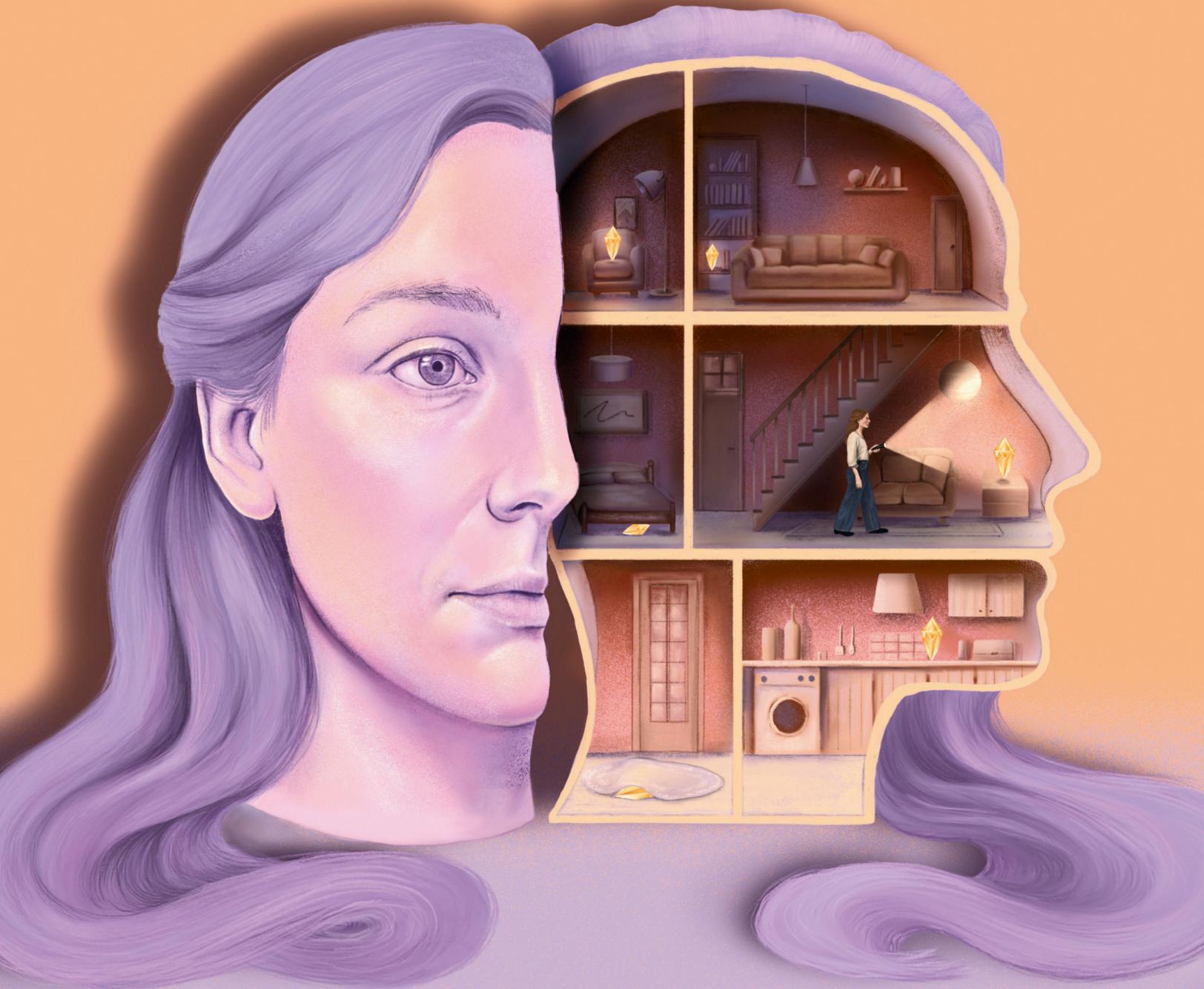


Science Focus

SHARPEN YOUR MEMORY

Six simple steps to train your brain to fight forgetfulness



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How do I know when to let go of past goals or dreams? →p87

FROM THE EDITOR



My sunglasses have disappeared. They vanished a few weeks ago. Right before my holiday. I haven't totally ruled out gremlins – or my other half – as culprits, but it's just one sign of many that my memory isn't what it used to be.

I'm not losing my marbles. It's just that now, there's far too much stuff in there to remember it all. Recall is a bit like that game at the fun fair, the one where little yellow ducks bob around in the water

and you have to fish them out with a flimsy rod. What's it called?

Anyway, the point is that our current understanding of memory and forgetfulness is that, to a degree, you don't actually lose your memories: it just gets harder to fish them out. Once you encode something to your brain, it pretty much remains there, you just need the right hook – psychologists call them cues – to extract the memory. It could be a smell, a song, even a word that can tug the memory and haul it directly into the present.

Which is all to say that remembering everything is getting harder as I get older. I know there are ways to tend to your memory to keep it working well, which is where Christian Jarrett, our psychology expert, steps in on p62.

Daniel Bennett

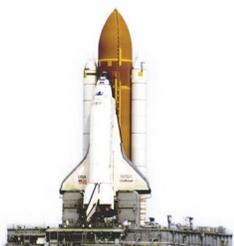
Daniel Bennett, Editor

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ON THE BBC THIS MONTH...

13 Minutes Presents: The Space Shuttle

In the third season of this multi-award-winning podcast, space scientist Dr Maggie Aderin-Pocock tells the story of mankind's return to space following the Challenger disaster. [Listen on BBC Sounds now](#)



Heatwaves: The New Normal? Wilting in the summer heat? You're not alone. The latest episode of *Behind the Forecast* uncovers how extreme temperatures are affecting the UK.

[Watch now on BBC iPlayer](#)

Tech Now: Mapping the Universe

Presenter Lone Wells is starstruck behind the scenes at the Rubin Observatory in Chile, where she explores how the world's biggest camera is mapping the night sky.

[Watch now on BBC iPlayer](#)



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DR CHRISTIAN JARRETT

Heard of a 'mind palace'? Psychologist Christian knows how to use it to hack your memory. →p62



DR REBECCA WRAGG SYKES

Our ancestors were wandering around with an assortment of 'other humans'. Archaeologist Rebecca explains. →p50



