

# CURIOUS?

**IFLSCIENCE**

DOES IMAGINATION  
DECLINE AS WE AGE?

ARE THERE PLANTS THAT  
CAN PHOTOSYNTHESIZE  
BY MOONLIGHT?

DECEMBER 2025



THE  
SCIENCE  
OF

Magic



16



## WHERE ON EARTH

## THE WORLD'S CLEAREST RIVER

Brazil's Sucuriú River is so clear that you can see its entire contents just standing on dry land.

7



## WHAT ON EARTH

## NIEVES PENITENTES

What gives these curious spikes of snow their texture?

10

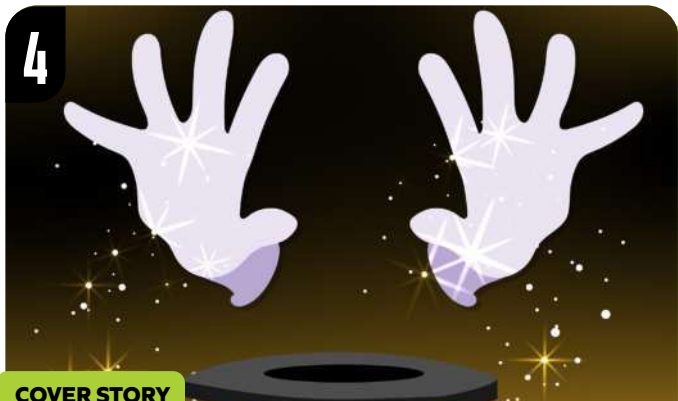


## DEEP DIVE

## DOES IMAGINATION DECLINE AS WE AGE?

Does it fade with time or get replaced by something else, Ben Taub ponders.

4



## COVER STORY

## THE SCIENCE OF MAGIC

Can magic be wielded as a scientific tool? Rachael Funnell investigates.

DECEMBER 2025

## CONTENTS

## PAGE 2 | NEWS BITES

What's new, what's weird, what's happening?

## PAGE 8 | WE HAVE QUESTIONS

Are There Plants That Can Photosynthesize By Moonlight?

## PAGE 14 | BOOK BITES

Bats Vs Moths

## PAGE 15 | MEET THE AUTHOR

Yossi Yovel on *The Genius Bat*

## PAGE 18 | SCIENCE IN MEDIA

What to watch, read, and listen to this month

## PAGE 19 | IFLS IN THE FIELD

Alfredo Carpineti gets many sneak peeks attending ESA's Open Day

## PAGE 20 | DATES TO REMEMBER

What to look out for this month

## PAGE 21 | DARK VS. LIGHT

How will you end the issue?

## EDITORS

Katy Evans  
Rachael Funnell

## DEPUTY EDITOR

Maddy Chapman

## CONTRIBUTING WRITERS

Ben Taub  
Dr Alfredo Carpineti  
Rachael Funnell  
Holly Large

## ART &amp; DESIGN

James Rodrigues

# NEWSBITES



## Track Santa!

Once again, you can track Santa as he gears up for his epic one-night-only trip around the world. The first Santa Tracker was developed in 1955 by what would become the North American Aerospace Defense Command (NORAD), which tracks everything that flies in or over North America 365 days a year. But how did US defense end up tracking jolly St Nick? It involved a department store advert to call Santa, a typo, and a young girl who had the luck to reach Colonel Harry Shoup, on duty at the Continental Air Defense Command operations center that night. Not wanting to disappoint her, he assured her they would guarantee Santa a safe journey from the North Pole, and NORAD has been doing it ever since. You can **track Santa right here** on Dec 24. You can even try and see Santa! NASA's **Spot The Station** app lets users track the ISS, which to small people can look like a sleigh whizzing by overhead, with up to two weeks' notice of sightings from your location.

## Surprising Science On Christmas Day

You'd be surprised how often Christmas Day crops up in the calendar of important science events, so here's some you can share with friends and family this year.

Isaac Newton was born on December 25, 1642 (in the Julian calendar, which was in use in England at the time. In the modern Gregorian calendar, his birthday is January 4, 1643). German astronomer Johann Georg

Palitzsch observed Halley's Comet on Christmas Day, 1758,

confirming Edmond Halley's prediction 50 years earlier that the comet would return on this date – the first successful comet prediction, how it got its name, and confirmation of Newtonian mechanics. The first web browser connected to a web page built by Tim Berners-Lee was published while he worked at CERN on Dec 25, 1990, and JWST, the most powerful space telescope ever built, launched on this day in 2021.

## A Museum World-First

For a curious day out without even leaving your home, you can now visit the world's first virtual **Museum of Stolen Cultural Objects**. Explore looted items from 46 countries around the world rendered in 2D and 3D, including artworks, rare books, musical instruments, jewelry, historical artifacts, and more for free in UNESCO's new digital museum. UNESCO was set up in 1945 to conserve international culture, from languages to historical sites. With the virtual museum, it is highlighting the illicit trafficking of cultural heritage artifacts by, unusually, hoping to get rid of those on display. "Unlike traditional museums, the Virtual Museum is designed to gradually empty itself with the goal of returning and not accumulating," UNESCO said. "As stolen objects are recovered and restituted, they will be removed from the digital collection, symbolizing justice and restoration."

## Send Your Name To The Moon

You – or your loved one if you need a last-minute Christmas (or Valentine's) present – could be joining NASA's historic Artemis II mission to visit the Moon early next year, the first humans to do so in 54 years. Scheduled for no later than April 2026, the four-person mission will see astronaut Christina Koch make history as the first woman to go to the Moon. The 10-day mission will circle the Moon, testing out systems and hardware in preparation for landing on the Moon with Artemis III. You can add your name to the flight manifesto by signing up before January 21, 2026. You can even download your boarding pass **here**.





## Wave As 3I/ATLAS Passes Earth

Our newest interstellar comet will pass closest to Earth on its epic trip through the Solar System this month. On December 19, the comet will pass about 270 million kilometers (168 million miles) from Earth, almost 700 times the average distance between us and the Moon. This should provide an excellent opportunity for Earth's ground-based telescopes to get a good look at this rare visitor, just our third known from outside the Solar System. The first, 1I/Oumuamua, was closer, passing within just 24 million kilometers (15 million miles) in 2017, but we only discovered it five days later. You should even be able to see 3I/ATLAS with a mid-sized telescope. If not, you can track it live [here](#).



## Prehistoric Planet 360°

Have you ever stood in front of a real-size *T. rex* and had it look back at you? Get yourself to London (or wait for the global tour) and you can, thanks to *Prehistoric Planet: Discovering Dinosaurs*, a new 360° immersive experience at London's Lightroom. Telling the story of dinosaurs from 66 million years ago to their legacy today, the experience blends scenes from Apple TV's Emmy-nominated show with brand new content, new illustrations, and extended CGI sequences, all projected on the walls, floor, and occasionally ceiling, to give the feeling of being fully immersed in their world. On from **now until March 2026**, details about where it will travel next will be available next year.

# WHAT'S UP?



## WORLD'S LONGEST FLIGHT

Because who doesn't want to spend a day on a plane?

