CURIOUS?

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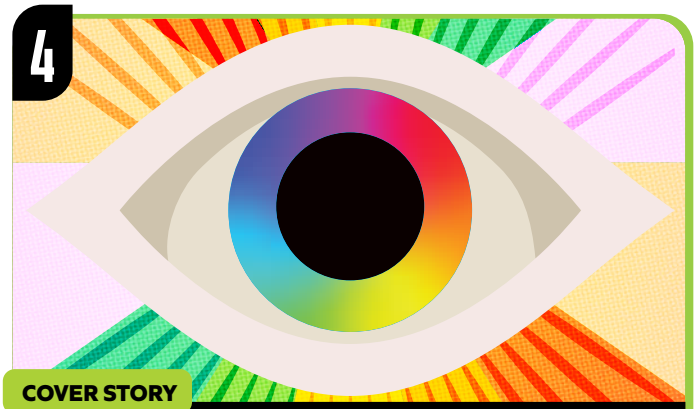


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ARE THERE COLORS THAT ONLY EXIST IN OUR BRAINS?

Tom Hale explores what happens in our minds when we perceive color.

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EDITORS
Katy Evans
Rachael Funnell

CONTRIBUTING WRITERS
Tom Hale
Holly Large
Maddy Chapman

DEPUTY EDITOR
Maddy Chapman

ART & DESIGN
James Rodrigues

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NEWS BITES



Asteroid Day

June 30 is Asteroid Day, held each year to raise public awareness of asteroid impact hazards on the anniversary of the 1908 Tunguska event, which saw an airburst over Siberia level 80 million trees and smash windows in towns 60 kilometers (37 miles) away. Curiously, no impact crater was found, despite scientists calculating the explosion at roughly 12 megatons. Eventually, they concluded it was the result of an asteroid the size of a 25-story building exploding 5-10 kilometers (3-6 miles) above Earth's surface. With missions like NASA's DART, the first time humanity successfully moved a celestial body, Earth's **planetary defense** has never been better. We're not asteroid-proof, but this is a great example of a truly global effort to protect humanity.

OMG, Birds Have Friends

Whether **animals have friends** has been difficult to prove. It depends on how we define "friends" – travel companions, social associates, shared experiences, helping individuals not related – but there is a long list of animals that seem to experience all of these with chosen individuals they interact with. Now, birds may have been added to that list. In a new **study**, data from over 20 years suggests starlings demonstrate "reciprocity" with each other; helping others with the expectation that a favor will ultimately be returned. "Many of these birds are essentially forming friendships over time," study author Professor David Rubenstein **said**. "I think this kind of reciprocal helping behavior is likely going on in a lot of animal societies, and people just haven't studied them long enough to be able to detect it."



Scoop: Walking With Dinosaurs!

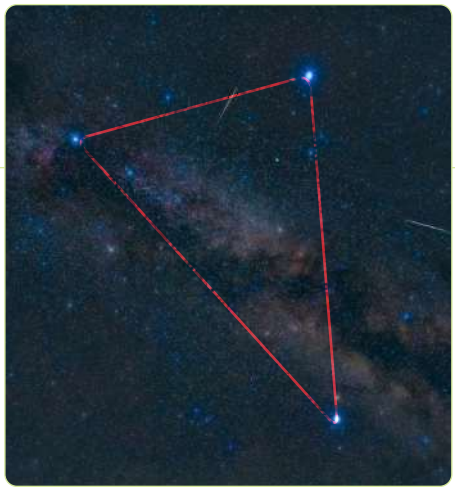
Is it even summer without a big blockbuster dinosaur vehicle showing on our screens? This month, it comes in the form of the BBC's huge revival of *Walking with Dinosaurs*, 25 years after the first series blew us away. IFLScience went behind the scenes to talk to consulting palaeontologist Professor Nizar Ibrahim, as well as the palaeoartists and production team, about the latest science resulting in decisions made on the creatures' appearance, behavior (ever seen a dinosaur in love?), and even which species were selected and why. We talked *T. rex* as a surprisingly stealthy predator, *Spinosaurus* as a caring dad, how the epic VFX "bibles" produced the most accurate moving images of dinosaurs on screen ever seen, and who stole what from set. The six-part series is on the BBC in the UK on Sunday nights from now, available on iPlayer, and coming to PBS soon.



Pride In STEM

Official Pride in STEM Day may be in November, but in the US, the whole of June is Pride Month. Visibility and representation matter greatly, especially in areas like science, technology, engineering, and math (STEM), where LGBTQ+ individuals have historically been underrepresented or faced discrimination. Sharing the stories, experiences, and ongoing challenges of LGBTQ+ professionals not only inspires others but also helps create more inclusive and supportive environments and provides valuable role models for students and future scientists. Find out more at **https://prideinstem.org/**.

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June Skywatching

Did you know that June has its own "unpredictable" meteor shower known as the June Boötids? It's considered unpredictable because it's mostly a slow shower, however, on random occasions, it has unexpected outbursts, like in 1998 when up to 100 shooting stars were seen an hour for over 7 hours. Before that, this had only happened three times on record in 1916, 1921, and 1927. Appearing to come from the direction of Boötes, the shower occurs between June 22 and July 2, peaking on June 27.

June is also usually when the summer triangle appears in the night sky in the Northern Hemisphere, visible until around September. The "asterism", a recognizable pattern of stars but not a constellation, comprises the three stars Vega, Deneb, and Altair, rising in the east, usually the first stars to light up the sky. Vega is the brightest of the three, so the easiest to spot. Deneb will be found to the lower left and Altair to the lower right. On a clear night, you should be able to see the edge of the Milky Way behind Deneb. The New Moon is June 25, so your best viewing night by far.

June and July are peak months for spotting noctilucent, or night-shining, clouds. Considered Earth's rarest, these high-altitude clouds form in the mesosphere, 80 kilometers (50 miles) above Earth's surface. They form when water vapor gathers on specks of meteorite dust and freezes, forming ice crystals, and are so high in the atmosphere that they can continue to reflect the Sun's light long after it has set, appearing as **silver or blue streaks**.