DR GEORGE DRANSFIELD

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DR STEPHANIE WRIGHT

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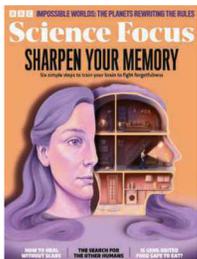
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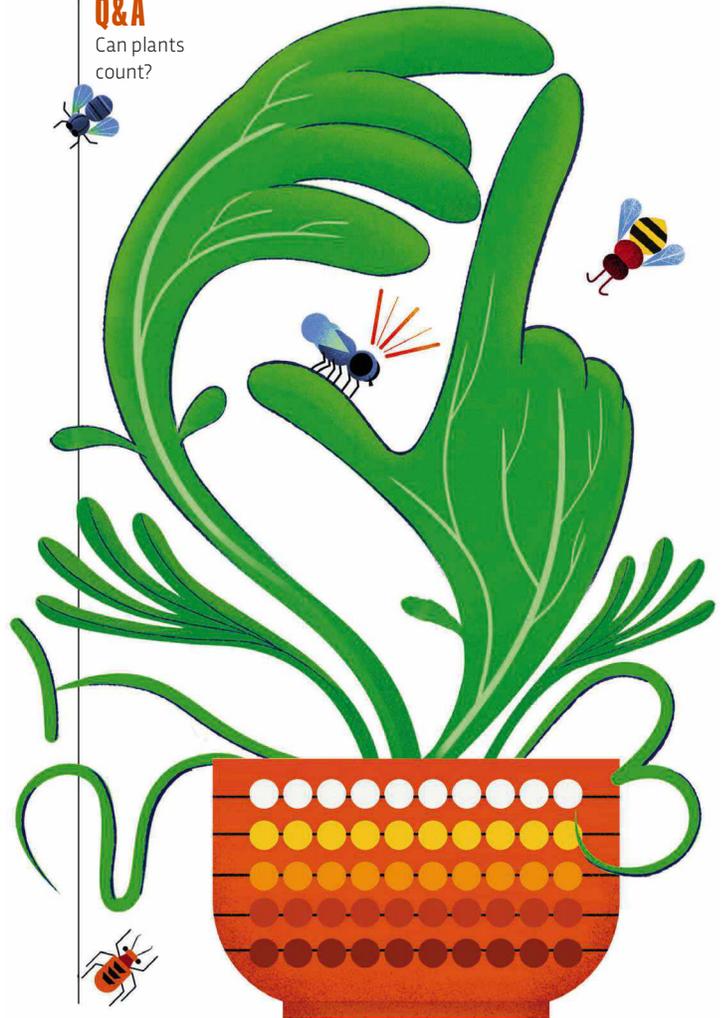
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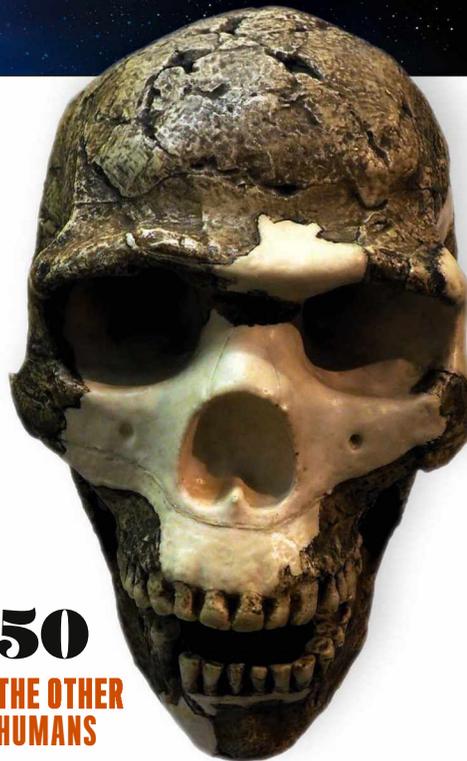


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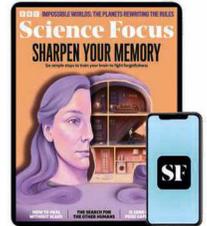


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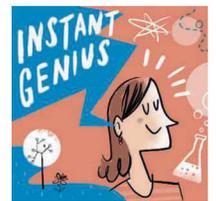
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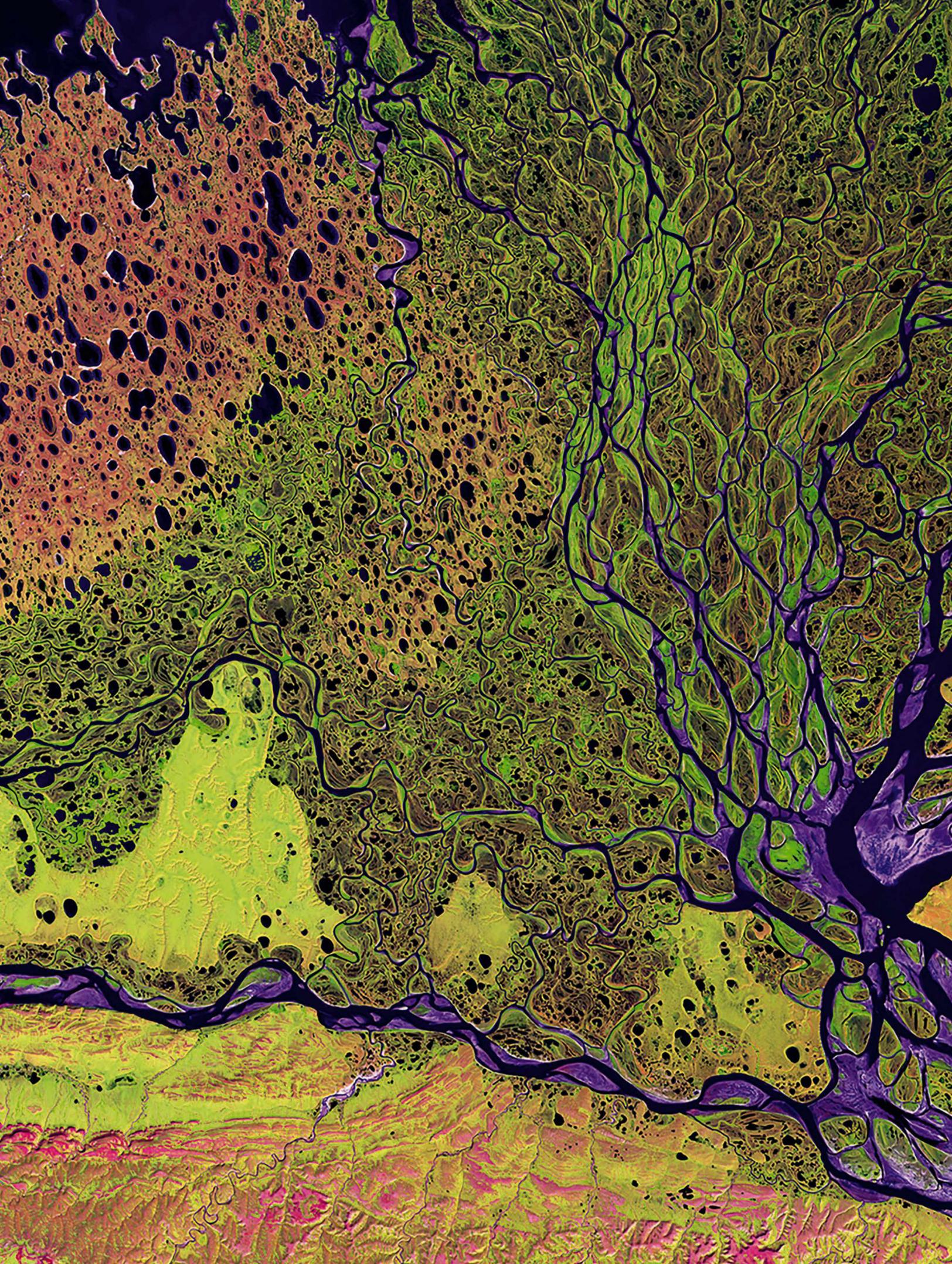
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EYE OPENER

Marbled masterpiece

LENA DELTA RESERVE, RUSSIA

This is what Russia looks like from above. Well, part of it. Specifically, the Lena Delta Nature Reserve on the northern edge of Siberia. And while it may look like an artwork created by marbling, it's actually an image, captured by NASA's Landsat 7 satellite, which was retired in June.