**Name:** Flights MU745 and MU746

**Appearance:** Giant metal bird on a migration

**Location:** Shanghai to Buenos Aires

**Surely a flight that long isn't possible?**

And now we've found the catch to the airline's claim for the world's longest flight – the plane won't actually be in the air for the whole time. There's a two-hour stop in Auckland, New Zealand. CEA still **calls it** a "direct air link" – which means the flight number will stay the same and passengers stay on the same plane – but it's not non-stop. No one's managed a non-stop antipodal flight yet.

**It's going to be expensive, right?**

Your suspicions are correct. Even an economy ticket for this flight will set you back between \$1,525-\$2,254, and business class a hefty \$4,994. You could subscribe to IFLScience for over 2,000 years for that price. We know which one we'd rather.

**You're not talking about Santa on Christmas Eve, are you?**

Nope, sadly OI' St Nick Airlines isn't involved here. This is a brand-new commercial flight from China East Airlines set to take passengers from Shanghai all the way to Buenos Aires, and back again. Fun fact: these two cities are antipodal, meaning they're at opposite points on the Earth's surface. The location of the airports might throw that off a bit, but it essentially means that this flight will go pretty much exactly halfway around the world.

**That's got to be a long flight.**

You bet. The flight from Shanghai to Buenos Aires is expected to take around 25.5 hours, and the return flight 29 hours, so passengers are guaranteed an entire day on the plane either way. Best to book an aisle seat and lock in to watch the extended edition of *The Lord of the Rings* trilogy. Twice.

**Maybe I've won the lottery. How soon could I catch one of these flights?**

The first longest flight is set to take off on December 4, and it'll run twice weekly from then on.

# THE SCIENCE OF MAGIC

When seeing isn't believing, how can magic be wielded as a scientific tool?

By Rachael Funnell



Are you watching closely?

Those are the four words that kick off arguably one of the greatest movies ever made. *The Prestige*, a tale of the extremes rival magicians were willing to go to back in the Victorian times. The film itself wasn't based on any one true story but instead borrowed inspiration from several real-life accounts and people, including – somewhat surprisingly – Nikola Tesla.

Yes, you can't really touch on *The Prestige* without a tip of the magic hat for David Bowie and his... convincing accent. A Serbian-American engineer, futurist, and inventor, Tesla is remembered for his contributions to the electricity supply system. He straddles a few disciplines within the sciences, which might have some people reasonably asking: What was he doing in a film about magic?

## "The science of magic"

If your idea of magic is novelty napkins pulled from a sleeve and human-filled boxes sawed in half, then I can understand your outlook. Magic, on its most superficial surface, looks more like a series of novelty staging with secret drawers and false doors, but take a moment to consider the performers. Each word carefully chosen, with everything from the staging, costume, and glamorous assistant designed to trick your mind into focusing on what they want you to see and obscuring what they don't.

Then we have the mentalists. Famous faces like Derren Brown, who tricked this pessimistic writer into thinking of the words "milk" and "wardrobe" even after I spent the entirety of his 2016 performance determined I wouldn't fall for his mind tricks (if you're reading this, Derren, please get out of my brain).

Not only do concepts of science underpin magic, but concepts in magic can also be used as a tool in science. Don't believe me? Then allow me to transport you to Britain's "Ocean City," where the Plymouth University MAGIC Lab resides on campus. Established by magician and psychologist **Dr Gustav Kuhn**, it's been a hub of exploration into human behavior and cognition, using magic as a tool for scientific research.

Kuhn's journey with magic began in his early teens, a time that was dominated by finding ways to entertain people. In pursuit of a more convincing performance, he began studying psychology as a way to improve his magic, but during his PhD, he noticed something.

"THERE'S A LOT OF CLOSE PARALLELS BETWEEN THE TYPE OF TECHNIQUES USED BY MENTALISTS AND HACKERS, BECAUSE A LOT OF HACKING INVOLVES EXPLOITING LIMITATIONS IN HUMANS."

"I realised that a lot of the questions that psychologists are interested in, questions about perception or attention, are actually very closely related to the kind of things that you learn to manipulate as a magician," Kuhn told IFLScience. "So, for the last 25 years, I've been trying to bring together magicians and scientists to create what is now known as the science of magic."

## Pick a card, any card

Think of a card trick. Often it starts with a request to choose a card, *any card*. It's implied that you have free will, but your decisions can be influenced before you've even gotten started.

Sleight of hand is a classic tool in such tricks. It requires finely tuned dexterity and misdirection to set traps that will lead your participant down the path you want them to take. In the bizz, they're known as card forces.

The dribble force. The riffle force. The "Now You See Me" force. There are myriad ways to get a trick off to your desired start, and you can find tutorials on how to perform them all over the Internet. It's clever, impressive, and something my pie-like dexterity certainly isn't capable of, but it's really just the tip of the iceberg in terms of what the science of magic can achieve and how those ideas

can help us to better understand the wider world.

"Magicians don't just manipulate what you see, they also manipulate what you think and the things that you choose," said Kuhn. "There's a lot of close parallels between the type of techniques used by mentalists – magicians who do mind-reading demonstrations – and hackers, because a lot of hacking involves exploiting limitations in humans."

"For example, phishing attempts to get you to hand over sensitive information, and actually that's very similar to what a lot of magicians do. So, I might ask you to think of something, and I use psychological techniques to extract that information – these principles are very similar to what a cyber-criminal will do. In the magic lab, we study the psychological mechanisms that underpin these principles, and then we try and apply that to the real world."

## Did you see the gorilla?

Kuhn mentioned there how magicians exploit "limitations in humans," another phrase for which is our cognitive weaknesses. One of the best demonstrations of this is an experiment by Daniel Simons and Christopher Chabris. In case you've made it this far through life without yet being bamboozled by an inability to count ball passes, you can check it out in the video below:



To the uninitiated, the big question seems like it should be: How many times did the players in white pass the ball? When actually what we should be asking is: Did you see the gorilla?

According to Simons, about half of people who participated in the selective attention test (before it became world-famous) failed to notice that a human in a gorilla suit wanders into the fray, beats its chest, and saunters off again. This isn't a lightning-speed sleight of hand, nor a cleverly placed ape. It's a big flip of the bird to your perceived alertness.

**"I ALWAYS THINK OF MAGIC AS THIS SPLIT SECOND IN YOUR BRAIN – OR, MAYBE, HEART – WHERE YOU THINK, 'ACTUALLY, THIS FEELS REAL,' AND I THINK THAT'S WONDERFUL."**

It's kind of scary, if you really think about it, how we can be so gently guided into missing what's right in front of us. This is known as inattention blindness, a psychological phenomenon in which we fail to notice something because our attention has been directed elsewhere.

Attention, it turns out, isn't just about where you're looking, it's about what you're thinking about. If you were primed that the above video was called the "invisible gorilla" experiment, chances are the gorilla wouldn't be so invisible anymore. The instruction to focus on the basketball passing between the players in white diverts your focus and all your cognitive processing gets used up on that. In short, perception is limited and shaped by where we direct our cognitive resources.