WHAT'S UP?



A VERY ROYAL ANNIVERSARY

Happy 350th birthday to the Royal Observatory Greenwich, where time itself was defined

Name: The Royal Observatory Greenwich
Appearance: Regal, with domes aplenty
Location: Greenwich, London, UK

What's so royal about it?
It's a royal observatory because it was founded by one – specifically, King Charles II, the son of the one who had his head lopped off. Charles II was a patron of the sciences, having earlier issued a royal charter to the Royal Society, and on June 22, 1675, he ordered an observatory to be built upon the highest point in Greenwich Park.

Why was it created?
Charles II might've been a key supporter of science, but the motivation behind the founding of the observatory was about seafaring dominance as much as it was scientific. Britain relied heavily on seafaring for trade, but this kind of travel was dangerous because the "longitude problem" – that is, accurately determining your position east or west – was yet to be solved. Scientists advising the King believed that astronomy – and thus, a national observatory – was the answer.

You mentioned Greenwich... does the observatory have anything to do with Greenwich Mean Time?
Yep – the observatory is home to the line of longitude that, in 1884, was established as the Prime Meridian, the global standard reference line for navigation. At the same time, it was recommended to create a new global time zone system based on the time at this line – Greenwich Mean Time (GMT). The meridian at Greenwich is no longer the standard prime one used (**although it's close by**), but GMT endures.

The most important question – are there going to be any birthday celebrations?
There sure are. The full program of events is still on its way (you can sign up to find out more **here**) and is set to run throughout the rest of the year, but every day in August – the anniversary of when the first foundation stone of the observatory was laid – the observatory will be running a special, live planetarium show called *The Sky Tonight 1675*, in which visitors will be able to see and compare the sky on that night with what astronomers would've seen 350 years ago.

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ARE THERE COLORS THAT ONLY EXIST IN OUR BRAINS?

Prepare to be bewildered by the riddle of the rainbow.

By Tom Hale

Image Credit: amarlettering/Envato, cosmicbirdy/iStock, modified by IFLScience

Color isn't what you think it is. That's not your fault; color science is repeatedly taught incorrectly, from elementary school posters right up to college-level textbooks. Even beyond classrooms and lecture theatres, you'll regularly come across viral videos making wild claims like "magenta doesn't really exist" or "this lemon isn't yellow" – most of which are misleading, if not totally erroneous.

The confusion stems from a fundamental misunderstanding. Light does not possess color intrinsically. Color is a perception.

This might sound like a stupidly fussy technicality, but it's foundational to how we understand perception and reality. Once you grasp this distinction, it's like taking the red pill in *The Matrix* – only, wait a second... do we mean *red* pill?

What are we really seeing?

When we look at an object, what we're really seeing is the light it *doesn't* absorb. The color we perceive in our mind is determined by the specific wavelength that the object reflects.

> "YOU SUDDENLY REALIZE THAT BEAUTY REALLY IS IN THE EYE OF THE BEHOLDER. WE'RE ALL SEEING THE WORLD DIFFERENTLY."

Our eyes are equipped with three types of cone receptors, all tuned to pick up light within a narrow band of wavelengths ranging from about 390 to 710 nanometers. At the shorter end of this range, we see vibrant violets and deep blues. As the wavelengths stretch out, we move through greens, then warm yellows and oranges, and finally arrive at the rich reds of the spectrum.

But here's the big clincher: the waves of electromagnetic radiation hitting the back of your eye don't carry color themselves. They're just fluctuations in an invisible field. It's the brain that interprets these signals, conjuring the colors we see. Color isn't an intrinsic quality of the rays we are witnessing, but a construction, pieced together by the neural machinery in our heads.

"What is out there is just matter and energy, then our brains are generating this sort of perceptual world we live in that feels very real. I mean, it's really like that movie *The Matrix*. That movie works quite well as a model of how perception works," **Dr Stephen Westland**, a Professor of Colour Science and Technology at Leeds University in the UK, explained to IFLScience.

"You suddenly realize that beauty really is in the eye of the beholder. We're all seeing the world differently."

Dr Westland isn't just spouting a far-out, philosophical musing here. He has written over 200 peer-reviewed papers, book chapters, and books on the topic of color. He started his career with a degree in color chemistry, then did a PhD in color physics before moving into neuroscience. He now works within Leeds University's School of Design with a focus on tech and design.

This multifaceted background underscores the necessity of exploring color and perception through a kaleidoscope of disciplines, from physics and neuroscience to philosophy and psychology.

"What makes color both hard and worthwhile to study is that it's really unusually multidisciplinary. You can't just look at it from the perspective of physics and think you understand it all," Westland added.

Sir Isaac Newton agrees with him wholeheartedly. In his book *Opticks*, published in 1704, he wrote: "For the rays to speak properly are not colored. In them, there is nothing else than a certain power and disposition to stir up a sensation of this or that Colour." Despite being outlined by the "father of classical physics" over 300 years ago, color, light, and perception are still regularly muddled up.

"Purple isn't real"

A major bugbear of Westland's is the claim that "magenta isn't real." The idea goes that magenta is an **"imaginary" color** because it doesn't correspond to a specific wavelength of light in the visible spectrum. Unlike colors such as red or blue, which are closely associated with particular wavelengths, magenta results from our brain's interpretation when both red and blue light reach our eyes simultaneously, with no green light present.

However, this thought experiment is built on a false premise. All colors are just our brain's interpretation rather than an individual wave of color. In reality, colors are rarely projected as a single, finely tuned wavelength. Even a "pure yellow" banana is composed of a broad mixture of wavelengths, including reds, oranges, yellows, greens, and a bit of blue and violet too.

> IT WOULD BE VERY CLUNKY AND SLIGHTLY CONFUSING TO CONSTANTLY HAVE TO SAY THINGS LIKE "I OWN A CAR THAT APPEARS BLUE."