Landsat 7's mission was to monitor Earth's land, surface waters and coastlines to track changes and supply data to climate scientists. Praised as the most accurately calibrated Earth-observing satellite when it launched in April 1999, it spent the next 26 years capturing images of Earth, like this one, using a multispectral scanning radiometer, known as the Enhanced Thematic Mapper Plus (ETM+) instrument.

During the approximately 9,000 days it spent circling our planet, Landsat 7 took over 3 million images – including one of the World Trade Centre just after the 9/11 attacks. But after logging over 6 billion km in orbit (around 3.7 billion miles), it's come to the end of its working life. With the batteries drained and communication systems silenced, Landsat 7 will now drift above Earth for 55 years before burning up as it reenters our atmosphere.

NASA / USGS

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EYE OPENER

Bon appétit!

SOUTH GEORGIA ISLAND,
SOUTH ATLANTIC OCEAN

All three of the small crustaceans you see in this picture are in imminent danger of becoming a meal. That's because the mess of tangles they're sheltering in doesn't belong to a new species of particularly flamboyant coral, but one of nature's strangest invertebrates – a creature known as a basket star (*Gorgonocephalus eucnemis*). This one was spotted by the pilots of a remotely operated vehicle 673m (2,208ft) below the surface of the waters off South Georgia Island in the South Atlantic.

Basket stars are part of the echinoderm family – marine animals with five arms protruding from a central body and spines or bumps covering their outer surface. There are over 7,600 species of echinoderms, but you're probably more familiar with the basket star's cousins: starfish and sea urchins.

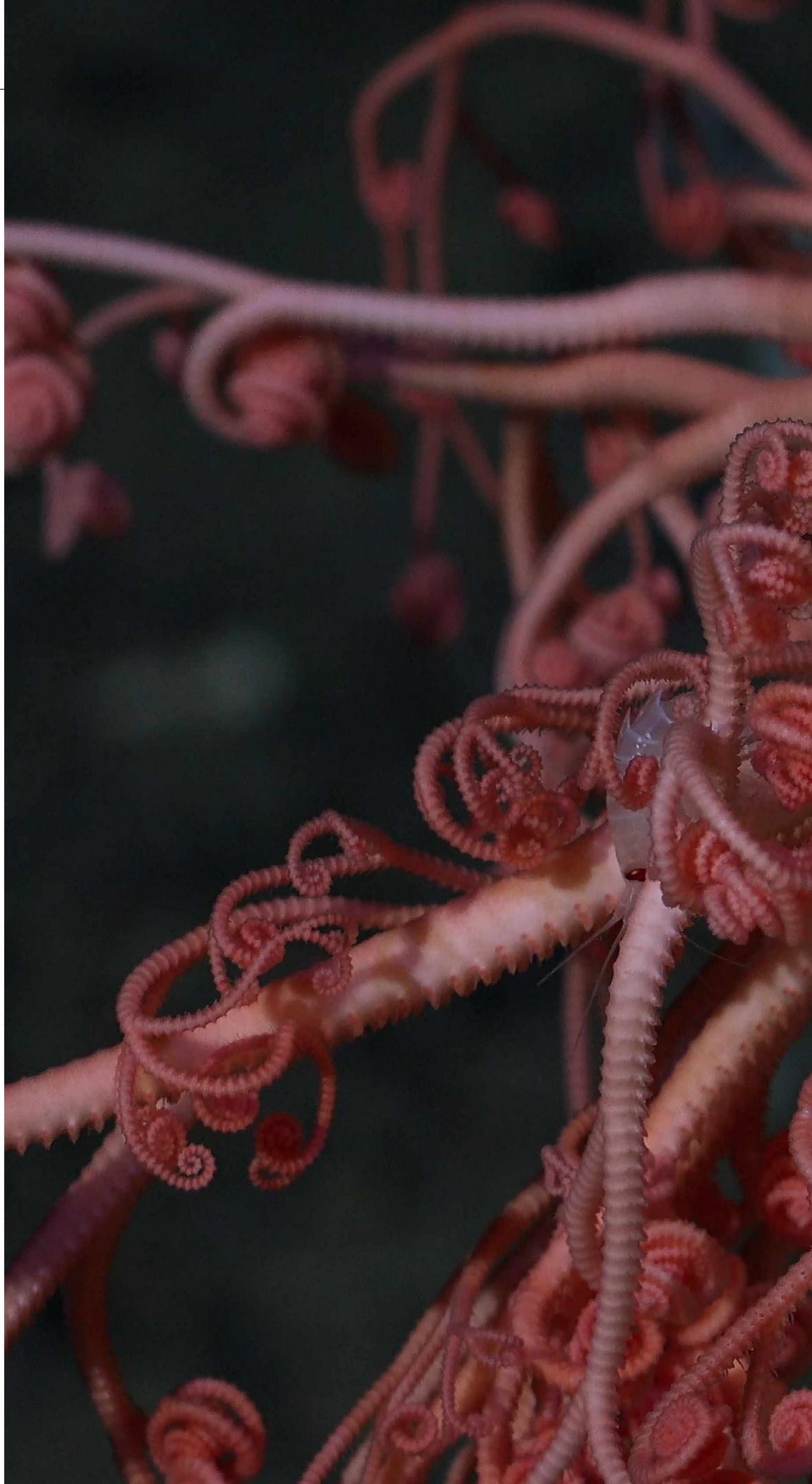
Where the basket star differs from its cousins is that its five arms continue to branch out repeatedly, forming a dense network of tentacle-like limbs, lined with hooks and spines, that it can unfurl and recoil at will. Once a prey animal becomes trapped, the basket star uses its arms to wrap it in mucus before slowly transporting the catch to its mouth.

