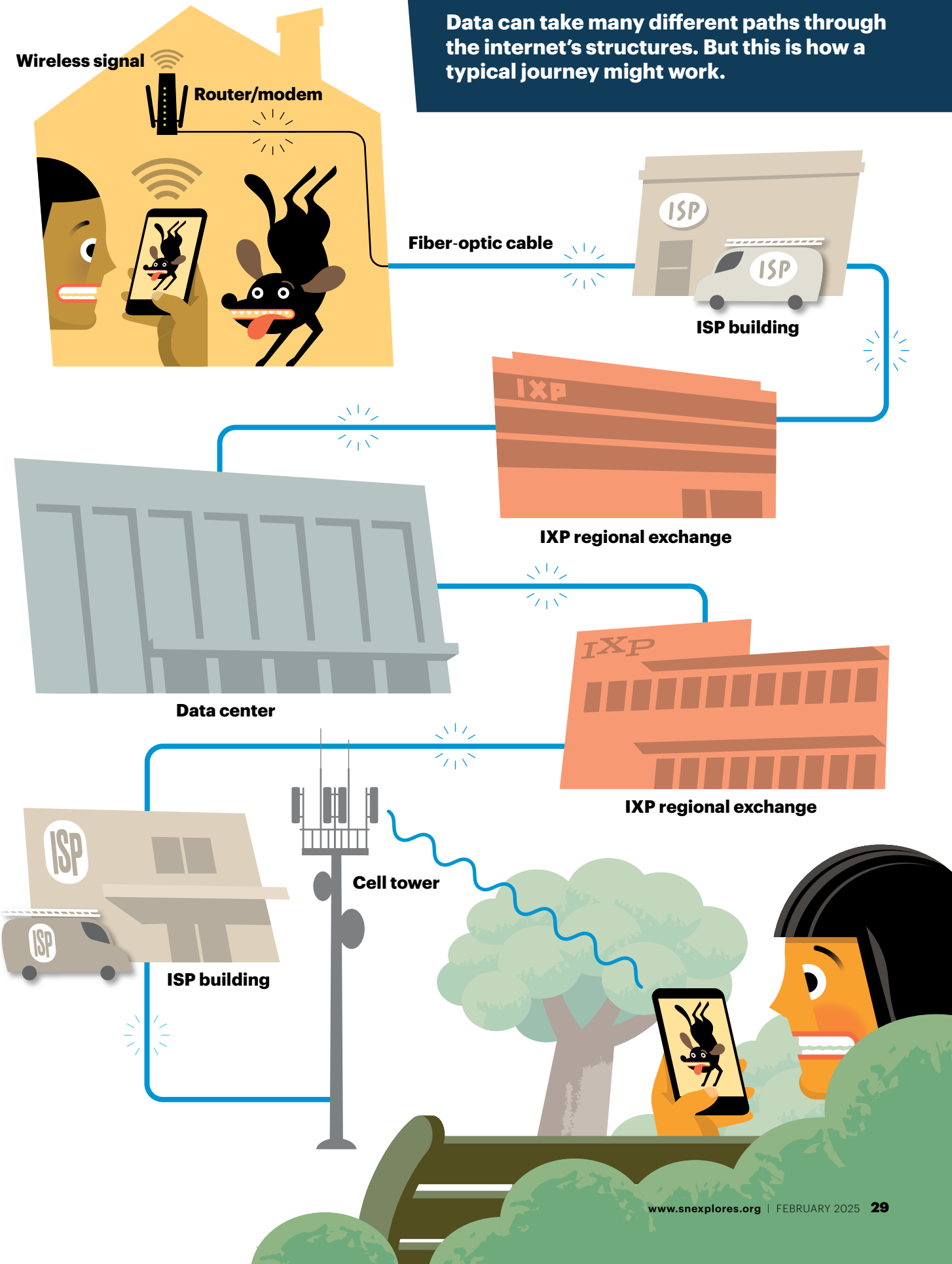
So the next time you share a silly pet video, think about the massive structure that makes your connection possible. Those data have a long road to travel.