"When you start thinking that the individual wavelengths are colored – and all the rest are somehow illusions – it suggests that there's like a separate visual process, almost like there's two visual processes. There's no evidence that there's any separate visual process," Dr Westland notes.

The closest you might get to seeing a pure wavelength is in a rainbow. As sunlight refracts and reflects inside each droplet, it separates into distinct wavelengths. Each color band in a rainbow corresponds to a narrow range of wavelengths with little overlap, making it one of the few times your eye sees near "pure"

spectral color. It's not perfect, but compared to most everyday light sources, a rainbow is about as true as color gets.

This helps debunk the myth that "magenta isn't a real color because it doesn't appear in the rainbow." While magenta isn't a single wavelength, it's no less "real" than any other color. It's what your brain creates when it receives a mix of red and blue/violet light with not much green in between.

In April 2025, a new discovery brought renewed attention to the shadowy world of color theory. Scientists at the University of California, Berkeley, claimed to have identified a "new color", which **they dubbed olo**.

Using a cutting-edge laser system designed to stimulate individual cone cells in the retinas of five participants, the research team reported inducing a visual experience described as a highly saturated "blue-greenish" hue – one that, according to participants, was like nothing they'd ever seen before.

But can we truly call this a "novel color" in the strict sense? That depends on how we define "new". The human eye perceives color through the interaction of three types of cone cells, and most of the colors we see are the result of overlapping stimulation across these channels. What the Berkeley team achieved was a more precise, isolated activation of those cells, bypassing the usual optical pathways and potentially allowing for visual sensations that the brain rarely (if ever) experiences naturally.

One could argue that this isn't a new color per se, but rather a new way of perceiving the existing range. While olo might feel like a new perception, it's still just messing around with the same old wavelengths of visible light, albeit in an interesting novel way.

An evolutionary illusion

Part of this confusion may stem from the limitations of language, Westland told me. It would be very clunky and slightly confusing to constantly have to say things like "I own a car that appears blue" or "can you pass me an apple that I perceive in my mind as green?" Another part of the problem might also have something to do with evolutionary advantage and natural selection.

"We've evolved so that we have this illusion that things are colored, because it helps us basically navigate the world. It's a very useful thing that we think that the light is colored," continued Dr Westland.

"If I'm cooking and I put my hand on a hot stove, there's no pain in the stove; that's not a property of the stove. It's got a property of heat, but through the senses in my hand, it will generate in my brain the perception of pain. But we would never say that the pain was a property of the stove itself," he noted.

"I believe it's to our evolutionary advantage. If you touched a stove and you thought the pain was a property of the stove, you'd be less bothered about taking your hand off quickly. It's very, very important that that pain is attributed to us for it to be an effective thing to stop us from getting hurt. On the other hand, with vision, it's actually helpful for us to think of these colors as properties of objects," he added.

All of this raises some questions about our relationship to reality; questions that have been pondered by humans for thousands of years, from the ancient Greeks to civilizations in India, China, and countless Indigenous cultures. We can understand the world around us through our sense organs, yet these senses are limited, subjective, and frequently deceptive. If color isn't truly "out there", isn't everything we think and feel a product of perception, rather than objective reality? Perhaps the boundary between what is objectively real and what is merely our mind's interpretation is fuzzier than we might realize.

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BUDDHA'S HAND

It looks like a lemon gone wrong, but this is the *sarcodactylis* variety of the fruit *Citrus medica*. Also known as Buddha's hand, it blooms with white flowers that can develop into bizarre yellow fruits with what look like lots of fingers. The fleshy rind is sweet and cocktail-worthy, but the fruits don't produce much in the way of juice. Still, it packs a punchy aroma that, ahem, is sure to tickle the nostrils.



Image Credit: Iuliia Tarabanova/Shutterstock.com



CAN SHEEP LIVERS PREDICT THE FUTURE?

Q&A

I mean, they saw Trump coming.

By Tom Hale

Is it possible to predict the future by slicing open a farm animal and peering inside its liver? Scientists of the 21st century would surely be skeptical about approaching this question, but for the curious minds of ancient Mesopotamia, it was a tried and tested method for looking ahead and foreseeing what the gods had in store for you, your family, or your world.

Dr Selena Wisnom, a lecturer in the Heritage of the Middle East at the University of Leicester, knows all about the ins and outs of Mesopotamia, and she believes liver divination is a surprisingly insightful window into this world of ancient humans and the emergence of science. After all, it did manage to predict the election of Trump…

Why was Mesopotamia so important?

SW: Well, Mesopotamia is literally where history begins, because this is where writing itself was invented as early as the mid-fourth millennium BCE. The area we're talking about is what is now modern-day Iraq. Mesopotamia is a Greek word. It just means between the rivers, the rivers of the Tigris and

Image Credit: Djordje Novakov/Shutterstock.com



Euphrates that flow through the Middle East, through the Fertile Crescent, where agriculture took off. This is also the land where people invented banking, law, maths, and science.

How did early inklings of science emerge from here?

SW: I think one of the most interesting things about this whole culture, and why it's important for us today, is the fact that the pillars of our scientific method actually come from people trying to predict the future.

They come from people trying to work out what the gods are trying to say to them. Essentially, things like modern-day astronomy are ultimately derived from that, and some of the incredibly advanced mathematical algorithms they had are from that.

So, where do sheep liver prophecies come into this?

SW: It's all part of this wider project of trying to understand the world around them. So, celestial omens are not the only kind of data that they're collecting. If you think about the underlying premise of all of this being that the gods are trying to communicate with people, and humans have to be attentive to see what those messages are.

Now, the sheep livers are part of this project, but it's a slightly different case because what they're doing here is it's their chance to ask direct questions to the gods. So, they're not just listening for messages from the gods, but they're directly asking them: Can you tell me if this is going to happen? Should I go to war? Will my mother recover from this illness? Can I trust this letter that's been put in front of me?

They believe that if they dedicate a sheep to the gods, and sacrifice it at the moment they ask the question, then the gods will write the answer to their question on the entrails.