These cognitive blinders aren't always a bad thing. We need selective attention in order to focus on a task while filtering out irrelevant information. It's what's enabled you to (hopefully) read this article rather than noticing the breeze shaking the leaves

outside the window, or the conversation taking place in the next room.

In a social society, it would be hard to function without selective attention, but it does create "blind spots" in our perception. Blind spots that can be exploited by everyone from Derren Brown (I'm watching you) to the hacker trying to make you click a malicious link in an email.

### Are you watching closely?

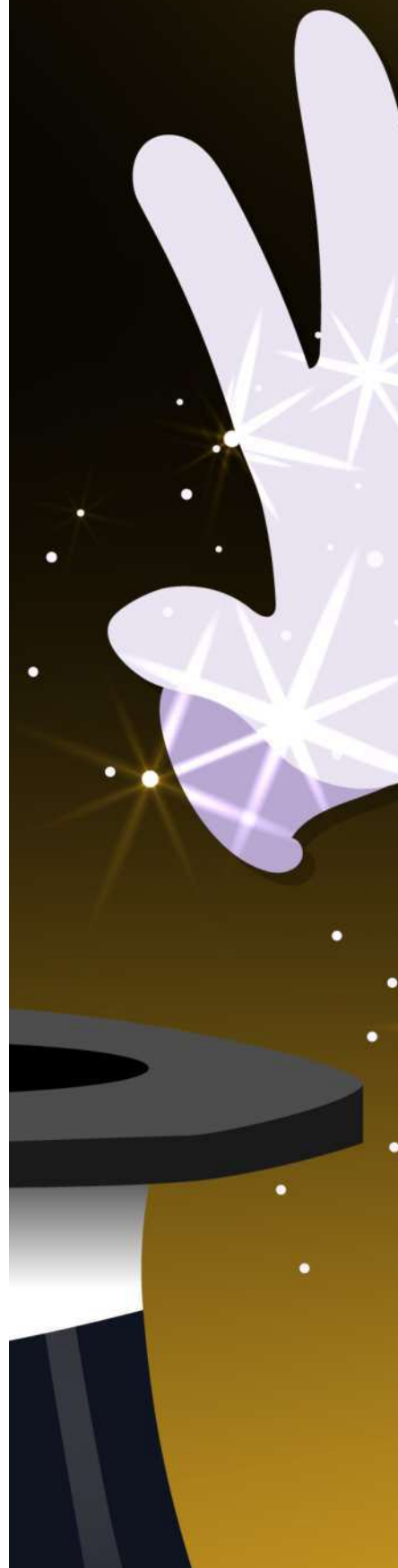
It's easy to see, then, how being aware of these cognitive weaknesses and better understanding them can help us to protect ourselves. So, sounds like a pretty worthy avenue of scientific study, right?

This is what makes the MAGIC Lab such an exciting treasure trove of research, and there is so much more to explore behind the proverbial curtain. If you'd like to take a peek, join us for the next CURIOS Live virtual event on December 11 where I'll be speaking with Kuhn about the intersection of magic and science, and how it applies to everything from driving to cybersecurity, the placebo effect, and misinformation.

Several demonstrations capture just how gaping my cognitive blind spots really are – seemingly, no matter *how closely I'm watching* – and at the end of it all, reminds us just why magic is such a hoot.

"At the core of any magic trick lies this experience of the impossible," said Kuhn. "From a psychological perspective, I think of magic as a conflict in beliefs. It creates this conflict between the things that you believe to be impossible – that rabbits can't appear from nowhere – and the thing that you've just experienced – a rabbit appearing from a hat."

"To achieve this, magicians exploit lots of psychological tricks. It looks like they can perform real miracles, but what they're actually doing is exploiting clever psychological tricks to create these illusions of the impossible. I always think of magic as this split second in your brain – or, maybe, heart – where you think, 'Actually, this feels real,' and I think that's wonderful." ✨



## NIEVES PENITENTES

These are nieves penitentes (Spanish for “penitent snows”), so named for their resemblance to the pointed headwear of Christianity’s Holy Week penitents. It’s the curious result of differential ablation as hollow areas of snow catch the Sun and sublime into gas, while spiky areas less exposed to the light endure even after the rest of the snow has gone. They’re found at elevations exceeding 4,000 meters (13,000 feet) and can grow anywhere from a few centimeters to over 5 meters (16 feet).



# ARE THERE PLANTS THAT CAN PHOTOSYNTHESIZE BY MOONLIGHT?

And how does cloudy weather affect the process?

By Rachael Funnell

Imagine having a job that's dependent on sunny weather. As a resident of England – AKA, cloudsville – I think I'd be pretty much done for. There are, however, hard workers on this planet that rustle up energy for the rest of the food chain to enjoy day in, day out. Yes, I'm talking about plants.

A little thing called photosynthesis enables them to essentially “eat the Sun,” creating food from sunlight, come rain or shine, but what about at night? Are there any plants that can photosynthesize by the light of the Moon? As Head of Living Collection Support at London's Royal Botanic Gardens, Kew, Thomas Freeth told me, plants have found all sorts of ways to overcome the changing nature of night and day.

## What is photosynthesis?

**TF:** It's the process that enables plants to create energy from the Sun, but it's like one of nature's miracles in a way. It is a completely self-sustaining factory. Yes, it produces energy, but it does all these amazing things, and it requires no energy other than sunlight to work.

It takes a photon from the Sun and excites an electron in the leaves, which starts to pass down a gradient and at the end of that, it converts the light energy into chemical energy. Plants eat sunlight, in a kind of surface level understanding, but the system of staggering efficiency and elegance not only produces the glucose – the sugars that the plant needs to work – but that

# WE HAVE QUESTIONS



glucose has got carbon in it, right? So, the plant then stores that carbon in its roots.

This is carbon sequestration in its roots, and its leaves, and its woody structures, which is obviously very on topic now. This is what it's doing. Photosynthesis takes the atmospheric carbon and brings it into the plant and sequesters it.

The fungi at the roots, they're tapping into that glucose. So, the oxygen, which is produced on the other side of the reaction, that's what makes this planet habitable for all life. The fact that this glucose is then kind of metabolised by the other side of the reaction, the respiration side, and then stored in the tissues, and then anything within the plant is then broken down and fully recycled when it's eaten by the things above it in the food web. This is really the foundational (possibly the most important) process in all of biology that enables life to occur.

## Can the weather affect photosynthesis?

**TF:** All photosynthesis requires is a photon. So, if the photons are getting through, which they are even on a cloudy day, it will be occurring. At a much slower rate, but it will still be occurring.

It's also worth saying that plants appear green because they are reflecting that part of the spectrum, and the most photosynthetically useful part of the light spectrum is towards the blue end and towards the red end. That's why we see green, because it's the middle part of the light spectrum that the plants are reflecting and as long as those wavelengths of light are getting through, then photosynthesis will be occurring.

## What about night – can plants photosynthesise by moonlight?

No, I don't think so. Moonlight is the Sun's reflection. It's the light reflecting off the Moon from the Sun. So, the Moon itself is not emitting any photons and I imagine that the strength of the light is too weak by the time it's bounced off the Moon and gone through the atmosphere. So, it's quite a simple answer to that. If no photons, then no. No photosynthesis.