— *Kathryn Hulick*

CROVIK MEDIA/SHUTTERSTOCK

The internet connects people to each other and to information. This involves a huge network of physical structures, from cables to towers to supercomputers. All sorts of devices — watches, phones, computers, appliances and more — share data using this network, often over Wi-Fi signals (illustrated).

Data can take many different paths through the internet's structures. But this is how a typical journey might work.



STEVE MCCRACKEN

HUMANS

Skipping through videos may increase boredom

Think twice before you fast-forward or scroll away

Katy Tam noticed that she would switch between videos a lot on YouTube. If the video didn't get to the point in the first 30 seconds, she'd scroll to something else. Or if a movie's plot felt too slow, she'd fast-forward. "But I realized that I wasn't truly enjoying the content I was consuming," she says.

Tam's own behavior — and boredom — made her curious. Tam is a social psychologist. She works at the University of Toronto Scarborough in Canada. No one had studied boredom and switching or skipping through videos. Tam wondered if this behavior, called digital switching, could actually make people more bored.

She and Michael Inzlicht, also at the University of Toronto Scarborough, decided to test the idea. They chose some YouTube videos and had a group rate how interesting each clip was. For its experiments, the team collected videos that were rated boring, interesting or somewhere in between. Boring videos included footage of water dripping from a tap. Interesting selections included cat videos.

Each experiment had one condition where it was possible to switch or fast-forward videos. In the other condition, participants had to watch the entire video. Participants took part in both conditions for each experiment. As part of each experiment, they rated their boredom, satisfaction and attention.

The researchers found that participants expected digital switching would relieve them of boredom. But the data showed that wasn't how these situations played out. "This behavior actually increases boredom," Tam says. "And it makes their viewing experience less meaningful, less engaging and less satisfying." The study had similar results for switching from one video to the next and fast-forwarding within a video. The team shared its findings in the *Journal of Experimental Psychology: General*.

It might seem like quickly skipping from one video to another would keep you from getting bored, but science says the opposite.

VISUAL GENERATION/SHUTTERSTOCK

Because of her research, Tam has changed her own viewing habits. Now when she watches a drama, she lets it unfold and tries to focus. She doesn't skip ahead — and she suggests that others do the same.

"If people want a more enjoyable experience watching videos, they should take their time before hitting the fast-forward or skip button," Tam says. This can help create a more immersive experience that brings more enjoyment. "Sometimes we feel bored while watching videos," she says. "It might not be because of the content itself, but because of how we behave."
— *Carolyn Wilke*

TO SWITCH OR NOT TO SWITCH

TABLE 1: PREDICTIONS ABOUT SWITCHING

	No-switching	Switching
Boredom	4.59	3.56
Satisfaction	3.32	3.88
Attention	3.68	3.89

TABLE 2: SWITCHING BETWEEN VIDEOS

	No-switching	Switching
Boredom	3.26	3.72
Satisfaction	4.34	3.9
Attention	4.48	4.06

Researchers had participants rank boredom, satisfaction and attention on a scale from 1 to 7. For instance, a score of 1 meant that subjects were not very bored or not very satisfied. A score of 7 meant that subjects were very bored or very satisfied. Table 1 shows the results of an experiment in which participants were asked to imagine several situations. In some, people imagined watching videos that they could not fast-forward or skip (No-switching). In others, participants imagined what it would be like to be able to fast-forward or skip (Switching). People rated how they thought they would feel in each type of situation. Table 2 shows results of an experiment with two conditions. In one condition, participants watched a 10-minute video they couldn't fast-forward (No-switching). In the other, they were given seven 5-minute videos that they could switch between (Switching).

DATA DIVE

1. Look at the tables. Make a bar graph of each experiment's results.

2. What is the difference between people's *predicted* boredom in the no-switching and switching conditions?

3. What is the difference between people's *actual* boredom between the no-switching and switching conditions?

4. How do *predicted* satisfaction and attention compare between the no-switching and switching conditions?

5. How do *actual* satisfaction and attention compare between the no-switching and switching conditions?

6. Do you think the results in Table 2 would change if the videos were very interesting or very boring? Why or why not?

7. What other experiments on digital switching could you run?

TAM AND INZLICHT/*JOURNAL OF EXPERIMENTAL PSYCHOLOGY: GENERAL* 2024

ANSWER

Deep-sea mountains host an unknown biodiversity hotspot

Discoveries include 20 new ocean species

Rare deep-sea creatures drift through a garden of sponges and corals that grow alongside an undersea mountain. An expedition in a remote part of the Pacific Ocean found this new deepwater biodiversity hotspot last year.