How does one read a sheep liver?

SW: There are lots of creases that can be found on different organs, particularly the liver. It's a little bit like palmistry. Everybody's hand has more or less the same lines on it, but they will look different from person to person. So, they're looking at, where is the line? How long is it? Does it branch? Is there damage from parasites? Because parasites love to live in the liver and eat away at it. Are particular parts of the liver big or small? What's the relationship between them all? They go into a huge amount of detail with this.

And you have (jokingly) tested whether sheep liver divination is a legitimate way to predict the future…

SW: Yes! Trump, in 2016, even before he was the official nominee, I thought, won't this be a hilarious joke: let's ask the sheep livers if he will win the presidency – and so it came to pass. I should emphasize I only do this as a joke, although I have been right a scary number of times.

I mean, it's purely random because you can only ask a yes or no question, so it's probably going to be right 50 percent of the time. But what I argue is that randomness is actually an advantage because it's useful regardless of whether or not it's accurate. After all, it gets people to stop and think. They see this kind of divination as a kind of ultimate, infallible thing, which is independent of the kinds of biases that human beings have.

So, this is not a case where people are just telling the king what he wants to hear. You can imagine a situation where everyone's agreed on a plan. Everyone thinks this is a great idea, but actually, maybe they've just all got caught up in the hype. Maybe they're all being swayed by vested interests. And if you suddenly get an answer out of a sheep that no one is expecting, saying "Actually, no, don't go ahead with that!" then they've got to stop and reconsider. They've got to talk again. And maybe in the process of doing that, they might come up with a plan that's even better. It gets people to think about things.

We have Questions with IFLSCIENCE

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Head to the *We Have Questions* podcast for new episodes monthly.

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DEEP DIVE



SCIENCE FACT OR FICTION:

IS A "GUT FEELING" REAL?

Should you listen to your gut, or is it your brain talking to you? Holly Large investigates.

Image Credit: ToozDesign/iStock, Viacheslav Besputin/iStock, modified by IFLScience



Do you just *know* when someone is lying to you? Or perhaps you've been in a situation where you knew something was going to happen, but couldn't quite put into words why. No, you're not psychic – but it's evidence that, like many of us, you've experienced a "gut feeling".

You've also probably heard that it's not always something that can be trusted – and some might say that what someone is feeling in their gut isn't even real. But is that really the case, or is it time we started taking our guts more seriously?

What is a gut feeling?

"Gut feeling" is the more colloquial, physically descriptive term for something many of us will have experienced and used without even realizing: intuition. It's a term that perhaps speaks to why some people believe intuition isn't actually real, or at the very least only fleeting, and thus not worth listening to.

"Normally people say things like 'it's very much out of your control', for example, and that it's something that is sort of ephemeral," **Dr Valerie van Mulukom**, Senior Lecturer in Psychology at Oxford Brookes University, tells IFLScience. "I would define it slightly different than how people usually do."

"I tend to think of it more as something that can be practiced, it's a knowledge that is more embodied, if you like, as opposed to something like analytical or logical thinking, which works through conscious awareness, which is very serial – so you have to think one thing, then you think another one, and so forth. With this more embodied type of thinking, intuitive thinking, many processes are happening at once."

What's being processed? Information – old and new. According to some, that information is emotional in nature, with one **study** defining intuition as "the productive influence of nonconscious emotional information on an otherwise unrelated decision or judgment."

In his book *Thinking, Fast and Slow*, the late psychologist and Nobel laureate Daniel Kahneman wrote that "intuition is nothing more and nothing less than recognition" of such information.

A gut feeling, then, isn't just a random, unexplainable feeling in our bellies. It begins not when we first feel it but whenever we first unconsciously pick up pieces of information about the world around us – seemingly undetectable shifts in smells, facial expressions, words, sounds, and temperature.

Without being aware of it, we process that information in the context of our emotions, store it, and then we're primed to pick up on it again, even in what may consciously seem to us as the most unrelated, unemotional circumstances. In those situations, gut feelings might seem like they come from nowhere, but they're only the last step in some extremely rapid information processing.

What causes it?

The end result of all that processing and recognition might physically manifest as a lurch of the stomach, but intuition is in fact driven by our brains. Some of the most important early evidence for that link was found **back in the late 1990s**, when Portuguese neuroscientist Antonio Damasio led a team in carrying out what has now become a classic experiment, van Mulukom tells IFLScience, in showing that intuition is real and hinting at its biological basis: the Iowa Gambling Task (IGT).

The task, which was carried out on a computer, went as follows: participants were presented with four decks of cards, some of which came with a monetary reward, and others with a penalty. The participants were asked to keep choosing cards from the decks to lose the least amount of money and win the most.

But there's something that the participants

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didn't know. "The stacks [are] rigged, because psychologists are evil," van Mulukom jokes. Instead of the decks containing a random assortment of cards, there were two decks that contained big rewards, but also big penalties, while the other two decks had smaller rewards, but also smaller penalties.

Damasio and colleagues found that by around the 50th card turn, some participants expressed a "hunch" that the decks were rigged – but what was more interesting was what happened in the lead up to that moment.

The participants also had electrodes on their hands measuring tiny changes in the skin's ability to conduct electricity, something that improves when we sweat. In turn, this is a sign of physiological arousal, which some scientists believe may be regulated in part by an area of the brain called the ventromedial prefrontal cortex.

In the participants who eventually developed a hunch about the card stacks being rigged, Damasio and colleagues identified that there was a build in this arousal before they expressed their hunch. In other words, as van Mulukom explains, "the hand knew which stack was rigged before people consciously said, 'Wait, I'm no longer getting from this deck because it's rigged.'"

However, some of the study's participants also had a form of brain damage in their ventromedial prefrontal cortices – and they never developed this anticipatory physiological response. Unlike the people without damage, they didn't start to avoid the "bad" decks either, though some eventually realized that something was up.

The research team concluded that something nonconscious – aka intuition – was driving behavior before conscious knowledge did, that it had something to do with the ventromedial prefrontal cortex, and that emotional states were involved too – the latter being something that we'll see more of in later intuition research.