## What are plants getting up to at night?

Photosynthesis in its traditional sense cannot occur at night, but plants have figured out all these weird and wonderful ways to

get around that. The first one is through this mechanism called crassulacean acid metabolism.

This has been known about since the 19th century. There's a plant family called Crassulaceae (you may know it as succulent house plants like *Kalanchoe*). The process is called that because it was first discovered in that family, but subsequent studies have revealed it to actually be present in many completely unrelated families.

This process has evolved multiple times in multiple lineages, it's so strongly selected for, but why does it occur? So, the acid metabolism bit, the original researchers who noticed this noticed a difference in acid concentrations from the day and the night, and that was the kind of initial hook to ask what was going on here.

Crassulaceae are succulent plants, which are adapted to drought in some way. They have succulent leaves that they store water in, meaning that normally they're existing in areas that are both hot and dry with super high UV, super high air temperatures, and very low humidity.

Photosynthesis requires carbon dioxide to work, and the way that plants get the carbon dioxide into themselves is by opening their stomata to their breathing pores. Not a great strategy for survival in the desert.

You're not going to persist very long if you open your breathing pores at the hottest, driest part of the day. It's just going to pull all of that water out of the plant. So, they close their breathing pores in the day. They essentially hold their breath, but photosynthesis can still occur because they open their breathing pores at night and pull in the carbon dioxide at night, and then they convert it into an acid, malic acid, which they are then able to use in the day. ☀



**Hungry for more CURIOUS questions? Head to the We Have Questions podcast for new episodes monthly.**

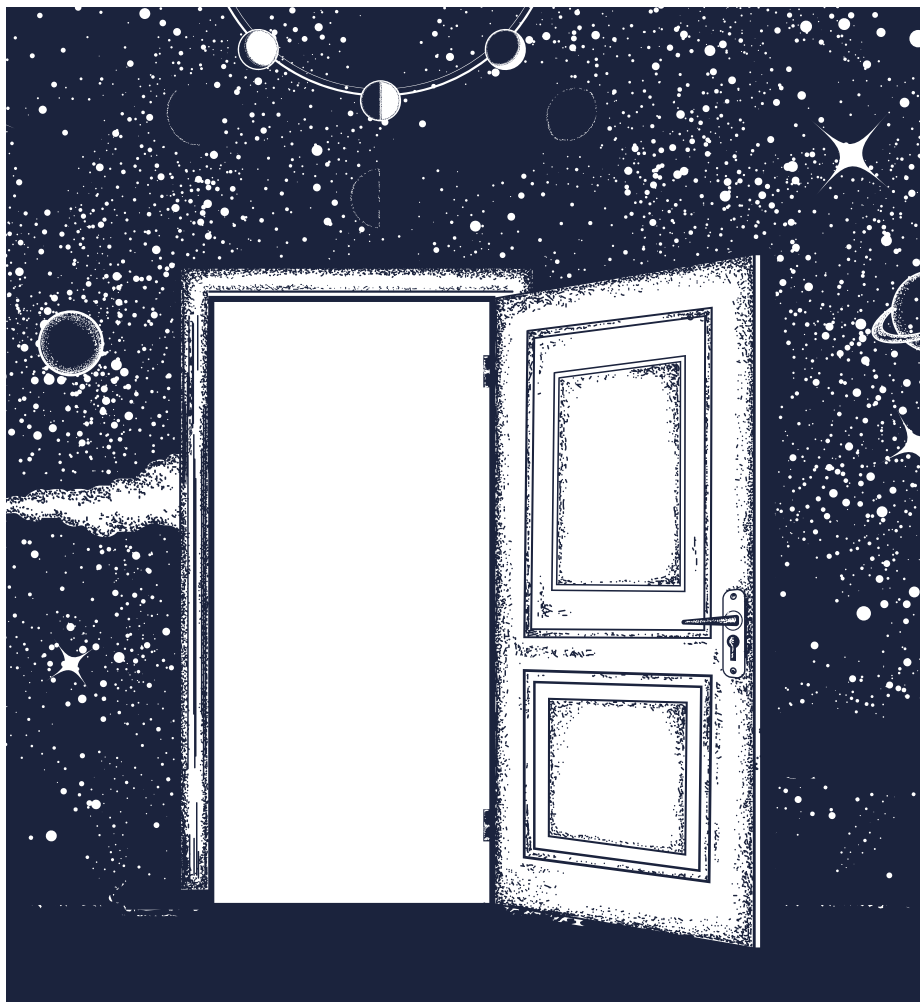
SCIENCE FACT OR FICTION:

# DOES IMAGINATION DECLINE AS WE AGE?

If so, what do we get instead, and is the trade-off worth it?

Ben Taub investigates.





"A dragon lives forever, but not so little boys" – so goes the famous folk song *Puff the Magic Dragon*, which recounts the achingly nostalgic tale of Jackie Paper as he outgrows his childhood innocence and abandons his imaginary reptilian friend. And while there's no doubt that we all lose an element of fantasy-based thinking as we mature, what's less clear is whether this corresponds to a deficit in imagination.

After all, few adults keep the company of fictional talking dragons, but that's probably for the best. In exchange for giving up some of this cognitive sparkle, we gain the ability to function in the real world of tax returns, rush-hour traffic, and parenting. As our mode of **imagination** transforms, we become less capable of fleeing into other dimensions, but gain the ability to come up with creative solutions to everyday problems.

### The mind's eye loses its vision

The idea that imagination decreases with age is

largely based on research showing that mental imagery becomes less vivid over the course of our lives. For instance, a study published in 2022 presented the results of a survey of 2,252 people between the ages of 12 and 60, in which participants were asked to rate the intensity of the **images they saw in their mind's eye**.

"I did not expect to see such a neat curve presenting the decline so beautifully," says study author **Dr Ilona Kovács**, a cognitive neuroscientist at Eötvös Loránd University in Budapest. "I mean, in experimental research, you never get such a perfect function as we saw there," she tells IFLScience.

On an 80-point scale, the average 14-year-old scored 65 for vividness of mental imagery, yet this dropped dramatically following the onset of adulthood, with the biggest decline occurring before the age of 25. By age 55, the average score was just 40.

The percentage of people classed as hyperphantasic – which refers to individuals with extremely rich mental imagery – was also negatively correlated with age, while **aphantasia** – or the lack of a mind's eye – was more common in older age groups.

However, as Kovács' subsequent work has highlighted, this gradual loss of color doesn't necessarily mean that our imaginations become impoverished as we age. Rather, the mode of imagination shifts from concrete visuals to more abstract, conceptual thinking.

"I don't really like the word 'imagery' anymore," she says. "I would call it mental simulation, because the lack of mental images in this context is not a disease. It's not really a lack, it's just an alteration of the internal simulation process."

### The imagination changes as we age

This diminishing capacity for mental imagery has been documented by a variety of studies that capture the many ways in which our cognitive toolkit appears to morph as we get older. For instance, a paper that came out in late 2024 demonstrated that more mature adults tend to use their "**mind's mind**" more than their "**mind's eye**", with the opposite being true for younger participants.

