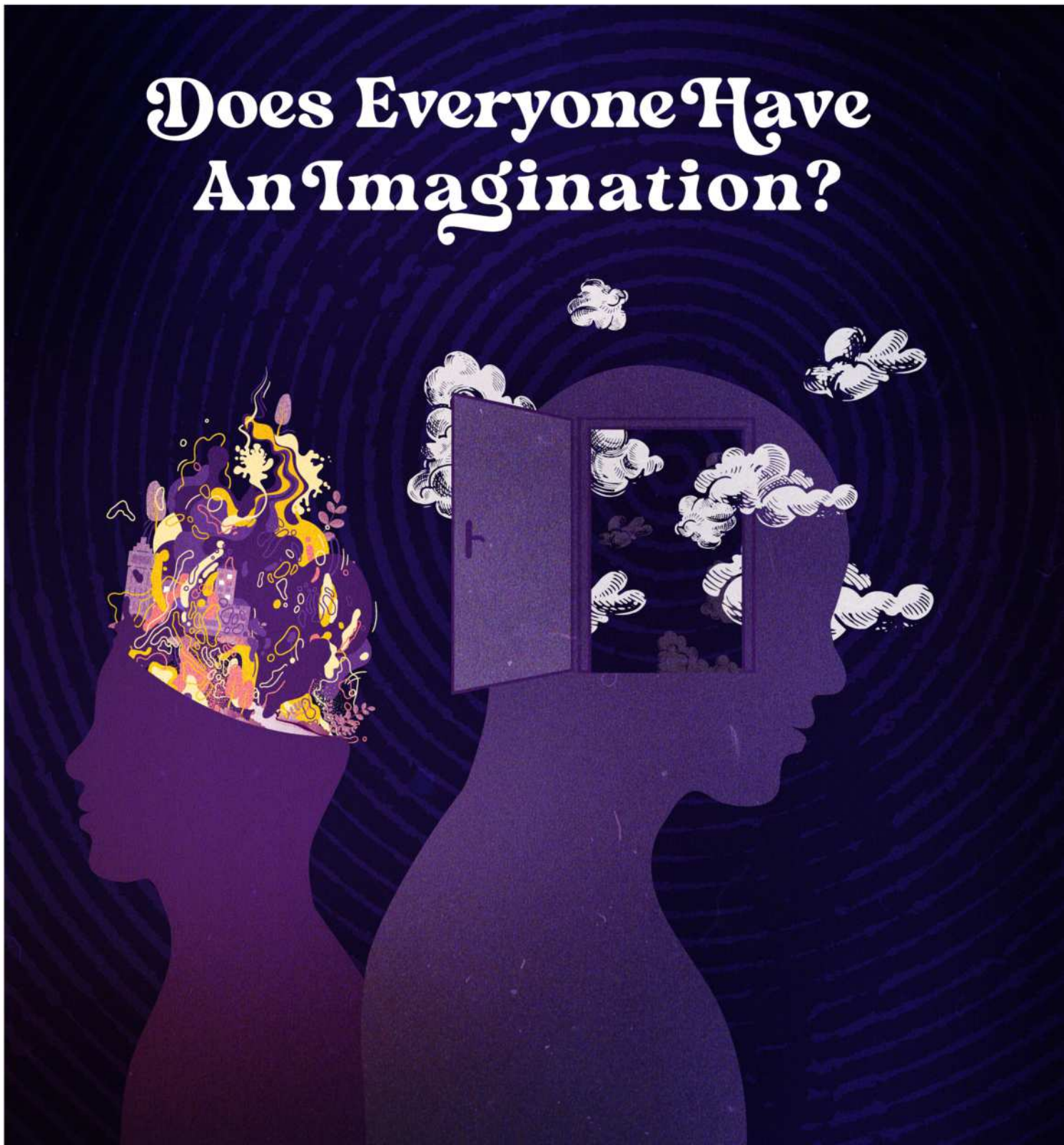
CURIOS?

IS THERE REALLY NO SOUND IN SPACE?

WHY ARE SCIENTISTS MAKING DRONES OUT OF DEAD BIRDS?

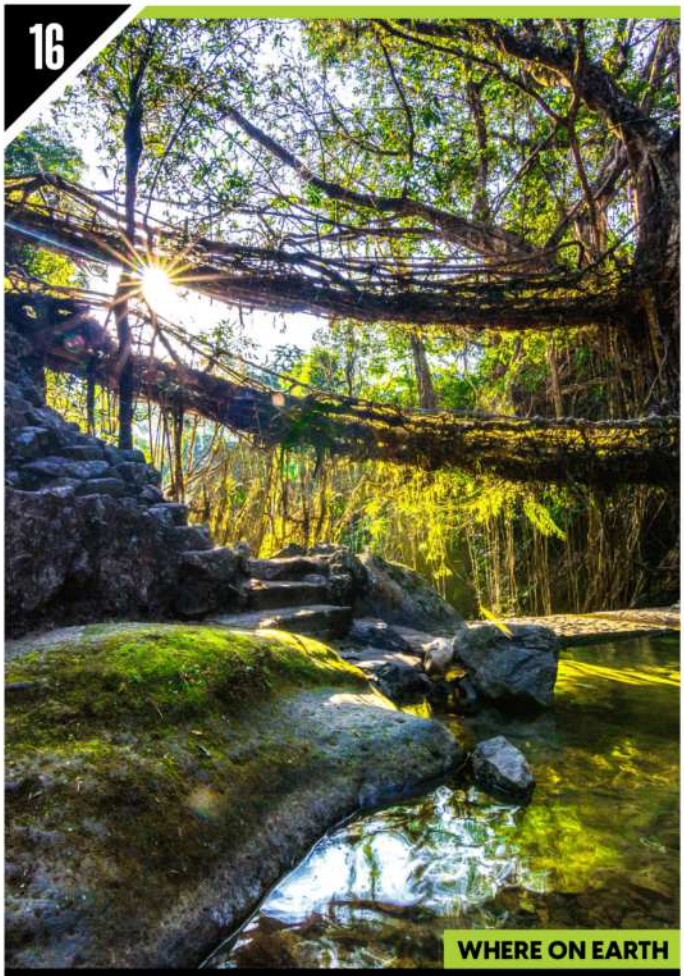
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NEWS BITES



Sucks To Be Him

Classic sci-fi gets an update in new movie *Renfield*, out on April 14. In Bram Stoker's seminal novel *Dracula*, published in 1897, many characters try and use science to explain the world of chaos and disorder they find themselves in, reflecting the distinct Victorian anxiety of the time that launched a thousand sci-fi novels. You could argue similar goals here, as the latest big screen adaptation focuses on the minor character Renfield (Nicholas Hoult), who is apparently using therapy to try and understand and quit his addiction to his "master". But who are we kidding, we're here for Nicolas Cage's gleeful take on the iconic vampire. How has it taken this long to get a Count Cage?