Is it actually related to the gut?

So, if intuition is all about the brain, is there any justification – other than physical sensations like a stomach flutter – for calling it "gut feeling"? Does it actually have anything to do with the gut?

It's a valid question to ask; our guts are packed with **over 100 million neurons**, leading some to refer to it as the "second brain". Researchers have long been exploring the link between this enteric nervous system and our noggins, known as the gut-brain axis, including the role that the microbes living in our digestive system might play in this.

We know that whatever's going on **in our heads** can affect our bellies too – just ask



anyone who's had to keep dashing to the toilet for a nervous poop before an exam. However, as for whether this connection works the other way around when it comes to intuition, the answer – as current evidence suggests – is no.

First, while we might call it a "second brain", the enteric nervous system isn't thinking and feeling in the same way as our actual brains – its role is to regulate digestion. It's not going to start forming opinions on the latest episode of *Severance*.

And while researchers have been investigating the possibility that gut microbiota can influence the enteric nervous system, and as a consequence, our brains, behavior, and **mental health**, there are still many questions left unanswered – and a distinct lack of evidence when it comes to intuition specifically.

Even for cognition in general, it's unclear. One **2022 study** of over 14,500 nurses found that those who'd reported using antibiotics for at least two months at some point in their midlife scored lower on cognitive tests taken seven years later than those who hadn't. Antibiotics affect the bacteria present in our gut, and so the study authors theorized that this could mean what was going on in the gut was affecting the brain.

The key word there is "theorized" – the results of the study only indicate **correlation, rather than causation**. It's far from certain that our guts affect things like learning and memory, let alone intuition. For now then, at least, a "gut feeling" remains something of a misleading term.

Should we trust it?

Our intuition is rooted in a whole lot of very real processing (even if it doesn't have much to do with our bellies). Still, just because something's real, does that automatically make it something we can rely on? After all, the way our brains process and recognize information isn't without bias, not to mention emotional states like anxiety that we could easily mistake for a gut feeling.

In his book *The Intuition Toolkit*, Professor Joel Pearson, a psychologist and neuroscientist who's spent the best part of a decade researching intuition, details what he's dubbed the "SMILE" rules for knowing when to act on a gut feeling. It's the "S" that's particularly important here – standing for self-awareness.

Pearson recommends that before following your gut, you stop for a moment and see how you're feeling. If you're in the throes of extreme emotion, whether it's positive or negative, you probably can't rely on your intuition.

That doesn't mean we can't find ways to trust and further hone our intuitive abilities. Intuition itself and our comfort in relying on it is something that can be trained, and it relates to something that we're often encouraged to practice more of anyway: **mindfulness.**

There's further data to back this up, too – and it takes us back to the good ol' IGT.

In a **2018 study**, people who'd been working on their emotional intelligence using an online training program were typically more confident in their decision making during the IGT, and it served them well in making more accurate decisions. **Later research** would also find that people with lower emotional intelligence tended to take those physical symptoms of intuition the "wrong" way, taking riskier decisions when it came to the IGT.

Mindfulness is one way we can develop our emotional intelligence and perhaps, by consequence, our intuition as well.

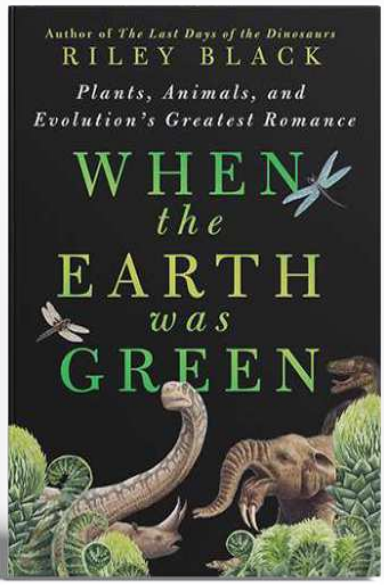
"I have only done a little bit of mindfulness myself, but it seems that [working on intuition] is stepping into something similar," says van Mulukom. "It's like meditation; it seems to tap into noticing what's happening around you, noticing what your body is telling you without that conscious awareness, that little reflective, analytical voice going, what's happening here?"

"So, if you want to increase your intuition, I think it would [involve] things like paying attention to what your body is telling you, better noticing the signs of your intuition."



Image Credit: ToozDesign/iStock, Viacheslav Besputin/iStock, modified by IFLScience

PLANTS ARE UNDERRATED IN PALAEONTOLOGY



The fossil record has dinosaurs aplenty, but it's also packed full of prehistoric plants, which are no less important despite often being overlooked. In this excerpt from *When The Earth Was Green*, author Riley Black explains why fossilized flora are essential to our understanding of planet Earth's past – and also its future.

Alone, a dinosaur is meaningless. We put them on literal pedestals in our museums, behind glass and railings as befits their place as the world's most ancient and long-standing celebrities. But what is a *Tyrannosaurus* without a forest to conceal its shadow as it stalks? What is a *Triceratops* without a buffet of ferns and cycad fronds to eat? What is a Mesozoic world without the busy machinations of pollen-collecting beetles and nectar-drinking butterflies that assisted the innumerable, vegetal lives that set the basis for so many other living things to exist? The fossil leaves I turned up from those tan rocks in Montana said more about the world of *T. rex* and her neighbors—the temperature, the rainfall, and forest—than a multi-ton enigma of which we are still striving to understand the biological basics. Even if you had complete skeletons of every single dinosaur species in a specific environment, imagining how they interacted would be a glorified version of mashing together dinosaur models in a sandbox. We need to know the stories of those smaller, but no-less-vibrant lives that surrounded and fed the terrible lizards. Ripped away from Earth's botanical history, life on our planet doesn't make the least bit of sense.