In this instance, the mind's mind refers to a more abstract or conceptual mode of thinking, whereby a particular phenomenon is imagined through words or an implicit mental reconstruction. The mind's eye, on the other hand, is a more concrete or perceptual form of conjuring up certain categories through image-based representations.

Importantly, the study found no evidence that younger people have better imaginations than older individuals, but highlighted how different types of imagination appear to predominate at different stages of life.

This is backed up by further research conducted by psychologists from the University of Kent in 2023, in which almost 500 people between the ages of four and 81 were asked to come up with creative and unusual uses for a series of historical artifacts. Somewhat surprisingly, the researchers found that older respondents tended to show **greater**

**originality** in their answers, suggesting that on some measures of imagination, they may outperform youngsters.

**"EVEN PEOPLE WITH LOW VIVIDNESS DO HAVE IMAGERY, THEY JUST USE IT DIFFERENTLY. THEY DON'T USE PERCEPTION-LIKE IMAGES, THEY USE ABSTRACT CONCEPTS."**

However, younger participants scored higher for fluency and flexibility of imagination, meaning they were able to come up with a

greater number of ideas that were more varied in their nature. Overall, these findings indicate that some aspects of our imaginations seem to be more accessible when we're young, while others increase in influence as we age.

Exactly why and how this happens is not yet clear, although brain imaging studies have indicated that functional connections between the prefrontal cortex and visual cortex decrease as part of the aging process. This, in turn, is associated with reduced activation of the visual cortex during mental imagery tasks, and may partially explain why our mind's eye becomes less dominant as we move through life, allowing other types of imagination to take over.

### **Does it matter if our mental imagery fades?**

"Mental imagery is an internal process that can move along a spectrum between abstract and

very concrete representations," says Kovács. "Even people with low vividness do have imagery, they just use it differently. They don't use perception-like images, they use abstract concepts."

In other words, any reductions in the vibrancy of our internal vision that may occur over our lifetime needn't mean that we're losing our ability to simulate imaginary scenarios. Rather, these changes serve to underscore the fact that there are many ways to engage our imaginations.

"We call this neurodiversity in mental simulation," says Kovács – and it's this variety of cognitive processes that may separate younger from older imaginers.

In a study published earlier this year, Kovács and her colleagues sought to investigate these contrasting forms of mental simulation,

CURIOUS LIVE  
CHRISTMAS SPECIAL

IFLSCIENCE



# THE SCIENCE OF MAGIC

**DECEMBER 11**

Join IFLScience writer and host Rachael Funnell as she visits Dr Gustav Kuhn at the **UK's only MAGIC Lab** to uncover The Science Of Magic, exploring everything from the psychology of sleight of hand to how magicians' techniques can be useful in cyber security.

The watch along party is free to join and Dr Gustav Kuhn will be with us in the chatroom to answer your questions. Whether you're a magician hoping to up their game or just want to know how Derren Brown does it, this is one you won't want to miss.

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providing new insights into the impact of this shift away from vivid mental imagery. To do so, they devised an experiment involving **binocular rivalry**, whereby separate images are presented to each eye.

In this case, participants looked at moving lines, with one of their eyes viewing gratings that drifted to the right while the other saw gratings moving to the left. Typically, when presented with such competing stimuli, the brain can't fuse them into a single, coherent image, and viewers instead tend to see the two separate pictures alternating back and forth.

WE'RE ALREADY FAMILIAR ENOUGH WITH THE CONCEPT OF A DOG THAT WE CAN MENTALLY REFERENCE THIS CATEGORY WITHOUT HAVING TO PICTURE A SPECIFIC FOUR-LEGGED FRIEND.

"It's a stochastic process, which means you can't consciously choose to see one or the other image," says Kovács. However, it is possible to prime the brain to favor one stimulus over the other.

So when the researchers asked the participants to imagine the gratings moving to either the right or the left, this often caused "modulation", whereby they predominantly saw that direction of motion. Interestingly, though, this worked better for people who reported having vivid mental imagery, and often failed to produce results in those who lacked a strong mind's eye.

The study authors then attempted to influence participants' visuals using a method they call "conceptual priming", which engages the mind's mind instead of the mind's eye. "We asked them not to imagine the picture or to see the movement, but to just think of the direction 'right' or 'left' in a more abstract sense," explains Kovács. "And that actually

worked, so people with low vividness [of mental imagery] then showed the same kind of modulation under these instructions."

Essentially, then, this experiment shows that it really doesn't matter if you have strong mental imagery or not, as there are multiple ways of using your imagination and none are necessarily better or worse than any others. You can be a perceptual thinker – meaning you tend to see images – or a conceptual thinker, and basically end up at the same point.

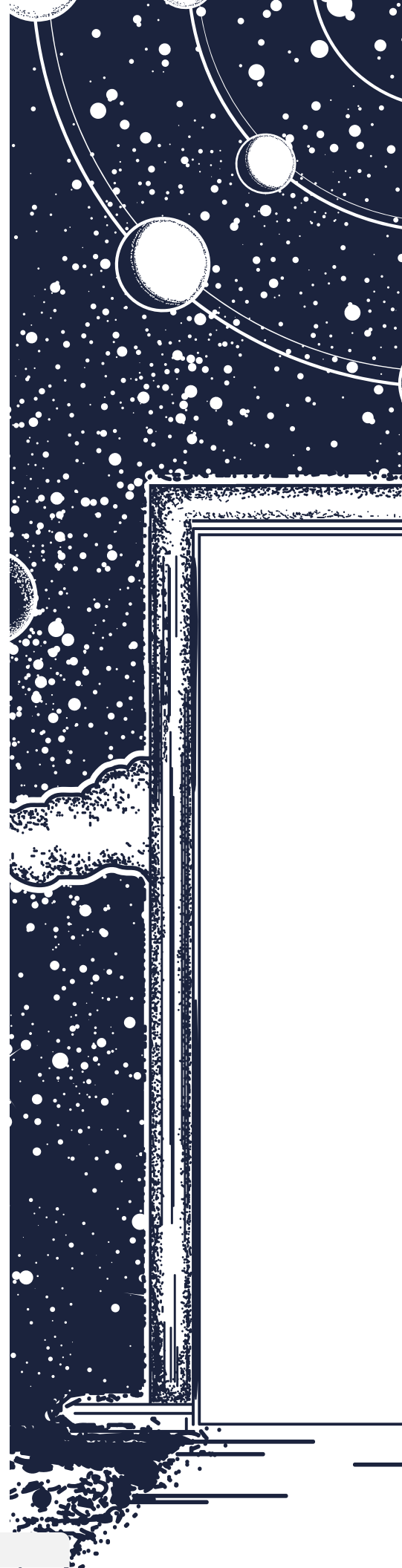
In the context of aging, these findings suggest that we may simply have a greater need for conceptual imagination as we get older, which could explain why our mental imagery tends to fade away. For instance, Kovács says that when children are first learning to categorize the various elements of their world, they generally refer to concrete examples, so that when they hear the word "dog" they picture their family pet.

Adults, on the other hand, "have refined abstract representations and prototypes, which may not require perceptual level representations," she explains. In other words, we're already familiar enough with the concept of a dog that we can mentally reference this category without having to picture a specific four-legged friend.