ROV SUBASTIAN / SCHMIDT OCEAN INSTITUTE

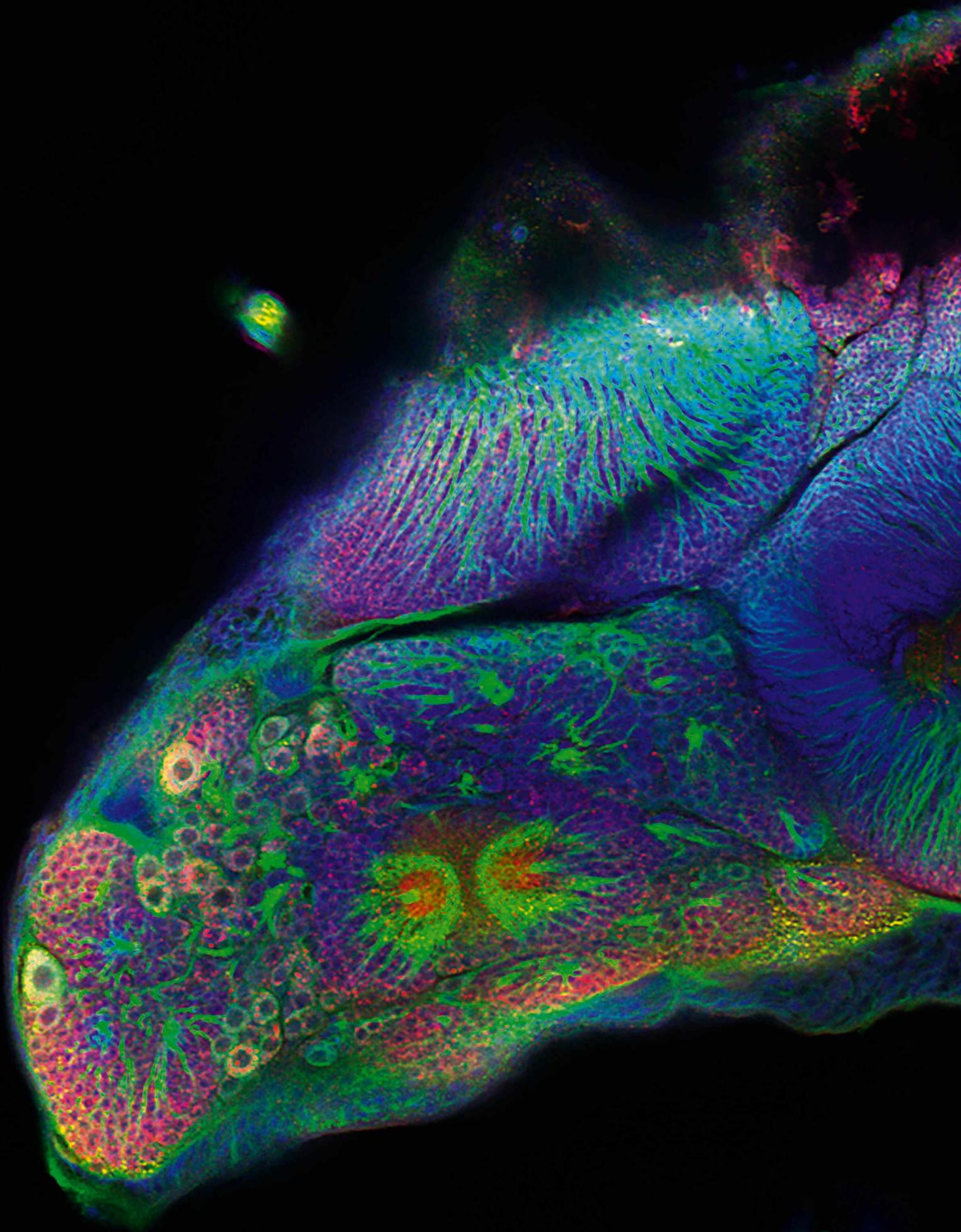
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EYE OPENER

Not-so-grey matter

CAMBRIDGE, UK

This is a brain. It may not be immediately recognisable as such – it's far from the pink and wrinkly blob most of us are used to seeing – but it's a brain nonetheless.

This colourful and oddly shaped brain belongs to a postman butterfly (*Heliconius melpomene*). Well... technically, it'll soon belong to a postman butterfly, because this image shows the brain of a caterpillar undergoing metamorphosis into its adult, butterfly form. Needless to say, it's not lifesize – the actual width of this image is a minuscule 0.9mm (0.03in).

During metamorphosis, new neurones are produced in the brain, through a process called neurogenesis. Neurogenesis occurs in many species during development and adulthood, and studying it can provide valuable insights into how the nervous system is formed. Disruptions to this process can lead to brain disorders and impairment.

PhD candidate Amaia Alcalde Anton took this scan in 2023 as part of an experiment assessing the visual memory of postman butterflies and it has been selected as one of the 'Marvels of Scientific and Medical Imaging' pictures for this year's Wellcome Photography Prize.

AMAIA ALCALDE ANTON / THE WELLCOME PHOTOGRAPHY PRIZE

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FEEDBACK

YOUR OPINIONS ON SCIENCE, TECHNOLOGY AND THE MAGAZINE

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LETTER OF THE MONTH



Currently, the Perseverance rover is the only active mission on Mars

Panspermia paused

I found your recent article *Are We Aliens?* (June, p62) very interesting. I noticed it mentioned that samples from the Mars Sample Return mission would “give us further clues” about the panspermia theory. Unfortunately, however, changes to NASA’s budget under the Trump Administration would lead to the cancellation of this mission. I was wondering how significant the impact of this would be on the search for ancient alien life.

Theo Palmer, Somerset

Jonathan O’Callaghan, author of *Are We Aliens?* responds...

Thanks for the question. NASA’s Mars Sample Return mission would be transformational in the search for life. We’re pretty sure Mars had the right conditions for life early in its history, namely water and a warm environment. If it did, and we found the evidence in samples returned from Mars, it would show that with the right ingredients, life can spring up anywhere.

If we don’t find such evidence, it might suggest that forming life even with the right ingredients is harder than we think, which might mean the number of inhabited planets in our galaxy is relatively small.

But yes, currently the Trump Administration is proposing to cancel the Mars Sample Return mission. If it does, we probably won’t know the answer to this question on Mars for decades, until either humans arrive or someone else does a comparable robotic mission.

WRITE IN!

The writer of next issue’s Letter of the Month will receive two popular science books in hardback: *Good Vibrations* and *Starwatchers* worth over £40!



Magnesium over coffee

I second the advice given by Dr Nish Manek – don’t give yourself a coffee enema (April, p84)! The best solution to troublesome stool is to take a magnesium supplement to soften the consistency. Once the stool is passed, you need to start drinking water to replace your fluids and not become dehydrated.

Frank D, via email



Gietan gripes?

Thank you for all the work you do to produce a really good popular science magazine. It’s much appreciated. However, one little moan, however – the first sentence in Editor’s Picks (June, p38) made me smart. It reads: ‘Why haven’t you gotten a controller for your smartphone yet?’. The first letter of BBC stands for British, so can we please stick to British English? Or are you reverting to the Old English ‘gietan’?