What's true of the past also applies to the present. We often depict plants as little more than the static background for animal behavior—grasslands are sustenance and setting for gazelle, rafts of duckweed conceal lurking alligators, and tigers need forests of the night to burn so brightly in. Even within the confines of our own experience, plants are often part of an inert-seeming landscape until they have some direct effect on our day-to-day lives. We'll get annoyed at annual influxes of pollen that coat our cars and send us into sneezing fits, weeds growing in the yard embody a hated chore to get around to some mild Sunday morning, and vegetables become dietary homework shoved to the sides of our plates, even as we close our eyes in relief under the shade of a summertime tree and drive out of our way to catch the one autumn day when every stand of forest seems aflame with color. We recognize that plants are alive, as we are, and yet we hold them apart. Plants become lives without mind and feeling, not so different from the soil out of which they grow. Who would stop to ponder the life of a Woods' rose or even a blade of grass? We are surrounded by all this verdant life—our own existence dependent upon it—but we generally lack the patience to confront what we don't know about the maple growing through the fence or the sunflowers raising their fibrous stalks from a roadside ditch. Our ignorance certainly colors what we understand of life's ever-expanding evolutionary panorama. Palms and conifers might frame a prehistoric scene where bizarre reptiles snarl at each other, but we tend not to ask about the lives that make up the habitats in which our favorite prehistoric creatures roamed. Such scenes are absolutely bursting with life, but it's challenging for us to think beyond the experiences of the toothy and reptilian.

From the book WHEN THE EARTH WAS GREEN by Riley Black, copyright (c) 2025 by Riley Black. Published with the permission of St. Martin's Press, an imprint of the St. Martin's Publishing Group.

Image Credit Top Right: St. Martin's Press



Q&A WITH RILEY BLACK

AUTHOR OF: *WHEN THE EARTH WAS GREEN*

Science writer and self-confessed fossil fanatic Riley Black talks us through some of the untold stories of plant palaeontology that can be found in her new book, *When The Earth Was Green*.

Why were plants so important in prehistory – and still today?

Earth as we know it wouldn't be the same without plants. That's true today and in the distant past. The whole reason oxygen is so important to us is because ancient photosynthesizers, including early plants by 1.2 billion years ago, gave off oxygen as a byproduct. The shift changed the atmosphere and allowed our sea-dwelling ancestors to evolve ways to breathe air instead of extracting the oxygen they needed from the water. The fact plants began growing on land around 470 million years ago, too, allowed forests to begin growing along the shores, drawing out insects that then lured our fishy ancestors from the water and gave rise to so many of the ancient ecosystems we're fascinated by.

Skipping ahead a bit, the fact the earliest humans of about 5 million years ago were living in trees fundamentally shaped their anatomy. Forward-facing eyes that can gauge distance, grasping hands and feet, flexible wrists, arms, and shoulders are all hallmarks of our tree-dwelling ancestry, which of course changed as grasslands were expanding and effectively pushed humans out of the trees and onto the ground, still carrying those evolutionary gifts from forest life. By growing and evolving over a billion years, plants have set the terms for how animals and other living things have changed and shaped the world in their own ways.

Do you have a favorite plant/animal interaction from the book?

About 150 million years ago in western North America, the landscape was dotted with floodplains populated by giant dinosaurs like *Apatosaurus, Diplodocus, Camarasaurus, Brachiosaurus, Supersaurus, Barosaurus*, and more. The big dinosaurs grazed on carpets of ferns, browsed on conifers and ginkgoes, and munched on horsetails. The plant productivity must have been incredible to support whole populations of immense dinosaurs that often exceeded 80 feet [24 meters] in length and weighed more than 20 tons. And that relationship shaped the bodies of these dinosaurs.

[…] Such dinosaurs started off small, hatching from grapefruit-sized eggs, and had to grow fast to evade being lunch for the likes of *Allosaurus*, so their whole anatomy was shaped by this need to fuel their rapid growth – which means eating lots and lots of plants. I had never thought about the dinosaurs quite that way before, but it's not a stretch to say that so many of our favorite dinosaurs embody such bizarre shapes because of the plants they fed on and lived among.

What can understanding the past teach us about the future?

The future very quickly becomes the past. Every moment, uncountable and untold relationships are changing the nature of life on this planet and what might come next. The fossil record allows us to see these connections in ways that can be difficult today, a view from 10,000 feet [3,048 meters] of how changes big and small can unfold. Prehistoric plants have helped animals raft between continents, grew in thick forests that supported the boom in mammal evolution after non-avian dinosaurs went extinct, and even preserved a great deal of small creatures in tree resin, creating the fossil record of amber, and so much more. We cannot hope to understand this moment, or what might come next, without understanding how we came to this moment through millions and millions of years.

What do you hope readers will take away from *When The Earth Was Green?*

My biggest hope is that *When The Earth Was Green* makes readers stop and smell the roses, as literally or figuratively as they please. The book, at its heart, is all about relationships and how one life can change another. Biodiversity is created through these constant, often-unseen interactions.

I'm hoping readers will look at a tree and not just see a plant by the sidewalk or in a forest, but as an ecosystem unto itself. I hope they can see a flower and understand that the abundance of flowering plants we know today came about not only through the aftermath of mass extinctions, but relationships with pollinators that directly connect plant and animal life. I hope they look at their own bodies and see the influence plants have had on our form over time, how much we owe to our ancestry in the trees. A small shift in perspective can reveal entire worlds we might otherwise pass by.

When The Earth Was Green is published by St Martin's Press and is out now.

Image Credit: Riley Black

WHERE ON EARTH



When Rudyard Kipling visited Milford Sound in the 1890s, he declared it the "eighth wonder of the world". Known as the land of a thousand waterfalls, its mountainous peaks sparkle with snow in winter, but when spring brings the rain, that's when it really lets loose.

Image Credit: Thijs Peters /Shutterstock.com

MILFORD SOUND PIOPIOTAHI



HOW TO GET THERE

Get to Te Anau or Queenstown in New Zealand and head in by road via the Homer Tunnel. Personal tip? Stick on the *Jurassic Park* theme tune when you start to see the light.