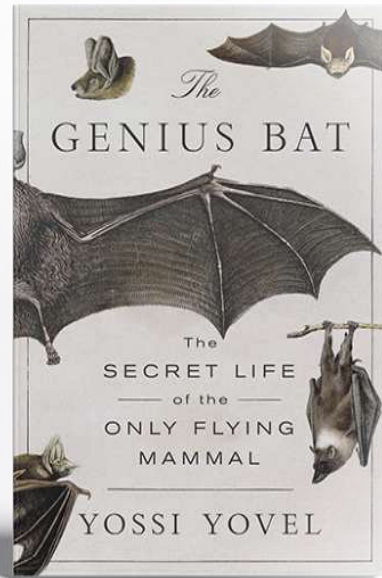
Yet the fact that our brains no longer produce a vivid image whenever someone mentions canines certainly doesn't hinder us or detract from our quality of life. As Kovács points out, "older people don't really complain about losing this vividness, because it's not a lack, it's just a different way of doing something."

Seeking a comprehensive explanation for this move away from a visual imagination, she says that "it may not even be related to the aging process" in the same way that achy knees, wrinkly skin, and cognitive decline are. Instead, Kovács posits that "it's a developmental stage," meaning that our morphing imaginations may simply be a sign of maturity and refinement.

So while Jackie Paper may not visit his old pal in Honah Lee anymore, he certainly isn't losing his imagination. ✨



# BATS VS MOTHS



Echolocation can be a help and a hindrance for bats stalking their prey. In this excerpt from new book *The Genius Bat*, Yossi Yovel explores this predator-prey arms race and the inventive strategies bats have evolved to come out on top.

In the course of evolution, insects also developed methods of maneuvering specifically designed for eluding bats. Moths with ears have an inherent advantage over bats. When sound waves are emitted from the bat's mouth or nostrils, they spread, and their energy decreases accordingly – like the fading ripples from a stone tossed into a pond. This fading sound wave hits the moth, and part of the wave bounces back toward the bat. This echo returning toward the bat again spreads in different directions, further weakening it. That is, the bat needs to be able to identify a very weak echo after it has faded twice, while the moth needs to identify the original call after it has faded only once.

Mathematically, this is a huge difference because the dissipation of energy is

multiplicative. Therefore, even with a very simple auditory system, the moth's range of hearing is still greater than the bat's. That is, it can usually detect the bat while still beyond the range in which the bat can detect it. This enables the moth to flee before the bat notices it, even though it flies several times more slowly than the bat. In cases where the bat manages to spot the moth before it has time to flee, the moth performs one of two emergency maneuvers: It may start to frantically fly in circles in different directions, making it very difficult for the bat to catch it, or it may drop down as fast as it can to escape the bat's range of detection, like in a dogfight between fighter aircraft. Anyone who's seen *Top Gun* will know what I mean.

One of the favorite games of bat researchers is to stand under a streetlight where lots of moths are hovering and produce ultrasonic sounds – any dog-training clicker will do the trick. About a third of the moths – those with ears – will immediately drop down upon hearing the sounds. The amazing thing is that just two neurons in each ear transmit enough information on the bat's direction and distance to the moth's nervous system to enable it to decide on a strategy to elude the predator. Who said that you need a big brain to make sophisticated decisions?

But the bat's R & D department didn't remain idle. During the course of evolution, many bats developed counter-abilities to contend with the moth's auditory ability. One of the strategies for evading detection by a moth with ears is to emit weaker signals. In general, the

echolocation calls of bats are among the most powerful sounds in nature, but certain species of bats "shout" softly. Many researchers regard this as a strategy that enables these bats to sneak up on their prey.

There are also bat species that have switched to a gleaning strategy: Instead of catching their prey in flight, the bats gather it when it's sitting or crawling on a plant or on the ground. Most of these bats, like the *Corynorhinus* we met earlier, evolved huge ears that enable them to hear the sounds of the prey's movements – for example, when it flaps its wings or crawls on a bed of leaves. And, naturally, those bats that glean prefer to forage when the leaves are dry because the rustling sounds of the crawling insects are louder then. Such bats continue to use echolocation, but only to avoid obstacles or sneak up on their prey, not to detect it. This allows them to shout more softly because they don't need to hear weak echoes returning from small insects. They only need to hear stronger echoes returning from relatively large objects, such as vegetation. Another bat strategy is to use frequencies that are higher or lower than the moth's auditory range. Horseshoe bats, for example – the ones who emit sounds through their nostrils and use the Doppler shift – employ very high frequencies, far above the auditory range of the moth and most other insects. Some studies have shown that bats that use such high or low frequencies catch more moths than bats that use frequencies that fall within the range of the moth's ear. 🌟



**Q&A** WITH

## YOSSI YOVEL

**AUTHOR OF:**  
*THE GENIUS BAT*

Ecologist and neurobiologist Yossi Yovel takes us on a journey of discovery for this misunderstood mammal in his new book, *The Genius Bat*.

### Why did you choose to write about bats?

I always wanted to work with animals. As a kid, I dreamt of being a veterinarian, but tortoises were my favorite animal. I never thought I would study bats until I learned about them during my undergrad studies. I've been studying bats for more than 20 years and discovered that they are amazing in so many ways. They are the only flying mammals and can use sound only (echolocation) to navigate over many kilometers. I wanted people to learn more about their unique features. But more than that, I think that bat science is fascinating. People had to invent new methods to study them and in fact, bat research in the past 80 years was like discovering an uncharted

territory. I think the book gives a feeling of what it was like to be there when the first discoveries were made.

### Do you have a favorite bat species?

They are all my sons.

One of the reasons I study bats is their diversity – there are nearly 1,500 species of bats, and each of them is different. Some are super social, roosting in caves with millions of bats; others migrate thousands of kilometers, and yet others exhibit remarkable hunting [behaviors] and prey on birds or frogs. So it is the variability that drives me, and not a specific bat.

If you forced me to choose one bat, it would be an individual greater mouse-tailed bat named bat 38, who was the first bat we mounted a GPS on. Looking at its track in Google Earth, seeing how it flew more than 30 km [19 miles] in one night was an incredible experience.

### Tell us a surprising fact that people might not know about bats.

There are so many. Here's one. In our research, we discovered that Egyptian fruit bat mothers teach their pups to navigate. Bats usually have one (or two) pups per year, and they often invest much in them. Egyptian fruit bat mothers carry their pups on their belly to

specific trees night after night for many weeks. Using miniature GPS devices, we found that while being carried by their mothers, the pups learn to navigate to these trees, and around the age of 2.5 months, they start flying to them independently. The trees probably serve as a familiar location where the pups can start their own exploration. It is a bit like we humans teach[ing] our kids the way to school by walking with them every day.

### Do you have any interesting stories from your time traveling the world studying bats?

Bat research took me to some of the most remote places on the globe. In one project, we worked on a tiny island in the middle of the Sea of Cortez. We had to sail for many hours to reach the site and live on the island without any electricity or communication. We showered in the ocean. The goal was to study fabulous bats that roost on the island and forage on fish at sea. They fly dozens of kilometers in search of food. We discovered that in order to search efficiently, these bats always move in groups, and this allows them to spread out and cover more space. This is also an example of how bat research can be used for biomimetic robotic applications. We are now building a group of drones that mimic the ability of these bats to operate as a group.