Tony Atherton, Winchester





“THE PROCESS OF BECOMING A NEUTRON STAR IS SUCH A VIOLENT END-OF-LIFE AFFAIR THAT THERE’S ALMOST NO CHANCE ANY EXISTING BODIES WOULD’VE MADE IT THROUGH”

DR GEORGE DRANSFIELD, p73

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 Circulations 347189
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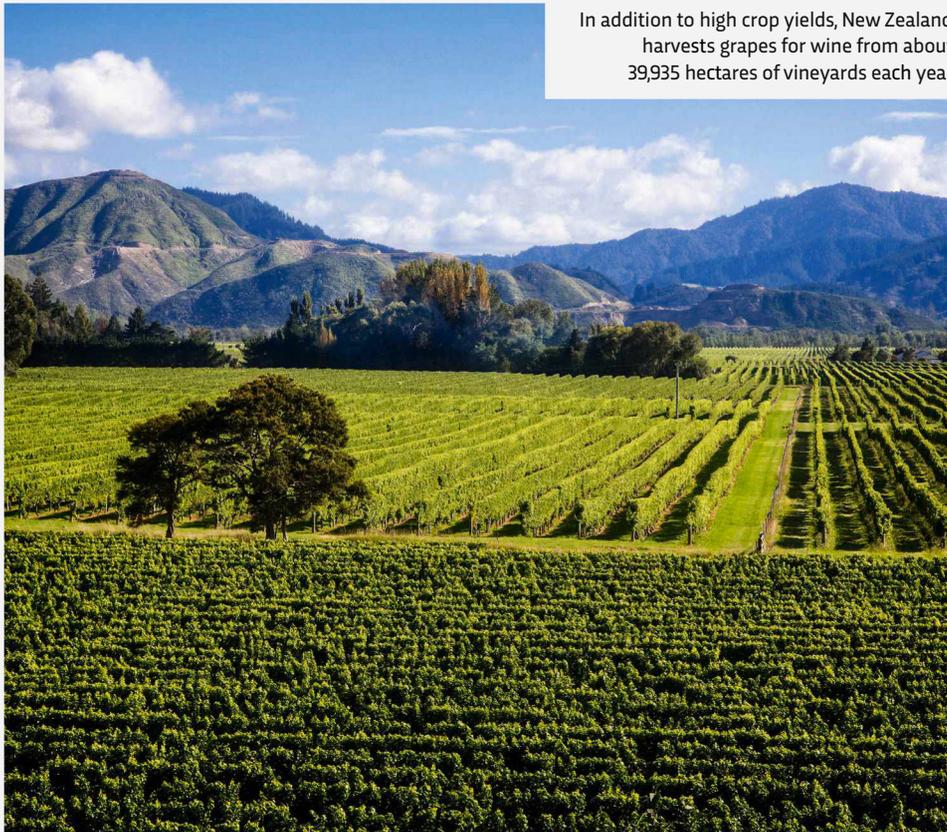


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In addition to high crop yields, New Zealand harvests grapes for wine from about 39,935 hectares of vineyards each year

No New Zealand?

It was interesting reading your news story 'Only one country in the world produces all the food it needs' (July, p22). Unfortunately, in the version that appeared on your website, it seems that New Zealand was left off the map that was included to illustrate the study's findings. Had it been included, it's likely that you would have noticed that New Zealand can produce seven of the food categories the study investigated and would have rivalled Guyana in terms of self-sufficiency.

While we don't grow rice, we do grow wheat, barley, oats, other grains and millions of potatoes.

Dr Marie O'Sullivan, New Zealand

Dr Jonas Stehl, the study's first author, replies...

It appears that there was a technical glitch in the files used to generate the maps, which led to New Zealand not being displayed visually. This omission was purely unintended and New Zealand is fully included in all underlying analyses and in the dataset available in the linked repository.

According to our analysis, New Zealand is fully self-sufficient in five out of the seven food groups we examined. The only exceptions are the food groups "legumes, nuts and seeds" and "starchy staples", where self-sufficiency falls short of the guidance set by the WWF's Livewell diet.



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**UNPLUGGED?**

Experts predict a skidding halt in electric vehicle progress p20

**STRICTLY COME DINO**

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**MARINE MAKEOVER**

Killer whales use tools to groom each other p22

NEWS FROM THE FRONTIERS OF SCIENCE

SPACE

First commercial space station is readying for launch

For the first time in human history, a space station built by a start-up, not a nation, is set to enter low Earth orbit

In 2026, a team of astronauts will float inside a glossy white cylinder orbiting hundreds of kilometres above Earth. But this won't be the International Space Station (ISS). It'll be Haven-1 – the world's first commercial space station, built by a private aerospace company called Vast.

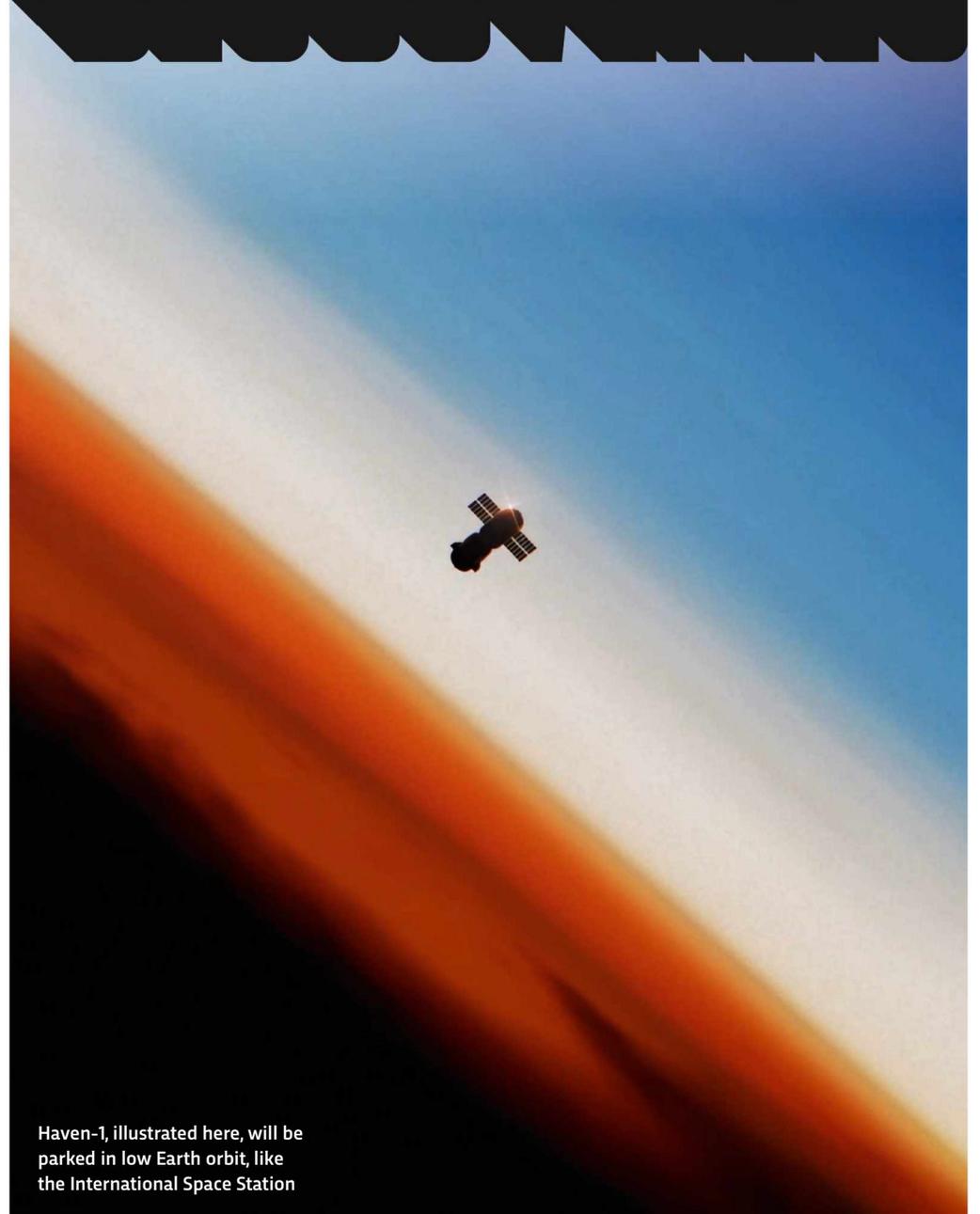
Expected to launch in May 2026 on a SpaceX Falcon 9, Haven-1 represents a radical shift in the way people will live and work in space.