Sitting within the Fiordland National Park in Aotearoa New Zealand's South Island, Milford Sound Piopiotahi is part of the UNESCO World Heritage site, Te Wāhipounamu. It's said to be the crown jewel of the region, and one that was carved into the landscape over hundreds of millions of years through glacial erosion and tectonic activity.

Despite its name, it's not a sound but a fjord. A sound is a wide and usually shallow waterway between landmasses that connects to the sea, but a fjord is a narrow and deep inlet with steep cliffs, like those seen in Milford Sound Piopiotahi. The result is a winding network of mountainous peaks that plunge into the Tasman Sea.

The tallest to be found here is Mitre Peak, which darts **1,692 meters** (5,551 feet) above sea level. So named after the ceremonial hat, the bishop's mitre, it's actually the culmination of five separate peaks. Following closely behind is The Elephant, at 1,517 meters (4,977 feet), and The Lion, which tops off at 1,302 meters (4,272 feet).

Milford Sound Piopiotahi is known as the land of a thousand waterfalls, but it's also home to some waterfalls that at wetter times of the year can stretch for 1,000 meters (3,281 feet). Among the most impressive year-round is Lady Bowen Falls, which plummets 162 meters (531 feet) in view of Mitre Peak on the opposite side of the fjord and provides water and electricity to local residents.

Reaching Milford Sound Piopiotahi can be done quickly by air or reasonably easily by road, but this wasn't always the case. Before 1954, there was no road access to Milford Sound Piopiotahi, but a **19-year** project saw construction workers carve the Homer Tunnel 1.2 kilometers (0.7 miles) through solid rock. The tunnel passes through the Darran mountain range, opening out into the Cleddau Valley 945 meters (3,100 feet) above sea level.

It's named after William Homer, who's said to have first suggested that carving out a tunnel would be the easiest way to make Milford Sound Piopiotahi accessible, but easy becomes a relative term when you're looking at a decades-long project like this.

It began with five workers with pickaxes, but eventually the crew grew and five years later they made it through to the other side. Then came the complex task of widening the tunnel enough that vehicles could pass through. Pause briefly for a dash of World War II, and come 1954, you finally have yourself a functional, under-mountain tunnel. What is it they say if you can't go over it?

So be thankful you exist in the timeline where accessing what Kipling called the "eighth wonder of the world" is just a car ride away (provided you're already blessed enough to be in New Zealand). Make the trip, and you'll be rewarded with blue mushrooms, little blue penguins, and if you're really lucky, the very rare blue duck (sensing a theme yet?). This land also has thriving populations of playful keas, but keep an eye on your belongings (and car windscreen wipers) if you don't want them to make off with a souvenir.

Image Credit: Veronika Oliinyk/iStock, modified by IFLScience

WATCH

THE SCIENCE OF SCI-FI

Virtual event from IFLScience

If you missed our exclusive interview and Q&A with neuroscientist Dr Austin Lim on the science that's inspired some of horror's greatest authors, you can still catch it on-demand. Subscribe for full access to this and all future CURIOUS Live events. **– Available now.**



EAT

NETTLES & PETALS

Book by Jamie Walton

Feel like you could be getting more from your garden? In this debut from ecological horticulturalist Jamie Walton, find out how you can use tools like companion planting, the power of weeds, and ecological garden planning to grow your garden in the most delicious way. **– Available now.**



COMPETE

SQUID GAME

Series from Netflix

Squid Game is back in session for its third and final season. Gi-hun goes in pursuit of The Front Man in his efforts to shut it down for good, but the last survivors face increasingly graver consequences as they approach the final round. **– Available from June 27.**



LISTEN

THE BIG QUESTIONS

Podcast from IFLScience

The Big Questions is back and kicking off season 5 with an absolute corker: Would You Rather Go To Space Or The Bottom Of The Ocean? This episode, hosted by IFLScience's own Space Correspondent Dr Alfredo Carpineti in conversation with Managing Editor Katy Evans, features conversations with explorer Victor Vescovo and astronaut Luca Parmitano to explore the perks and problems that come with visiting the extremes of pressure. How does the team feel? "Absolutely 100 percent yeet me into space," said Evans. "For some reason, this doesn't scare me as much as the bottom of the ocean. It was incredible to listen to people who have actually done both compare them. I'm not telling which one won out, though."

– Available June 19.

READ

BRAIN AND HEART

Book by David I Sandberg

In this medical memoir, pediatric neurosurgeon David I Sandberg gives rare insight into what it's like performing brain surgery on children. He reveals the deep humanity behind such high-stakes surgery, and the profound connection that exists between a child's brain, their life, and their loved ones. **– Available now.**

PLAY

ARCTIC AWAKENING

Game from GoldFire Studios

Somewhere over Alaska, your plane is taken out by a storm. With only your AI drone for company, you'll have to explore the treacherous landscape in search of clues hidden beneath the ice as you look for your missing co-pilot. **– Coming 2025.**

WATCH

PANGOLIN: KULU'S JOURNEY

Documentary from Netflix

A human finds a new life purpose after rescuing one of the most trafficked animals in the world during a sting operation in South Africa: Kulu, the baby pangolin. From the director of ***My Octopus Teacher,*** this poignant exploration of humans' connection with wildlife is sure to make you fall in love with one of the planet's most remarkable creatures. **– Available now.**

Image Credit Top Right: IFLScience, **Middle:** No Ju-han/Netflix

DATES TO REMEMBER

5
WORLD ENVIRONMENT DAY

Celebrated by millions of people across the globe, World Environment Day is the largest global platform for environmental public outreach. This year, it will focus on beating plastic pollution and will be hosted by the Republic of Korea.

8
WORLD OCEANS DAY

Our oceans are under threat. On June 8, join the United Nations to celebrate, protect, and restore our blue planet.

11
FULL STRAWBERRY MOON

No, the Moon's not turning red – in North America, the harvesting of strawberries in June gives the month's Full Moon its delicious-sounding name.