From Fan to Fanatic

With Donald Glover's obsessed fan horror TV series *Swarm* hitting our screens recently, you may be wondering what distinguishes a fan from a stan. A **new study** has the answer, apparently. With social media allowing 24-hour access and the rise of threatening behaviors like doxing, researchers looked into which characteristics may predict celebrity stalking behavior, including threatening harm. Surveying almost 600 US students, they found that those who were more invested in the personal lives of their favorite celebrities, coupled with being prone to boredom, were more likely to engage in stalking behaviors. However, those who admired them just for their ability to entertain were not. Perhaps surprisingly, anger, thrill-seeking, and relationship attachment styles were not associated with the more threatening behavior. If you're not sure where you stand, perhaps put your phone down just in case.

2024 Women US Quarter Honorees

The US Mint has announced the honorees of its **2024 American Women Quarters**™ program, which celebrates the remarkable women that made significant impacts and pioneered change in their lifetimes but have been overlooked by history. Included are Dr Mary Edwards Walker, a Civil War-era surgeon, prisoner of war, and the only woman ever to be awarded the Medal of Honor; Patsy Takemoto Mink, the first woman of color to serve in Congress who fought for gender and racial equality; and Pauli Murray, one of the most important social justice advocates of the 20th century.

Dark Skies Ahead

A tiny Welsh island has just become the first Dark Sky Sanctuary in Europe. Ynys Enlli (Bardsey Island) joins just 16 other sites of the kind across the world. The island is just 2.4 kilometers (1.5 miles) long and half as wide, and has just a handful of year-round residents, which swells to around a dozen in the summer. **International Dark Sky Sanctuaries** are legally protected for scientific, educational, cultural, and heritage purposes and have to be available to the public to enjoy. Their sky brightness must routinely be 21.5 magnitudes per square arc second or darker (for context, a theoretically perfect dark site would have a brightness of 22), which explains why, in an increasingly bright world, they are so rare.

Image Credit Left: Universal Pictures, *Right:* Robert Daly/iStock



Global Astronomy Month

April is Global Astronomy Month and depending on where you are in the world, there is plenty to see if you look up.

Hybrid Solar Eclipse

On April 20, some lucky viewers will be able to observe a cosmic delight not seen from Earth in a decade. The Southern Hemisphere will experience a rare kind of solar eclipse known as a hybrid solar eclipse. This means that the eclipse will go from annular to total briefly before becoming annular again as the Moon's shadow moves across Earth's surface. If you're not in the Southern Hemisphere, you can watch it livestreamed **here**.

Da Vinci Glow

On April 20-22, you can see the phenomenon known as earthshine or the Da Vinci glow, where sunlight reflects off Earth's surface and illuminates the unlit part of the New Moon when you can usually only see the crescent. Technically, you can see earthshine whenever there's a crescent Moon on the horizon at sunset, but it is at its most intense in April. It's named the Da Vinci glow because Leonardo da Vinci himself explained the phenomenon for the first time 500 years ago.

Lyrids Meteor Shower

The Lyrids will peak on April 22-23. Viewing should be particularly good as the Moon will be only 6 percent illuminated thanks to the New Moon, so you could see around 18 shooting stars an hour. If you look for the constellation Hercules above the horizon, you should be rewarded. Coming from the debris of Comet Thatcher, it's the oldest recorded meteor shower still visible today, and was first recorded in 687 BCE.

WHAT'S UP?



A Superbloom Spring

Don't Doom the Bloom

Name: Superbloom
Appearance: Very large, very colorful
Location: California, USA

What's happening?
California could be in for a spectacular superbloom this spring, the first in four years.

What's a superbloom?
Superblooms are rare occurrences where millions of wildflowers all sprout at once from dormant seeds in the earth after a very specific amount and order of rain and dry, warm weather.

And California has one?
They are extremely difficult to predict due to the complex set of weather circumstances and temperatures required, but California State Parks says they're anticipating a good one thanks to a combination of years of drought and a wet winter.

What's in a superbloom?
The stunning, colorful displays feature poppies, sand verbena, desert sunflowers, chia, evening primroses, and desert lilies in a striking wash of yellows, reds, oranges, pinks, and purples.

How big are they?
They usually happen every 10 years, but climate change has put paid to that. They have occured in **2016**, **2017**, and **2019**.

Where can I see it?
Stretching from Death Valley to Big Sur, the state parks are your best bet for incredible flower carpet views. However, after 2019's superbloom brought hundreds of thousands of visitors all armed with selfie sticks and a lack of respect for nature, many trails are already closed to protect the delicate ecosystems.

How can I not ruin it for everyone?
If you're planning on visiting, state park officials are asking people to not "doom the bloom" by checking accessibility and respecting park rules. Remember, no photo for the 'gram is worth ruining this rare, fleeting thing of beauty.

Image Credit Left: DWPhoto/iStock, *Right:* nkbimages/iStock

DOES EVERYONE HAVE AN IMAGINATION?

How do you know if you have a "mind's eye" or not, and is it good or bad if you don't?

By Dr Katie Spalding



Image Credit: *Ashleigh Campsall*

In 2003, in Exeter, UK, a 65-year-old man, now memorialized in scientific literature as patient "MX", decided to visit his neurologist. He had a very peculiar problem: after a minor heart surgery, he had awoken to find that he had completely lost his ability to visualize images in his mind's eye.