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

Nature is wonderful. It is inspiring, it is smart, and exciting. The more we discover about it, the less we understand. We should not be afraid of nature and surely not of bats. We should avoid interfering with them as much as we can and this will keep both us and them safe.

Bats are remarkable, and I am sure that you will see them differently after reading this book. But more than a book about bats, this is a book about science unraveling the innovation and dilemmas that scientists face every day. I'm convinced that people who read the book will also view science differently after reading it. ✨

***The Genius Bat is published by Oneworld Publications and is out now.***

# WHERE ON EARTH

Snorkeling is great fun, but what's that?

You forgot your goggles? Fear not, because the waters of Brazil's Sucuriú River are so clear that you can see its entire contents just standing on dry land. An underground water source and the filtering powers of rock are behind the near-optical illusion, creating a river that's unlike any other on Earth.

By Rachael Funnell



# THE WORLD'S CLEAREST RIVER



Something strange snakes through the southern Brazilian state of Mato Grosso do Sul, known to locals as Rio Sucuriú, or “anaconda river”. It’s named for its winding shape rather than being a hotspot for the giant snakes, but anacondas do live here, too. The good news is you needn’t worry that one might sneak up on you. Oh no, you’d see it coming a long way off.

You see, the Sucuriú River is famous for its crystal-clear waters. That phrase gets thrown around a lot when talking about dreamy bodies of water, but Sucuriú is arguably the clearest river in the world.

The effect is most prominent in the Bonito region, where you’ll be able to see animals passing through the water even while standing on dry land. That’s because the region’s karst geology, with subterranean springs and limestone caves, helps to filter sediments, maintaining the unusually clear conditions.

Bonito used to be home to the Indigenous Guarani and Terena peoples, but in the late 19th and early 20th centuries, they were displaced by cattle ranching. Its striking karst ecosystems remained something of a secret until the 1990s, when the area became famous for its ecotourism.

Today, visitors can explore its fragile ecosystems on boat and snorkeling tours that lead groups along 1,830 meters (6,000 feet) of the river to see the beautiful wildlife and vegetation. The water comes from natural springs underground, and it’s the filtering effect of limestone that makes it so clear.

The visibility means you can see all the way to the bottom, not that it’s very deep. At most, people bobbing on the water’s surface will be 3 meters (10 feet) from the bottom, where you’ll find a rich diversity of wildlife.

Piraputanga (*Brycon hilarii*) are very common, easily recognizable as golden fish with bright red tails. You might also spot the “river tigers” known as dourado (*Salminus brasiliensis*), and armored catfish (*Hypostomus* and *Ancistrus*) clinging to rocks on the riverbed, and lucky visitors may even spot river otters.

The river is a comfortable 21°C (70°F) during high season, which is typically December through March. Reaching the river entails a hike through the riparian forest, which is also celebrated for its biodiversity, rich in birds, monkeys, and snakes. 🌿

## READ

### GHOSTS BEHIND GLASS

Book by Dolly Jørgensen

Journey with environmental historian Jørgensen to natural history collections across the globe to see how museums tell stories about extinction. During a period of rapid species loss, *Ghosts Behind Glass* asks what we can learn about our world from those we have lost.

– Available now.

## LISTEN

### FROG PREGNANCY TESTS?

Podcast from IFLScience

*We Have Questions* is back for a deep dive into something that really raised many questions. Did you know that it was only just recently we stopped using frogs as a form of pregnancy test? Yes, really. Expectant mothers would send off a sample of their urine that was then injected into a frog, and if that frog laid eggs? Congratulations, mom! Weirdest of all, it was actually a very reliable method, one we obviously had to know more about. The Natural History Museum, London's Isobel Davis tells us all about them in this latest eye-opening episode. – Available December 22.

## FIGHT

### ANACONDA

Film from Sony Pictures Entertainment

The Christmas gift none of us knew we needed is slithering onto the big screen this winter. What's better than Paul Rudd and Jack Black in a movie? Paul Rudd and Jack Black in a meta remake *Anaconda* movie. Expect ridiculously big snakes, misadventure, and a movie format that simply never gets old.

– Out in cinemas December 25.



## EXPLORE

### EVERGREEN: THE TREES THAT SHAPED AMERICA

Book by Professor Trent Preszler

From Devonian Period trees in New York to the Roman baths that almost led to the extinction of firs across two continents, and the Ancestral Puebloan builders of New Mexico who dragged wood 100 kilometers (60 miles) to the Chaco Canyon by tying massive trunks to their foreheads, Preszler explores our complicated relationship with one of Earth's most precious resources. – Available December 2.

## SURPRISE

### THE SCIENCE OF MAGIC

Podcast from IFLScience

As a holiday treat for your ears, we have a bonus episode of *The Big Questions* to reward you for being good all year. Some say the holiday season is a magical time, but why do humans love magic, even enjoying being tricked when we know it's happening? Join host Rachael Funnell as she takes a dive into the science of magic with the UK's only magic research lab.

– Available December 23.

## DISCOVER

### MATH CATS

Book by Professor Daniel Look

Discover the math behind cats in this exploration of topology, perfect numbers, fractals, and more. – Available now.

## ESCAPE

### FALLOUT

TV show from Prime Video

The post-apocalyptic series based on the game of the same name returns for its second season this Christmas. Expect more mysterious mutants as we journey back to the beginning of the end of the world (and see Howard with his nose back on!). – Available December 27.



# At The European Space Agency's Open Day

From spacecraft sneak peeks to interviewing an astronaut, this was no regular day out for Dr Alfredo Carpineti.

The role of IFLScience Space Correspondent is never boring, but there are days that are almost too exciting. On a fun day out of the office, you might do something brilliant or see something incredible, but it is rare that you chat with an astronaut, see the next big exoplanet-hunting spacecraft, chat with an actor from *Stargate*, shoot the breeze with a famous composer, and be recognized by the Astronomer Royal (I was one of her students). Well, that was my whirlwind experience at the European Space Research and Technology Centre (ESTEC) Open Day in the Netherlands.

I was invited there to moderate a panel on exoplanets alongside those working on ESA missions focusing on worlds beyond the Solar System: Cheops, currently in space; PLATO, which will launch next year (and I got to see it being fully assembled in a sneak preview); and Ariel, which will fly in 2029.

The panel was the closing event of the Space Rocks stage, but before we got to that, I had a chance to explore around the facility. I met with the team of the Proba-3 mission, a pair of spacecraft orbiting in perfect synchronicity that you might remember were used earlier this year to create the very **first artificial solar eclipse**, helping scientists to study the Sun's corona.

I also met ESA Astronaut Rosemary Coogan, who is part of the recently graduated Hopper class of astronauts. We talked about training, of course, but also her hopes and expectations for her trips to space, as well as her scientific work.

Space Rocks had a panel featuring Jeff Wayne, composer of the legendary musical adaptation of H.G. Wells' *War of the Worlds*, as well as *Stargate* alumnus actor David Hewlett, whom I had the pleasure of interviewing on science fiction and science fact.