"If we're able to do this before we win the NASA contract [to replace the ISS] using our own funding, we'll be not only the world's first commercial space station, but the only one of the expected bidders to have done that," Vast's CEO Max Haot told *BBC Science Focus*.

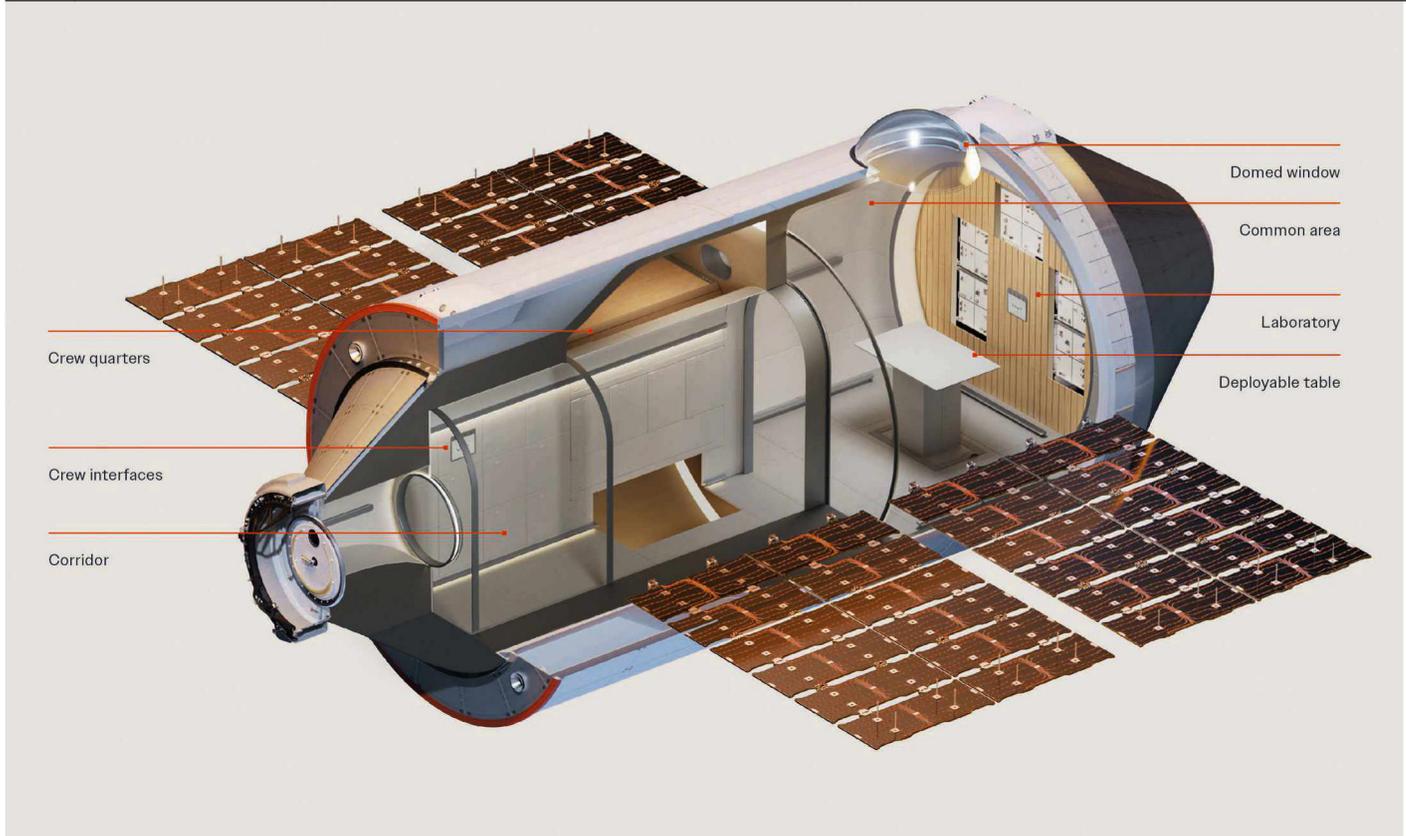
KEEPING THINGS SIMPLE

Vast's approach is fast, focused and unashamedly pragmatic.

DISCOVERIES



Haven-1, illustrated here, will be parked in low Earth orbit, like the International Space Station



Instead of building a sprawling orbital laboratory, the team at Vast has designed a tightly constrained system that does just enough – safely.

At 45m³ (1,590ft³), Haven-1 has roughly the interior volume of a small tour bus. Its life-support system borrows from earlier NASA tech, running on a simpler ‘open loop’ design like that used on the Space Shuttle.

Crew members won’t stay for months here, like they do on the ISS. Instead, four astronauts will visit for roughly 10 days at a time, arriving on a SpaceX Dragon spacecraft. Over Haven-1’s three-year orbital lifetime, only four such missions are planned.

“The number one priority for Haven-1, as a demonstration of a minimum viable product space station, is safety,” Haot says. “Number two is to make it happen within this unprecedented timeline. A rapid timeline also means lower cost.”

Keeping things simple allows Vast to move quickly. The primary structure is already being assembled and is due for initial testing this summer, following completion in July. By early 2026, the entire

“The primary structure is already being assembled and is due for initial testing this summer”

system should be integrated and undergoing final tests in preparation for launch.

INTERIOR DESIGN

Visually, Haven-1 is a striking departure from its predecessors. The ISS – though a miraculous feat of engineering – has always looked a little like a floating plumbing supplies store. Haven-1 is designed to look more like something from science fiction. Its interior is clean, considered and unusually elegant for a space habitat.

But this aesthetic overhaul isn’t just for show. It’s about function. “We go to space to work,” Haot says. “It’s

ABOVE Offering its four occupants just 45m³ (1,590ft³) of living space, the Haven-1 is almost seven times smaller than the ISS, which provides astronauts 388m³ (13,696ft³) to live and work in

not difficult to understand that if you’re able to rest better, feel better and communicate better, you’re going to work better.”

Guided by veteran NASA astronaut Andrew Feustel – who spent over 200 days in space and conducted spacewalks on both the Shuttle and the ISS – the Vast team has rethought the basics of crew comfort.