For his doctor – one Professor Adam Zeman, cognitive and behavioral neurologist at the University of Exeter Medical School – it was a mystery. The phenomenon didn't even have a name, let alone a set of diagnostic criteria or clinical presentation – with **vanishingly few exceptions**, there was essentially no mention of such a condition in the literature at all.

Bizarre cases make for good headlines, however, and MX's story soon went viral. But along with this newfound fame, Zeman started getting something unexpected out of the world's interest in the sudden disappearance of a stranger's imagination: thousands and thousands of similar stories, all from people genuinely surprised that the term "mind's eye" isn't, for most people, just a poetic turn of phrase.

The evidence was clear: this wasn't just an isolated incident after one person's heart surgery, but a real phenomenon experienced by a non-negligible number of people. Eventually, 10 years after MX first approached Zeman and unwittingly kickstarted a decade of intense public and scientific interest, the condition **finally got a name**: aphantasia.

How do we define imagination or a "mind's eye"?

Whether or not you have a mind's eye – that is, the ability to picture things in your imagination, even when you can't actually see them in real life – you may well be struggling to understand exactly what the above means. Aphantasia is thought to affect up to **one in 50** people, many of whom are quite shocked when they learn those around them really can "see" things in their "mind's eye".

"Some individuals with aphantasia have reported that they don't understand what it means to 'count sheep' before going to bed," **noted** Wilma Bainbridge, an assistant professor of psychology at the University of Chicago, who led a **2020 study** of the condition. "They thought it was merely an expression, and had never realized until adulthood that other people could actually visualize sheep without seeing them."

Similarly, people used to taking their imagination for granted are often **baffled** by the idea of going through life without it. Even more confusing is that, despite a lack of visual imagery, aphantasic folk often can recall information that you'd think would be ruled out by their condition: in fact, Bainbridge found that not only can such people **correctly recreate photographs** from memory, but they might even be better at it than those with a visual imagination.

It's a puzzle with profound consequences: aphantasics' seemingly unaffected spatial imagery, combined with their very **seriously affected** object imagery and episodic memory – that is, the internal home video reel (and yes, aphantasic readers, we mean that literally) that most people think of as "memories" – has led to important **breakthroughs** in our **understanding of perception**. We know now that aphantasia can be brought on by **injury** or illness, or it may be something you're simply born with; that some people with the condition can dream images, while others cannot – in short, that aphantasia is not just one condition, but a spectrum of experiences.

To Zeman, though, that's far from surprising. "We know that there's this big network [in the brain]: visual, decision-making, working memory, attention, long-term memory and introspection," he told **Science Focus** in 2019. "Where there's a network, you could predict that it might break down in a number of different ways, which helps to explain why there's more than one sort of aphantasia."

How can you tell if you have a "mind's eye" or not?

As you might expect from all this fuzziness, aphantasia is a pretty difficult phenomenon to measure. It's not hard to see why: try imagining a person kicking a ball, for example. Now: what color is the ball?

Could you do it? Maybe you could visualize the ball, but not the person – does that count as aphantasia? Perhaps you thought you were fine until we asked about color, and are now wondering if it's normal to **only imagine things in black and white**. Maybe you could imagine the ball, but not really "visualize" it, and are now left wondering whether that's what we meant, or if everyone else is basically surrounded voluntarily by hallucinations most of the day.

PEOPLE WITH A VIVID VISUAL IMAGINATION WILL HAVE A PHYSICAL RESPONSE – THEIR PUPILS WILL CONSTRICT – WHEN THEY MERELY IMAGINE SOMETHING BRIGHT. FOR APHANTASIC INDIVIDUALS, THIS ISN'T THE CASE.



Image Credit: benedek/iStock

It's not an exact science, is the point. Or at least, it wasn't – until **last year**, when researchers at the University of New South Wales's Future Minds Lab managed to find what they called "the first biological, objective test for imagery vividness".

The answer was pleasingly poetic: to measure a person's mind's eye, just look into their actual eyes. "The pupillary reflex is an adaption that optimizes the amount of light hitting the retina," **explained** project lead Professor Joel Pearson. "And while it was already known that imagined objects can evoke so-called 'endogenous' changes in pupil size, we were surprised to see more dramatic changes in those reporting more vivid imagery."

In other words, people with a vivid visual imagination will have a physical response – their pupils will constrict – when they merely imagine something bright. For aphantasic individuals, this wasn't the case.

"Our results show an exciting new objective method to measure visual imagery, and the first physiological evidence of aphantasia," Pearson said at the time. "We are now close to an objective physiological test, like a blood test, to see if someone truly has it."

The pros and cons of not having an imagination

So, there's a fair chance that about one in 50 of you are feeling a bit disappointed right now, having just found out about a whole dimension of experience you were likely born missing out on. But, as it turns out, having a "mind's eye" isn't all it's cracked up to be.

Or, to put it another way, not having one isn't necessarily that bad. One **2020 study,** led by Zeman, revealed that people with aphantasia are noticeably overrepresented in **scientific and mathematical occupations**. Noted biotechnologist Professor Craig Venter, who led the team behind the first draft sequence of the human genome back in 2000, even pointed to the condition as key to his success in the field.

"I have found as a scientific leader that aphantasia helps greatly to assimilate complex information into new ideas and approaches," Venter told **BBC Science Focus**.

"By understanding concepts vs fact memorization I could lead complex, multidisciplinary teams without needing to know their level of detail."

This rational bent can be seen in another secret superpower of aphantasic folk: their **near-total unflappability**. They're basically impossible to spook with scary stories, for example: one **2021 paper** found that skin conductivity levels – which should increase when people become distressed or scared – "pretty much flatlined" for those lacking a mind's eye, lead author Joel Pearson explained.

It's not that aphantasic people lack the emotional response of fear, the researchers pointed out – but unless they can actually see the horror playing out in front of them, it just doesn't hit that hard. As Pearson put it: "We can think all kinds of things, but without imagery, the thoughts aren't going to have that emotional 'boom'."