I also interviewed Professor Michele Dougherty, who just became the first female UK Astronomer Royal. She told me about the JUICE mission, the incredible spacecraft en route to Jupiter, and how it is helping scientists to study interstellar comet 3I/ATLAS (stay tuned!).

Last but not least was the panel! When these three missions are all in space, they will be gamechangers for exoplanet research – hopefully leading to the discovery of a world similar to our own. This was definitely a great way to spend a Sunday! 🌟



Alfredo with ESA astronaut Rosemary Coogan

MEET ASTRONAUT ROSEMARY COOGAN AND FIND OUT WHAT IT TAKES TO BECOME ONE.



With UK Astronomer Royal Prof Michele Dougherty



Starstruck to get a sneak peek at new planet-hunting telescope PLATO

1

## WORLD AIDS DAY

Since 1988, December 1 has been World AIDS Day, dedicated to raising awareness of the condition caused by the spread of HIV infection and mourning those who have died of the disease.

23

## NEW TBO'S PODCAST BONUS EP!

Who wants a bonus holiday season ep of *The Big Questions*? Don't say we don't treat you! Tune in on Dec 23 as host Rachael Funnell explores the science of magic...



22

## NEW WHOS PODCAST EP!

Frog pregnancy tests? Yes, you read that right. You'll just have to listen to the latest episode of *We Have Questions* to find out more.



21

## URSID METEOR SHOWER PEAK



3

## INTERNATIONAL DAY OF PERSONS WITH DISABILITIES

4

## COLD MOON SUPERMOON

The last supermoon of the year will appear about 14 percent bigger and shine 30 percent brighter than a regular Full Moon.

4

## WILDLIFE PHOTOGRAPHER OF THE YEAR DEADLINE

The deadline for the 62nd Wildlife Photographer of the Year Awards is fast approaching, so get your submissions in by December 4 to be in with a chance of a prize.

10

## HUMAN RIGHTS DAY



11

## CURIOUS LIVE

The Science Of Magic. Find out more [here](#).



21

## WINTER SOLSTICE

It's solstice time once again. For those in the Northern Hemisphere, Earth will be tilted away from the Sun, giving you the shortest day and the longest night of the year. Meanwhile, in the South, the opposite is true.

17

## WRIGHT BROTHERS DAY

On this day in 1903, brothers Orville and Wilbur Wright completed the first-ever successful flight in a heavier-than-air, mechanically propelled airplane.

14

## GEMINIDS

One of the most reliable showers of the year, the Geminids will be active from Dec 4-20, peaking on the 14th. Expect to see bright, fast, and multicolored space rocks whizzing across the sky at a rate of over 120 meteors per hour.

# 2025 DECEMBER

It's officially winter in the Northern Hemisphere, which means shorter days and longer nights, as well as Nobel Prizes, a festive podcast, and a bumper crop of meteor showers.

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

Choose how you end each issue. For those who prefer the darker side, Holly Large explores how a spider Sports Day revealed the strength of an invasive species. If you like your science lighter, discover how you can become a marine biologist with just a smartphone and a comfy place to sit.



**EXPLORE YOUR SIDE ON FACEBOOK**

## SPIDER OLYMPICS

Imagine you're just hanging out in some sand dunes, when all of a sudden, you're scooped up by a giant ape and placed in an arena to compete in a sports day against someone who looks eerily similar to you. No, this isn't me recalling my weird dream from last night – this is what some spiders living in New Zealand experienced when scientists set out to find out how an invasive species might be outcompeting a native one.

The native species in question is the katipō (*Latrodectus katipo*), a smallish spider found on the New Zealand coast, and one that's now considered to be endangered. That might be because of the false katipō (*Steatoda capensis*), an invasive species from South Africa that looks similar to its namesake.

One of the big problems with invasive species is they can outcompete native species for food and resources. How willing a species is to explore new environments can play a part in this, and in a recent **study**, scientists from the University of Auckland aimed to figure out if this was the case for the katipō and false katipō.

To do so, they set up what's been amusingly dubbed the "spider Olympics", a set of

sports-like trials designed to mimic how the spiders would move in their natural habitat. This included the spiders exploring a maze, climbing a pole, and running on a flat track while being chased by a paintbrush. Let's hope we see that last one in Los Angeles in 2028.

So, who placed where on the podium? The gold goes to... the false katipō. Though there was no difference between the species on the pole climb, the false katipō performed much better in the other two trials. It was five times faster at finishing the running task than the katipō, primarily because it didn't slow down or stop as much when it was being chased. In the maze trial, the false katipō was also more willing to explore.

Fortune really does favor the bold, then – but that's not good news for katipō. Though the authors caution that this is only a small study, and thus more research with more spiders needs to be done, the spider Olympics may have explained why the katipō is endangered, whilst the false katipō is thriving.

"High levels of exploration could be a key factor in the false katipō's ability to invade new habitats, including empty habitats in sand dunes left open by storm damage, faster than katipō," the authors write. "In contrast, katipō may be confined to a narrower range of habitats due to their less exploratory behaviour."

## OCEAN EXPLORER

Move over *Animal Crossing* – there's a new cozy game in town. Rather than handing over your hard-earned bells to Tom Nook for a tiny new room, mobile game *FathomVerse* will have you exploring the oceans and contributing to real-life science from the comfort of your very own sofa (or toilet – we know you use your phone in there).

Created by the Monterey Bay Aquarium Research Institute (MBARI) and &ranj Serious Games, the aim is to fill the gap in what we know about life in the ocean. That's no small task; there's a lot of ground (or should we say water) to cover, given that the ocean spreads over 70 percent of the planet's surface and up to two-thirds of the life within it remains unknown.

But nowadays, scientists have the tech to speed up the process. "With advances in imaging and AI technology, we can capture images of the ocean and quickly analyze them," explains the ***FathomVerse* website**. "However, AI needs people to continuously train and verify the models."

And that's where *FathomVerse*, and budding citizen scientists come in. After downloading the app, the game trains players through a series of "dives" (minigames) to identify more than 50 groups of

ocean animals. It does this using underwater images of animals with an expert-verified identity, taken on real-life expeditions, which players tap to reveal and collect as they swim through the depths.

Once players have collected enough animals to end the dive – which earns you points – they're then tasked with correctly identifying them. Once players have completed three dives for each group, they're a certified identifier.

At that point, players can then go on missions in which they see images that haven't yet been labeled with an identity. The player's task is to assign them to a particular group, and if everyone playing the game reaches a consensus on which group it belongs to, that information is used to train AI in better recognizing ocean life.

Those behind the game hope that this could lead to the discovery of new species. In a **livestream** launching the second version of *FathomVerse*, MBARI Principal Engineer Kakani Katija said: "The thing that gets me really excited with this technology is if we get an AI model, a machine learning model, to the point where it's able to recognize something that's new."

"So we can be sure that we've never encountered this new animal, and that means it's a brand new species that is undiscovered and undescribed."

So, grab a hot drink, snuggle down under a blanket, and get exploring.



The **Darker** Side of Science



THE **LIGHTER** SIDE OF SCIENCE