13
RARE CHROMOSOME DISORDER AWARENESS DAY

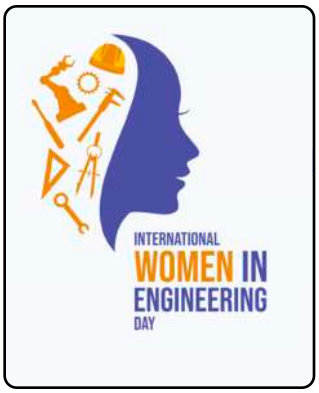
1
DINOSAUR DAY



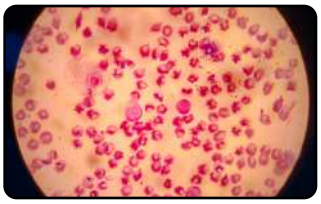
14
WORLD BLOOD DONOR DAY

This event serves to raise awareness of the need for safe blood and blood products and to thank voluntary blood donors for their life-saving gifts of blood.

23
INTERNATIONAL WOMEN IN ENGINEERING DAY



19
WORLD SICKLE CELL DAY



2025 JUNE

This June, get ready to celebrate terrible lizards, protect the oceans, and enjoy a less-yummy-than-it-sounds Strawberry Moon, plus IFLScience's *The Big Questions* podcast is back for season 5.

23
NEW *WE HAVE QUESTIONS* PODCAST EPISODE!

Have you ever wondered: **Why Does Snow Sometimes Look Blue?** Well, wonder no more, as host Rachael Funnell puts the question to an expert in the latest episode of ***We Have Questions.***

21
SUMMER SOLSTICE

In the Northern Hemisphere, June 21 will mark midsummer: the "longest day" and "shortest night" of the year.



19
NEW *THE BIG QUESTIONS* PODCAST EPISODE!

Season 5 of ***The Big Questions*** starts with a cracker of a question: Would You Rather Go Space Or The Bottom Of The Sea? Host Dr Alfredo Carpineti speaks to some of the few people who have done both to find out.

Image Credit Top Left: Orla/iStock, **Top Middle:** Betka82/iStock, **Middle Right:** IFLScience, **Bottom Left:** nopparit/iStock, **Bottom Middle:** Md Ariful Islam/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, Holly Large explores how "dating" artificial intelligence might change how we feel about real-life relationships. If you like your science lighter, discover how a spot of stargazing could do wonders for your wellbeing.





EXPLORE YOUR SIDE ON FACEBOOK

AI LOVE

The idea that someone can be in a "relationship" with an animated character powered by artificial intelligence (AI) isn't exactly a new thing – it's been the subject of multiple documentaries at this point. But could a relationship with one of these so-called "virtual agents" (VAs) end up making someone less inclined to find a real-life lover? According to a recent **study**, quite possibly.

> PEOPLE WHO FELT HAPPY AND CONFIDENT IN THEIR RELATIONSHIP WITH A VA ACTUALLY HAD A MORE POSITIVE ATTITUDE TOWARDS REAL-LIFE MARRIAGE.

To reach that finding, researchers needed a group of participants who'd engaged in relationships with VAs – and they found them amongst video game players. Previous research had shown that romantic relationships with VAs were common in this group, and so they targeted players and encouraged them to let others know about the study too.

In total, they wound up with 503 Chinese participants – 182 men and 321 women – who'd been in a romantic relationship with a VA at some point during the past year. All were asked to complete an anonymous online survey, with questions such as how much time they'd spent with VAs each week, how they viewed their relationship with VAs in terms of positivity and closeness, and their attitudes and intentions towards getting married in real life.

The researchers discovered both positives and negatives when it came to how romantic relationships with VAs might affect someone's intentions to get married to an actual human being. For example, contrary to what some might assume, they found that people who felt happy and confident in their relationship with a VA actually had a more positive attitude towards real-life marriage – and that they might one day end up in one.

On the flip side, those who reported feeling strongly bonded to their VAs and that their relationship with them was authentic also showed less interest in getting married in real life – an effect that was seen particularly keenly in males.

It's important to note that this study doesn't show that people who spend time with VAs aren't bothered about getting married. Rather, it's pointing out a potential relationship that's worth investigating further – and in a world where it's now commonplace to find love online in any shape or form, we'd say that's a pretty worthwhile avenue of research.

STARGAZING FOR WELLBEING

As if we needed another reason to leg it to the nearest open space on a clear night, research has suggested that gazing up at a starry sky might give our mental health a nice boost.

While there's a fairly significant body of research out there establishing a relationship between spending time connecting with nature and its positive impact on wellbeing, there's been relatively little focus on how people might specifically be affected by a connection with the night sky.

> NIGHT SKY CONNECTEDNESS COULD BE ASSOCIATED WITH "SIGNIFICANT BENEFITS TO A PERSON'S MENTAL HEALTH AND HAPPINESS."

Researchers Christopher Barnes and Holli-Anne Passmore sought to change this by developing and testing what they dubbed the **Night Sky Connectedness Index** (NSCI), a measure of people's connection to the night sky that could then be weighed up against measures of things like their mental health and happiness.

To test out the index, Barnes and Passmore tried it out on a sample of 406 people from the general population, all of whom had some degree of interest in the night sky, whether they acted on it regularly or infrequently.

These participants were asked to say how much they agreed or disagreed with statements such as "I find beauty in the night sky" and "I feel at home under the night sky". They were also measured on their emotional regulation, mindfulness, resilience, happiness, and mental wellbeing – and the results showed that night sky connectedness could be associated with "significant benefits to a person's mental health and happiness," the authors wrote.

This is the sort of research that might help to support initiatives that get more people looking up at the night sky for their mental wellbeing. One such program is already underway: **Astronomy for Mental Health**, a project spearheaded by the International Astronomical Union's Office of Astronomy for Development.

The project aims to find diverse, cost-effective ways – backed up by psychological research – to improve mental health through astronomy. As the program's website explains: "By harnessing the rejuvenating impact of nature and fostering a profound sense of awe through contemplation of the expansive universe, we aim to create a context or setting for self-exploration and reflection."