This, too, may be why aphantasia seems to – anecdotally, at least – go hand in hand with the enviable ability to cope with past trauma. Spared the pain of having to **relive distressing memories** or experiences in glorious technicolor, people who lack a mind's eye are simply "really good at moving on," Zeman told the **New York Times** in 2021.

"One wonders whether that's because they're less troubled by the kinds of images which, for many of us, come to mind and give rise to regret and longing," he added.

Perhaps that's why, despite the superficial "lack" that comes with aphantasia, Zeman – and many aphantasic individuals themselves – do not consider the condition to be a problem. Indeed, "if [there] was an experience where you take this pill and you can visualize forever, I probably wouldn't risk it," Thomas Ebeyer, one of the first people studied by Zeman, told the Times.

And, more than a decade and a half since MX first came to his practice, Zeman has to agree.

"This is not a disorder as far as I can see," he said. "It's an intriguing variation in human experience."



Image Credit Background: Ashleigh Campsall



Image Credit: © Kat Zhou/UPY2023

THE AMAZON'S PINK RIVER DOLPHIN

In the murky waters of the Amazon lurk strange, toothed whales with long, narrow snouts and pink skin. They start their lives gray but as they age more blood shows through, deepening the color, which also flushes pink when they're excited. Kat Zhou was judged **Underwater Photographer Of The Year 2023** for her photo entitled Boto Encantado. There's a legend that these dolphins, known as "botos", turn into handsome men called "boto encantado" to seduce women, hence the name.



Image Credit: *Dr Mostafa Hassanalian*

TAXIDERMY DRONES: THE ULTIMATE SPIES?

SCIENTISTS HAVE BEEN MAKING DRONES USING MATERIAL FROM DEAD BIRDS – SO OBVIOUSLY, WE NEEDED TO KNOW WHY.

Q&A

By Rachael Funnell

The BBC's *Spy In The Wild* demonstrated the unique insights into animal behavior that can be observed when we hoodwink wildlife into thinking that a hidden camera is just one of their own. It doesn't always go right, of course (RIP **fake langur baby**), but even accidents sometimes work out, such as an **egg-cam stolen by a bird** that managed to capture a killer shot of a penguin colony before it was discarded.

It's one thing to stuff a camera in an egg and see what happens – but what about when the answers you seek are airborne? This is something that scientists at New Mexico Tech have been trying to tackle as they ponder the flying dynamics of migrating birds.

These animals move in a V-formation, swapping positions within the V so that each bird can take turns to carry the worst of the energetic burden. However, the exact choreography and decision-making that goes into this marathon performance has evaded our scientific understanding as humans in microlites can't get close enough to observe it without upsetting the animals.

Creating a naturalistic spy to enter the fold is easier said than done, but as **Dr Mostafa Hassanalian** and his team at **New Mexico Tech**

have discovered, bringing wild animals into the picture can help in more ways than one. In their efforts to create energy-efficient, naturalistic drones, they have created concepts that use material taken from dead birds to blend in and fly better.

What are the benefits of taxidermy drones?

MH: Currently, the drones that are being used for wildlife monitoring are mainly hexacopter and quadcopter, which means they have propellers that create a lot of noise. They are a potential hazard as well because there is a chance birds might go towards the drone and get hurt. This is why we came up with the idea to develop nature-friendly drones. What would be really helpful about a taxidermy bird drone is if it could fly with a flock and have those birds accept it as a part of the flock. Then, it would be able to monitor their flight and natural behavior.

Another application is one of the challenges that airports near the oceans face regarding bird strikes. These types of taxidermy birds can actually be applied to fly in and guide other birds out of the airport.

How could the flapping models eventually take off?

MH: For takeoff and landing we have been looking at simulating their legs, or in future we may even be able to use their actual legs to attach to mechanisms that can allow them to take off or land in trees. We are trying to create models that are as close to the actual birds, so that's why we have a combination of flapping drones.

How do you get the materials?

MH: We haven't killed any birds for this research. We only purchase wings that are available online for pigeons, and we also work with a local taxidermy team in Albuquerque for pheasants. We haven't worked with other birds because it's against US policy, which is important to follow. We are developing these concepts to help nature, not to try and hurt it.

All the research we are doing is inspired by nature. We love it, we learn from it, and we are trying to apply this knowledge to help humanity and our society. That's something I really like about bioinspiration biomimetics.

Do the drones have uses outside of wildlife?

MH: This kind of nature-friendly drone could also be integrated into a "smart city" for use in delivery, inspection, or monitoring. For these urban applications, we are developing a concept for a drone garden that's inspired by trees. It can house multiple configurations of the drones, including flapping wings. We have to be careful with how we present any technology that comes into society, people have to like it.

What else are you working on?

MH: Right now, we are developing ideas for a drone for Titan exploration. NASA, with the John Hopkins Applied Physics Laboratory, is going to send drones to [Saturn's moon] Titan, and it takes nine to 10 years to get there. Also now, we are trying to mimic birds to gain insights that could be applied to these drones so they can fly for a longer time. There are multiple ways that we can learn from birds how to manage energy, and that's a core part of my research group.

Any other cool robots in the mix?

MH: We're also looking at nature to develop autonomous systems for planetary exploration. For example, dandelion seeds can fly up to 100 miles [160 kilometers] in the wind. Then there are pill bugs that can walk and roll. Also, NASA has been trying to study **Martian lava tubes**, but they have not been able to send any robots there. Our overall goal is that a pill bug robot could disperse thousands of these tiny [dandelion-seed-inspired] sensors into the atmosphere so they can collect information as they fly. •





Image Credit Right: Dr Mostafa Hassanalian

SCIENCE FACT OR FICTION:

IS THERE REALLY NO SOUND IN SPACE?

Is there any truth to the line "In space no one can you hear you scream"? Dr Alfredo Carpineti investigates.



Image Credit: *dzika_mrowka, seamartin/modified from iStock*



To quote Edwin Hubble, "Equipped with his five senses, man explores the universe around him and calls the adventure Science." Of course, we enhance our senses as much as we can with technology, but it is here we often start. How would the sky look if we could see in infrared? Depending on the wavelength, you might only see the water vapor in the air. What does the Moon *smell* like? Of gunpowder, according to astronauts. And truly a fan favorite: is there *sound* in space?