Sleeping, for instance, will take place on inflatable beds that apply gentle pressure to the body, mimicking Earth conditions and thereby providing a sensation some astronauts crave in microgravity. “People want to sleep in different

ways on the ISS,” Haot says. “A lot of astronauts like to have pressure applied to their bodies when they sleep – we’ve heard that some of them wedge themselves in cupboards in the ISS.”

Each 10-day mission to Haven-1 will be short but jam-packed. With four such missions planned, scientists will have around 40 crew-days to work with in total – a valuable resource, given how rare human time in orbit still is.

Research projects already lined up include studies in human biology, drug screening, plant growth and protein crystal formation.

Between missions, the station will be used to test artificial gravity systems – an early step toward making long-duration space travel safer and more viable.

NEXT-GEN SPACE PLATFORM

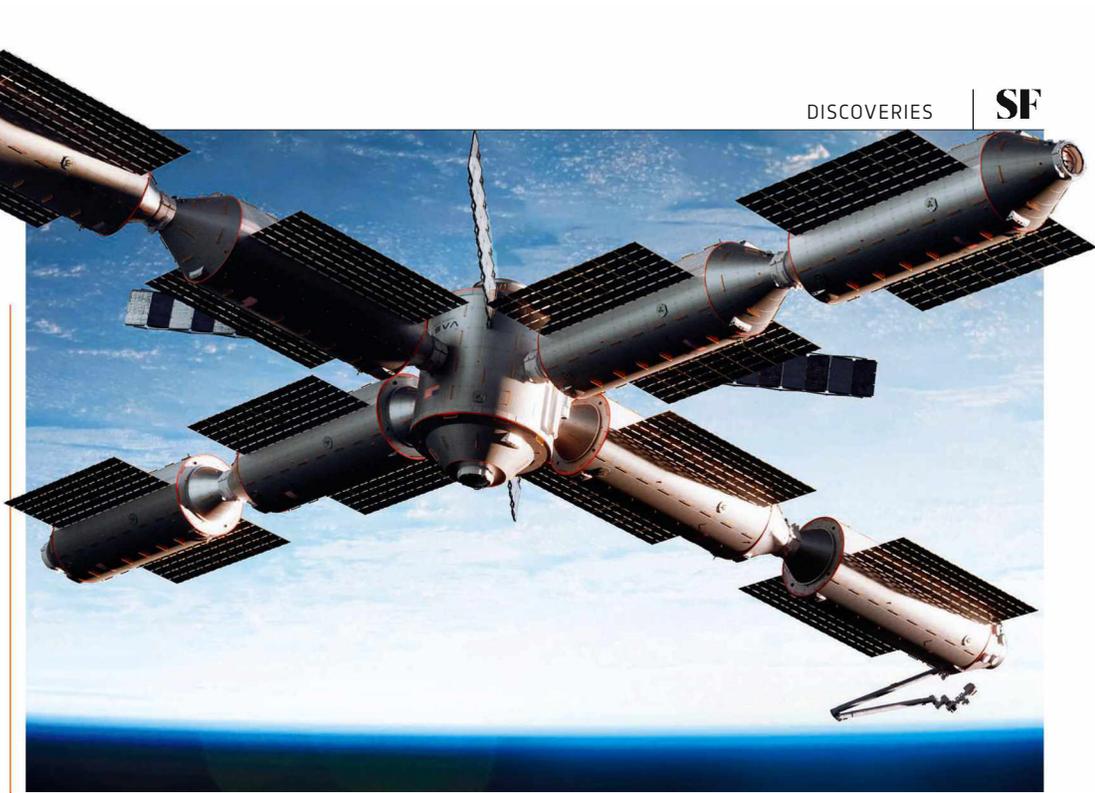
There’s more to Haven-1 than just research. It’s a calculated move in a much bigger race.

NASA plans to retire the ISS around 2030 and is currently evaluating bids for the next generation of orbital platforms.

Haot wants Vast to win that contract and launching Haven-1 early, with private funding, is a bold way to leapfrog the competition. “Our strategy is to be the one that has done the most out of all the competition – to be the furthest along in technology development, team, facilities and proof point,” Haot says. “We’ve kind of already reached that point.”

The race is by no means won, however. Another company, Axiom Space, has already been awarded a \$140m (£102m) contract with NASA to attach at least one module to the ISS. Construction at Axiom is underway, with the first launch targeted for the end of 2026.

If Vast achieves its goals, it’ll be in a strong position when NASA makes its decision in 2026. But even if Vast is unsuccessful, Haot insists Haven-1 will still have value. Vast



ABOVE To help maximise space in Haven-1 this table can retract into the floor of the habitat

TOP Haven-2 is expected to have a central core and detachable modules, each of which will be bigger than Haven-1

may look to foreign governments and private organisations if its NASA goals don’t come to fruition.

“We still think there’s likely a bright future for Vast, but internally we’re very focused on this,” Haot says. “It’s the biggest opportunity in the world right now in the space station market.”

THE FUTURE OF SPACE

Haven-1 is only the beginning. Vast’s next step is Haven-2 – a more advanced module that follows the same approach. From 2028 onwards, the company plans to

launch new modules roughly every six months, eventually assembling a full commercial station by 2032.

This modular future opens the door to more frequent crewed missions, private research programmes and, eventually, a broader orbital economy.

And thanks to a deal with SpaceX, Haven-1 will also be the first space station to hook up to Starlink, providing gigabit-speed internet to those in orbit – a leap forward for real-time communication, outreach and data transfer.

“Aboard Haven-1, if you want to speak to somebody 24/7, you can,” Haot says. “That’s going to be very different in how the general public and the crew can interact.”

Haven-1 won’t be the most advanced station in orbit, but by showing that space infrastructure can be lean, elegant and commercially viable, Vast hopes to redraw the map of low Earth orbit. Whether for science, exploration or industry, Haot is betting that the future of space doesn’t belong to nations. It belongs to whoever gets there first.

“The purpose is not to build a luxury hotel in space and attract tourists,” Haot says. “The purpose is to build a great environment to be and work in. “It’s not without risk... We’ll just have to see what happens in reality.”

ENVIRONMENT

US military could slash a whole country's emissions, finds study

The world's largest fighting force is also one of its biggest emitters

The US Air Force consumes approximately 2 billion gallons of aviation fuel annually



GETTY IMAGES

“While the science on this is clear, the politics is anything but. Governments around the globe are spending more and more on defence”

A new study has revealed the astronomical scale of the US military’s carbon footprint – and how relatively modest budget cuts could significantly reduce it.

Published in the journal *PLOS Climate*, the research found that US Department of Defense (DoD) spending is tightly linked to energy consumption and greenhouse gas emissions. Reducing military expenditure, the authors argue, could yield dramatic benefits for the planet.

The US military is the largest emitter of greenhouse gases of any institution on Earth, generating an estimated 636 million metric tonnes of CO₂ equivalent (a standardised measure of greenhouse gas emissions) between 2010 and 2019.