During the month-long voyage, researchers found 20 species of sea life that appear new to science. Another 80 species were seen in this part of the ocean for the first time.

Even the submerged mountain — also called a seamount — was a surprise.

Satellite imaging of the area had shown only a blurry bump on the seafloor. But the mammoth seamount turned out to be more than 3,000 meters (1.9 miles) high. Its summit sits 994 meters (0.6 mile) below the sea surface. It's part of an underwater mountain chain called the Nazca Ridge off the west coast of Chile.

The Schmidt Ocean Institute in Palo Alto, Calif., led the expedition. A diving robot filmed and explored the new seamount and nine others. It turned up a teeming ecosystem, including a garden of sponges and ancient corals.

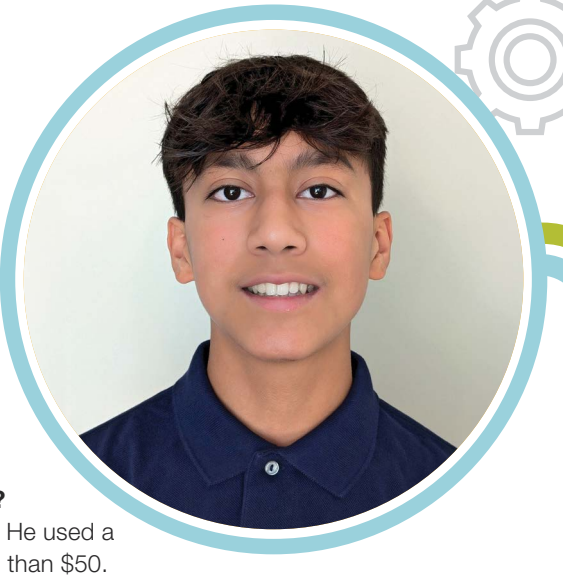
— *Jake Buehler*

This ghostly white octopus is nicknamed the "Casper octopus" after a cartoon character, Casper the Friendly Ghost.

A diving robot recorded this golden coral near the new seamount. Mixed in with the coral are an orange *Calliaster* seastar and pinkish squat lobsters. The yellow, gelatinous blobs are tentacled animals called comb jellies.

INSIDE THE MIND OF A YOUNG SCIENTIST

A Thermo Fisher Scientific Junior Innovators Challenge winner 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? **Yash Mehta**, who won a First Place Technology Award at the 2024 Thermo Fisher Scientific Junior Innovators Challenge, shares his experience and advice.

Q What was your favorite part of this project?
A Yash built an affordable electronic braille reader. He used a 3-D printer to make a motor-based device for less than $50. Tiny spinning motors create vibrations that feel like the bumps of braille letters. "I love 3-D modeling, so having everything fit in the first time, it was just pure excitement," he says.

Q What's next for your project?
A "I'm planning on adding OCR" to the device, Yash says. OCR stands for optical character recognition. Right now, Yash's machine translates text from a computer into braille letters. But with OCR, it could translate printed text or handwritten notes into braille. Yash adds, "I would probably go back to the Blind Relief Association and get more feedback with my new prototype."

Q Any advice for science fair newbies?
A "Try to find something that you think could be done at your skill level," Yash says. "Even if you have to grow a little bit more in knowledge." Also, ask people in your community what problems they need solved. "I think that's the most important part — getting first-hand feedback."

Thermo Fisher Scientific Junior Innovators Challenge winner

Yash Mehta

Yash Mehta, 14, designed an affordable electronic braille reader. He was inspired after visiting a school for blind students on a trip to Old Delhi, India. Students were able to read braille on his device with 86 percent accuracy, compared with print braille. Yash is in the 9th grade at Durham Academy in North Carolina.

EXPLORE
OUR SOCIAL MEDIA

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