The answer, as always, is a lot more interesting than a simple yes or no. In interplanetary, interstellar, or intergalactic space there is no sound that we can hear. Thanks to the *Alien* movies' tagline, everyone knows that in space, no one can hear you scream. However, if we are talking about sound in general, beyond the senses of people who can hear, then outer space definitely has sounds – and some of them are absolutely mind-boggling.

How can sound travel in space?

But first of all, let's discuss what sound is and how it travels. Sound is a vibration propagating through a medium as a wave. It cannot propagate through a perfect vacuum – a truly empty void absent of anything, including particles – because there is nothing to travel through. Outer space is certainly a vacuum, but not a perfect one. The Sun is constantly releasing particles. This stream is known as the solar wind and it has an extremely low density. While there is an ebb and flow, depending on the activity of the Sun, scientists estimate between 3 and 10 particles per cubic centimeter at Earth's orbit. Even on top of Mount Everest, you would have a density of billions of trillions of particles.

While the density is low in interplanetary space, waves still propagate throughout. The Voyager space missions have now left the Solar System, but their decade-spanning travel among the planets allowed them to measure waves propagating through the plasma released by the Sun as the solar wind.

When the solar wind is released by the Sun, it's extremely hot and moves at high speed. As it expands outwards, it cools down and has a lower density. As mentioned, sound waves are just waves that move through a medium and interplanetary plasma can be such a medium. At Earth's orbit, 150 million kilometers (93 million miles) from the Sun, the speed of sound is about 50 kilometers (31 miles) per second.

Plasma and the speed of sound

Plasma is where the conventional wisdom about sound waves pretty much goes out the window. You might have learned in school that sound travels faster in a liquid than in a gas, and faster in solids than in liquids. A classic example is to compare air (about 340 meters per second), water (1,480 meters per second), and iron (5,120 meters per second). But compared to plasma, those speeds are tiny.

The reason for the difference is that you can interpret sound waves as pressure disturbances traveling in a medium. Without getting into the details of the math, the speed of sound will depend on pressure (and due to the laws of gases, temperature) and it will be inversely proportional to the density. So you have something that is big (hot) divided by something that is small (density) making the speed of sound through plasma a much bigger number.

Despite the speed of sound in the plasma being a big number, the solar wind moves faster than that. The particles in the wind move at a variety of speeds from about 200 to 750 kilometers (124 to 466 miles)

Image Credit Top: EzumeImages/iStock, **Bottom:** libre de droit/iStock

per second. So the solar wind is intrinsically supersonic, which ends up creating some fun effects throughout the Solar System. Something pretty neat is that the plasma waves that arrive at Earth from the Sun have a frequency in the audible spectrum, which goes from about 20 Hertz to 20 kiloHertz.

Would that mean that we could hear the sound of these waves? Well not exactly. "There is too little plasma for us to hear the sound directly," Dr Nigel Meredith, Space Weather Research Scientist with the British Antarctic Survey, told IFLScience. But these waves have an effect on Earth that allow us to hear them.

"It's interesting because when they come down to Earth, they're guided by the Earth's magnetic field in the ionosphere high up, and they get converted to radio waves," Dr Meredith explained."So you have this conversion from the plasma to radio waves and then you're converting them back to sound." The frequencies of these waves do not change, just the medium in which they travel.

Hearing a star being born

Plasma waves are found everywhere in the universe where there is plasma – and given that plasma is the most abundant state of matter in the universe, this means they are everywhere. The speed of sound in the different aggregations of the interstellar medium (the gas that exists in the space between stars) and the plasma turbulences present in this gas have huge implications for the birth of stars.

Stars are born in large molecular clouds. Gas in the clouds cools down over time. The regions where it is cooler are denser, and when they cross a certain density, they collapse under their own gravity into a star. The star formation rate in large molecular clouds is pretty inefficient. Just 1 percent of the gas turns into stars, and astronomers believe it is due to turbulence – the chaotic changes in the pressures and velocities of the medium in question. By measuring these movements and the speed of sound in the plasma, scientists can estimate how many new stars are being born.

But sounds don't stop once the stars are born. The interiors of stars are full of waves moving about at sonic speed, just like quakes propagate through the Earth. The field of asteroseismology actually employs these oscillations to study the interior of stars. A violin sounds like a violin because of its shape, and so stars have unique sounds too. Astronomers can measure these sounds by looking at small changes in the star's brightness. Resonant oscillations produce small but significant changes in the amount of light we get from a star.

This approach can be used to measure the mass and age of a star. This is extremely useful as a star's age and mass matters both in the context of an individual star and for how we consider the properties of



stars as a group. Asteroseismology is a tool that can literally go even deeper: different vibrations can reach layers at different depths, providing a way to understand the internal properties of stars. Similar techniques can even be applied to the Sun.



The deepest note in the cosmos

If those Sun vibrations are not enough like sound for you, worry not. There is something out there that can produce actual musical notes: **supermassive black holes**. Both the Virgo Cluster and the Perseus Cluster have a central galaxy with an active supermassive black hole that has generated bubbles of plasma moving close to the speed of light. These ripples are concentric, spaced over millions of years. In the case of the Perseus Cluster, the **note is a B flat**. Unfortunately, the ripples are every 9.6 million years, making this the deepest note in the universe, 57 octaves under middle C, and way below what humans can hear.

We can't mention black holes without mentioning mergers and the emission of gravitational waves. These are also vibrations (of space-time itself rather than a medium), which physicists have sonified as the **iconic "chirp"**. Different types of merging events have different chirps.

Can we hear sounds in space?

At the end of the day, the most intriguing aspect of sounds in space are those that we could potentially hear ourselves. It is a matter of location after all, but also of atmospheric composition. Assuming for a second that we could survive the hellish temperatures, acidic conditions, or incredible pressures, this gives us a wide range of places in the Solar System where we could go and find extraterrestrial sounds. All the planets (except for Mercury) and Saturn's moon Titan have a significant atmosphere. If we consider the giant planets alone, Uranus and Neptune will have a slower speed of sound than Saturn and Jupiter.

That's because they are colder. Researchers think that equipping a probe with a microphone and sending it down into the planets might actually provide insights into the different layers due to changes in the speed of sound. No such mission is planned, but microphones have been employed on terrestrial planets.

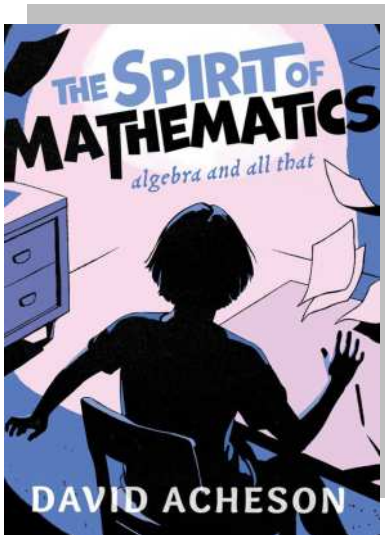
The Soviet-era missions Venera 13 and 14 had instruments to measure sound waves on Venus in the early 1980s, producing a measurement of wind speed on the planet. NASA's Perseverance Mars rover has also got a mic that has been used to measure the **sound of its lasers** and even the **first-ever sound of a dust devil** (and thus its properties) on another world. Interestingly, especially in relation to this discussion, thanks to the instrument, researchers were able to estimate the **speed of sound on Mars**, and it is slightly lower on average than on Earth.

Sounds there move at about 240 meters per second (540 miles per hour, or 787.4 feet per second). But there is a peculiar effect taking place on Mars. Due to its atmosphere being made almost exclusively of carbon dioxide and at low pressure, something weird happens if sounds are above 240 hertz (just below a piano middle C). The CO_2 molecules can't relax their vibrational modes and the speed of sound is 10 meters per second (32.8 feet per second) faster for those noises.

Sound may not be the most useful of our senses when it comes to space exploration, but the universe is filled with these waves, whether we can hear them or not.



Image Credit: dzika_mrowka, seamartin/modified from iStock



THE 1089 TRICK

In this excerpt from *The Spirit of Mathematics: Algebra and All That*, mathematician and best-selling author David Acheson uses a neat little trick from a "curiouser and curiouser" source to show that actually, math is pretty fun.

Mathematics at its best often has an element of surprise, and the simplest example I know is a magic trick.

The first step is to write down a three-figure number.

Any such number will do, as long as the first figure is greater than the last by 2 or more.

Now reverse your number and subtract. Finally, reverse the result and add.

The final answer is then always 1089.

I first came across this at the age of 10, in the *I-SPY Annual* for 1956.

And while it is not exactly "serious" mathematics, it blew my socks off.

Why does it work?
Let the starting number have digits *a*, *b*, and *c*, where *a* - *c* will be greater than 1. Then that number is actually 100*a* + 10*b* + *c*, and after reversing and subtracting we have

100*a* + 10*b* + *c* – (100*c* + 10*b* + *a*)

= 100*a* + 10*b* + *c* – 100*c* – 10*b* – *a*

= 99*a* – 99*c*

= 99(*a* – *c*).

So, at the end of the first part of the trick, *we always have a multiple of* 99.

Now, *a* - *c* is at least 2 and at most 9, so the possible multiples of 99 are

198	**594**
297	**693**
396	**792**
495	**891**

and as we proceed down the list, the first digits increase by 1 each time, while the last digits decrease by 1.

There is no mystery to this of course; adding an extra 99 is equivalent to adding 100 and subtracting 1. In consequence, the first and last digits of any number in the list *always add up to* 9.

So, when we reverse any one of these numbers and add – which is the last part of the "trick" – we get 9 lots of 100 from the first digits, 9 lots of 1 from the third digits, and 2 lots of 90 from the second, giving

900 + 9 +180 = 1089.

Who invented it?
The history of this trick is a little curious.

In the *Boy's Own Paper* for 1893, a version of it appeared using pounds, shillings, and pence!

The final answer is then always £12 18s 11*d*.

One intriguing possibility is that this version of the trick was invented by the Oxford mathematician Charles Dodgson – better known as Lewis Carroll, author of *Alice in Wonderland* – though the only evidence for this appears to come from *The Lewis Carroll Picture Book* of 1899. This was compiled by his nephew, who describes the trick as a *"numerical curiosity which I believe to have been discovered by Mr Dodgson"*.

In any event, the monetary version seems to have preceded this 1089 trick itself, and predominated until the early 1950s, reappearing from time to time in books such as *Willane's Wizardry and Uncle Mac's Children's Hour Story Book*. •

Image Credit: Oxford University Press



Q&A WITH DAVID ACHESON

AUTHOR OF *THE SPIRIT OF MATHEMATICS: ALGEBRA AND ALL THAT*

In his latest book, *The Spirit of Mathematics*, mathematician and best-selling author David Acheson uses quirky and everyday examples, from snooker to chocolate, to demonstrate mathematical concepts that may have been mind-boggling at school but just needed someone to reveal math's secret: it's not just important, it's fun.

What inspired you to write this book?

I wanted to see if it is possible to capture some of the deepest ideas and pleasures of mathematics using only simple materials, by which I mean the most elementary parts of arithmetic, algebra, and geometry that we all meet at school.

One very important idea, for instance, is that it is possible for infinitely many numbers to have a finite sum, and I establish this in the book with a simple but highly unusual "proof by chocolate".

The book is full of fun examples of algebra in an everyday context. How does that help in stressing its importance?

Algebra is important, above all, because it allows mathematicians to make general statements, the simplest example being the idea of a formula, which we find, of course, all over the physical sciences. But I'm not sure that all my examples are necessarily in an everyday context.

It's true, for instance, that I use algebra to explain the vibrations of a guitar string, and why some snooker shots are more difficult than others. But I also consider some absurd problems about men filling baths, taken from long-forgotten 19th-century textbooks. And, even there, I still managed to find an example where the method of solution, if not the answer itself, showed algebra at its best.

What do you enjoy most about working in mathematics?

One aspect I have always liked about mathematics at its best is the way that it really lasts. Even as a 10-year-old boy, I loved the classical geometry of triangles and circles, especially when the result contained an element of surprise. And, some 60 years later, I thoroughly enjoyed trying to recapture that youthful enthusiasm in another recent book of mine, called *The Wonder Book of Geometry*. In my experience at least, the very best results in mathematics tend to stay with you, throughout life, a bit like old friends.

How did you get into maths popularization?

It happened, really, one rainy November afternoon in 1992, when I discovered what is now called the "upside-down pendulums theorem". This was a startling phenomenon that appeared to defy gravity, a little bit like the legendary Indian Rope Trick, and it eventually featured, with the actual experiment, on prime-time television.

But around the same time, I also began using the electric guitar in my public lectures, to show certain aspects of algebra at work. And this, too, helped propel me towards maths popularisation, especially as part of a team called "Maths Inspiration", which puts on big shows for teenagers in major city-centre theatres, including London's West End.

What do you hope people will take away from the book?

I hope they will take away the idea that first-class, serious mathematics of real importance can nevertheless be fun. •

The Spirit of Mathematics: Algebra and All That is published by Oxford University Press and available now.

Image credit: Julia Baier



Living root bridges have stood for centuries in the state of Meghalaya, Northeast India, where the Indigenous Khasi and Jaintia tribal communities have crafted them from nature. Each artfully engineered suspension bridge takes decades to establish, but they are worth the effort as a vital means of moving through dense, wet jungles.

Image credit: *Nitish Waila/iStock*

INDIA'S INGENIOUS LIVING ROOT BRIDGES

Jungle living can be treacherous, and if *The NeverEnding Story* taught us anything it's that horses and wet floors don't go well together. In the jungles of Meghalaya in Northeast India, the Indigenous Khasi and Jaintia tribal communities have come up with an artful solution to getting around by manipulating trees to form living root bridges.

Known locally as the **Jingkieng Jri**, each bridge represents decades of hard human labor that sees tree roots manipulated to grow over bamboo scaffolding. The roots of rubber trees (*Ficus elastica*) are teased out to make the bridges, which are incredibly strong, being able to hold around 50 humans and even people on horseback.

In 2022, the Jingkieng Jri were added to UNESCO's "tentative list" marking the first step towards having the living root bridges considered for World Heritage Status. UNESCO celebrated the skill that goes into making each bridge, describing them as a "profound harmony between humans and nature".

The ingenious and sustainable solution to infrastructure has subsequently connected over 75 remote villages in one of the wettest regions on Earth. Meghalaya is home to the village of Mawsynram, said to be the world's rainiest place. To overcome the threat posed by swelling rivers in monsoon conditions, the Indigenous tribal communities created the living root bridges as a way of safely getting around.

The use of root inosculation blends living material to create lasting bridges that can tolerate the turbulent weather conditions Meghalaya enjoys and that other human-made structures might crumble under. As living structures, any damage the bridges incur can be repaired and actually sees the bridges grow stronger over time.

Research has shown the remarkable diversity that goes into creating Jingkieng Jri, with different approaches being employed to create ladders, platforms, towers, and even erosion/landslide prevention structures. And to top it all off, the rubber trees also provide waterproofing for local communities as they secrete latex.

"Besides playing a critical socio-economic role within each village, Ficus-based Living structures also contribute to the ecology through forest and riparian restoration," **UNESCO** said. "The Indigenous community, including traditional farmers and hunters, continue to use and nurture these structures, reinforcing the remarkable spirit of their ancestors."



How to get there

Two of the most visited Jingkieng Jri are found in Riwai and Nongriat, which, respectively, can be found near Mawlynnong and Cherrapunji in Meghalaya.

PLAY



Star Trek: Resurgence

Game from Dramatic Labs

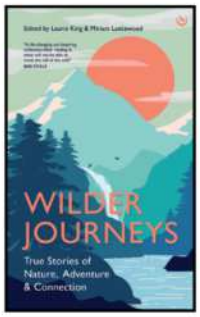
Explore new worlds in this narrative adventure game that follows *Star Trek: The Next Generation*. Gameplay is split between First Officer Jara Rydek and Engineering Crewperson Carter Diaz, giving you the chance to fly shuttles, fight with phasers, and whip out a tricorder to scan your environment, Dr McCoy-style.

***Available from* April.**

ESCAPE

Wilder Journeys

Book by Laurie King and Miriam Lancewood



Escape into nature with this collection of works from a vast range of adventurers, nomads, and naturalists, each with unique experiences in the wild. Through their pieces of narrative non-fiction and poems, they'll transport you on boats drifting down the Amazon, boards surfing in California, and even a 32,000-kilometer (20,000-mile) hike across 14 countries.

***Get 20 percent off with discount code* WILDER20 *Order* here.**

WATCH



The Super Mario Bros. Movie

Film from Universal Pictures

A plumber, a princess, and an army of adorable Mushroom People take on evil in this animated film based on the world of Super Mario Bros. With Chris Pratt voicing Mario and Anya Taylor-Joy as Princess Peach, the miniature heroes venture through worlds inspired by the games to stop Bowser from conquering the world. Let's a-go!

***In cinemas from* April 5.**

SCIENCE IN MEDIA



DISCOVER

Wanderlust: An Eccentric Explorer, An Epic Journey, A Lost Age

Book by Reid Mitenbuler



Discover the stranger-than-fiction true story of eccentric adventurer Peter Freuchen, whose 20th-century adventures took him from uncharted Arctic wastelands to the underground resistance networks of World War II. Freuchen championed Indigenous communities and environmental stewardship all while enduring dangerous expeditions, surviving a Nazi prison camp, and losing a foot.

Available now.

READ

The Right Stuff

Book by Tom Wolfe



One of the most celebrated books ever written about space has received a jaw-dropping makeover from the Folio Society in this luxury edition featuring retro illustrations by Tavis Coburn. In it, Wolfe investigates America's first astronauts with the question: What is it that makes a man willing to sit on top of an enormous Roman candle and wait for someone to light the fuse?

Available now.

Image Credit Top Row Left: Dramatic Labs, *Middle:* Watkins Publishing, *Right:* Universal Pictures, *Bottom Row Left:* Harper Collins, *Right:* © The Folio Society

DATES TO REMEMBER

It's the first full month of spring and there's plenty to celebrate, from citizen science to vaccinations. The World Health Organization sees in a big birthday, while the Lyrids should keep us entertained with a stunning meteor display. This April, don't be a fool: put these events in your diary before you forget.

APRIL

Citizen Science Month

Calling all budding scientists: now is your time to shine! **Citizen Science Month** offers thousands of opportunities to roll up your sciencey sleeves and put your curiosity to use. Science is not just for those with formal training – everyone can, and should, get involved. Find out more about how citizen science is changing the world **here**.





7 World Health Day

World Health Day is observed on April 7 each year, the anniversary of the World Health Organization (WHO) being founded. This year marks 75 years since its inception, and to celebrate, the WHO is looking back at public health successes in the last seven decades in its campaign "**Health For All**". From smallpox eradication to malaria vaccines (which will be celebrated in their own right on World Malaria Day, April 25), a lot has been achieved in those 75 years. Party hard, WHO, here's to the next three-quarters of a century.



22 Earth Day

In the midst of a climate crisis, our world needs transformation. This Earth Day, organizers invite us all to "Invest In Our Planet" by dedicating our time, resources, and energy to fighting climate change. Wondering what you can do to further the cause? Find out what Earth Day recommends and look for events happening near you **on its website**.

22 Lyrids Meteor Shower

It's been a hot minute since the last meteor shower back in January – but fortunately for those chomping at the bit to see some shooting stars, the wait is almost over. Come mid-April, the Lyrids will be back to fill that meteor-shaped hole in your life. Your best chance to see them will be at their peak on the night of April 22-23, and this time, the Moon is playing ball. It will be just 6 percent illuminated, meaning you should be able to catch a glimpse of the fiery space rocks as they soar through the night sky.



24-30 World Immunization Week

In the last week of April, the WHO celebrates **World Immunization Week** to promote the importance of vaccines in protecting people across the globe against disease. Whilst celebrating the monumental achievements so far in the field, the week also serves to highlight just how far we still have to go to ensure that people everywhere have access to potentially life-saving vaccines. "The ultimate goal of World Immunization Week is for more people – and their communities – to be protected from vaccine-preventable diseases," the WHO states.

Image Credit Top Left: Mart Kose CC BY 4.0, *Top Right:* danijelala/iStock, *Bottom Left:* ipopba/iStock, *Bottom Right:* Adventure_Photo/iStock





ARE YOU DRAWN TO THE DARKER OR LIGHTER SIDE OF SCIENCE?

Choose how you end each issue. For those who prefer the darker side, Rachael Funnell reveals some eye-opening details of male millipede, ahem, "machinery". If you like your science lighter, Maddy Chapman discovers that bumblebees are quite the social puzzzzzzzzle solvers.

A PENIS WITH MOVING PARTS

Genitals glowing under ultraviolet (UV) light made it possible for researchers to observe a neon peep show back in 2020, revealing for the first time the **intimate details of how millipedes do it**. The complex way millipede sperm has to be transported from the male to the female is quite a journey.

It figures that complicated copulation might be complemented by some pretty complex reproductive organs, and it doesn't get much stranger than the gonopods of *Spinotarsus glabrus*.

A new reveal-all **preprint** studied copulating millipedes to create 3D reconstructions of their male and female sexual machinery. To a backing track of *Best of Muddy Waters*, copulating millipedes were recorded before being shock-frozen using a sport injury spray and preserved in 70 percent ethanol at -20°C (4°F). The star-crossed lovers were then cut in half and prepped for scanning.

The resulting 3D reconstructions showed that the vulvae of females were quite simple – but it was a very different story for the males. Gonopods are walking-leg derived copulatory organs that have a big job, and getting it done involves several moving parts.

After a male releases sperm, it has to be translocated down its body from the paired penes to the gonopods, which can sit several sets of legs apart. The gonopods then have to transfer the sperm to the female, while also plunging out any that's been left behind by competitors.

Doing so means leaving the safety of the gonopodal sac, a hiding place the leg-inspired protrusions are normally concealed within for safekeeping. When it's go time, the gonopods leave the safety of the sac with what's effectively a millipede erection.

Standing to attention is achieved thanks to the "gonopodal pillow" that erects as it fills with hemolymph through hydrostatic action. As it rises, it takes the gonopods with it so that they can reach their goal: the vulvae. Each gonopod then dips in and out of the vulvae for around 30 to 90 minutes, before the male "unlocks" himself and the tryst is over.

When it comes to love – how did Cornershop put it? – **every millipede needs a gonopodal pillow**.

The Darker Side of Science

SOLVING PUZZZZZLES

There's nothing like a good puzzle to get a colony of bees abuzz (apart from the promise of nectar or the threat of **eviction**). A new study has found that puzzle-solving can spread through bumblebee colonies like wildfire, with the little critters learning solutions from one another in much the same way that social animals like primates do.

Bees may not seem the most natural puzzlers, but they have an unexpected track record that suggests otherwise: They're the only known non-human animal capable of **distinguishing odd from even**. And they **play ball** just for fun.

They're also, according to the **new research**, pretty adept at unlocking puzzle boxes to access a sugar solution. It's not quite sudoku, but the ability to learn the behavior simply by watching has been identified on an individual – and now colony – level, suggesting that bees can learn the art of puzzling from their winged besties.

Bumblebee colonies were provided with a box that could be opened by pushing either a red tab clockwise or a blue tab counterclockwise. Some bees were trained to use one of the two tabs while the others watched, learned, and then copied the behavior, which they did 98.6 percent of the time.

"Our research shows [...] that new innovations can spread like social media memes through insect colonies," Professor Lars Chittka said in a **statement**.

This, Chittka added, means they can respond quickly to environmental challenges. As well as hinting that bees are much smarter than we thought, this could mean they are capable of culture.

"These results in bumblebees, which are tiny-brained invertebrates, echo those previously found using similar experiments in primates and birds – which were used to demonstrate the capacity of those species for culture," **said** study author Dr Alice Bridges.

Well la-di-da.



THE LIGHTER SIDE OF SCIENCE