If the US military were a country, it would rank 47th globally in emissions – ahead of nations like Sweden and Portugal.

And that’s just the tip of the iceberg. These figures only include what’s known as Scope 1 and 2 emissions – the direct emissions from fuel combustion and purchased electricity. They exclude indirect (Scope 3) emissions from employee travel, waste disposal and the supply chain, meaning the true carbon footprint is likely much higher.

Using publicly available data from 1975–2022, the analysis, led by Prof Ryan Thombs of Penn State University in the US, sought to identify a link between military spending and energy consumption.

Unsurprisingly, increases in spending led to higher energy use, while cuts caused it to fall. A puzzling – and promising –

asymmetry was found between the two, however: reductions in spending had a significantly larger impact on energy consumption than increases did.

“We find that reductions in spending are associated with reductions in energy consumption from military facilities, vehicles, equipment – and jet fuel in particular,” Thombs told *BBC Science Focus*.

“Although future research is needed to investigate the specific mechanisms, these findings suggest that spending cuts may place greater pressure on the military to reduce the scale, distance and frequency of movement of machinery, goods and personnel than increases in spending do to increase these activities.”

Another likely reason for this trend, Thombs added, is that budget cuts may disproportionately reduce aviation activity.

Globally, military jets are among the most energy-hungry machines in operation – and in the US military, jet fuel accounts for 55 per cent of total energy use over the past half-century.

“Reducing aviation activities must be a key focus given its share of energy consumption,” Thombs said. “Aviation is very energy-intensive, and any serious effort to reduce the military’s footprint will require focusing on this category.”

Curbing emissions from aviation is notoriously difficult. Both military and commercial aviation are considered ‘hard to abate’ sectors, where existing technology can’t yet substitute fossil fuels at the required energy use or scale.

636
MILLION
METRIC TONNES
The US military’s
greenhouse gas
emissions between
2010 and 2019

\$150
BILLION
The amount the
Trump administration
has already increased
the budget for
defense (as of 4 July)

13.4%
Year-on-year
increase in proposed
US defense
spending

This, Thombs said, “suggests that reducing the scale of aviation operations is imperative to reducing emissions.”

The team also produced forecasts for various future budget scenarios. They found that if military spending were reduced by 6.59 per cent each year from 2023–2032, the DoD’s annual energy savings would be equivalent to the total energy use of the entire country of Slovenia, or the US state of Delaware. The military has experienced these rates of reduction before over the last five decades, so – though this is at the higher end of typical budget cuts – it is, in theory, possible.

But while the science on this is clear, the politics is anything but. Governments around the globe are spending more and more on defence in a world increasingly rocked by conflict and instability.

On 26 June this year, President Trump’s administration proposed a \$1.01 trillion national defence budget for the next fiscal year – a 13.4-per-cent increase on the previous year.

Despite this trend, Thombs is optimistic that, given the correct framing, spending cuts are feasible. He pointed to previous proposals from Senators Edward Markey and Bernie Sanders to slash military spending by 10 per cent, with the money redirected to jobs, healthcare and education.

“The most impactful way to reduce the social and environmental costs and harms of the military is to scale it back,” Thombs said.

The researchers now plan to investigate why spending cuts appear to yield such outsized savings.

ENERGY

Electric vehicle boom could hit major roadblock in just 5 years

With sales skyrocketing, a shortage of a critical material could halt progress



The electric vehicle (EV) revolution may be heading for a supply chain snag, according to a new study published in *Cell Reports Sustainability*.

Rapidly rising demand for lithium – the key ingredient in EV batteries – could outstrip domestic supply by the end of the decade.

The analysis focused on China, the US and Europe, which together account for 80 per cent of today’s EV sales. Researchers warn that without major changes, these regions will be unable to meet their lithium needs from local sources by 2030 – increasing their reliance on imports and the risk of global shortages.

“A lot of previous studies have looked at how much lithium is needed for the low-carbon transition,” Dr André Månberger, co-author of the new study, told *BBC Science Focus*.

“The problem with those is that often they compare lithium demand in the future with how large the reserves in the ground are, or current mining rates. But there’s a gap in the literature on the feasibility of expanding mining.”

The International Energy Agency predicts that EVs could make up 40 per cent of all car sales by 2030. But that growth hinges on a steady supply of lithium carbonate equivalent (LCE) – a standard unit that represents how much lithium is usable for batteries.

The study projects that by 2030, annual demand for LCE will reach 1.3 million metric tonnes in China, 792,000 in Europe and 692,000 in the US. But even with all current and planned mining projects included, domestic supply would fall short: China could produce up to 1.1 million metric tonnes, the US 610,000 and Europe just 325,000.

Nevertheless, there are reasons to be optimistic, said Månberger. Higher lithium prices could spur innovation and investment in new mining projects and push manufacturers to develop more efficient battery technologies. Alternatives to lithium, such as sodium-ion batteries, may also help diversify the market. In the longer term, recycling could also play a bigger role, as recovered materials from old batteries could reduce the need for fresh lithium extraction.

HEALTH

This simple snacking habit could help cut your cholesterol, study finds

It’s good news for those who love a nibble between meals

Snacking on 50g of almonds – about 45 nuts – every day could improve your cholesterol levels, as well as provide a host of other metabolic benefits.

That’s according to a recent study from Oregon State University (OSU), published in *Nutrition Research*.

Scientists recruited 77 adults, aged 35–60, to take part in a 12-week clinical trial where they snacked on either 320 calories of almonds or crackers each day.

All the participants had metabolic syndrome, which is a group of risk factors for chronic diseases like heart disease or type 2 diabetes. These risk factors include excess

ILLUSTRATIONS: ADAM GALE

PALAEOLOGY

Prehistoric 'dancefloor' could reveal how dinosaurs flirted

Fossilised scrape marks may be the best evidence yet of dinosaurs gathering for elaborate mating displays

Around 100 million years ago, on a tidal flat near what is now the city of Denver in Colorado, US, dinosaurs may have gathered to dance.

According to a new study published in *Cretaceous Research*, new findings suggest that dozens of mysterious scrape marks preserved in stone at Colorado's famed Dinosaur Ridge represent

one of the largest-known dinosaur mating display arenas – or leks – ever discovered.

"Leks (or 'courtship arenas') are areas where a number of individuals congregate to participate in courtship display behaviours to attract potential mates," Dr Caldwell Buntin, lead author of the study, told *BBC Science Focus*. Many modern birds (the descendants of dinosaurs),

including knots and plovers, exhibit such behaviours, Buntin said.

The idea that dinosaurs performed such rituals was first proposed by palaeontologist Dr Martin Lockley, who noted similar traces nearby. This new study significantly expands on that evidence, revealing more than 30 distinct scrape marks across multiple layers of sediment.

The traces fall into two categories: broad, shallow bowl-like marks and narrower, overlapping scrapes. Many appear to have been made by backwards kicking movements from both feet, sometimes while rotating.

Drone imagery from a 2019 US Geological Survey and follow-up surveys in 2024 helped the team map the site in detail, as walking on the site is prohibited.

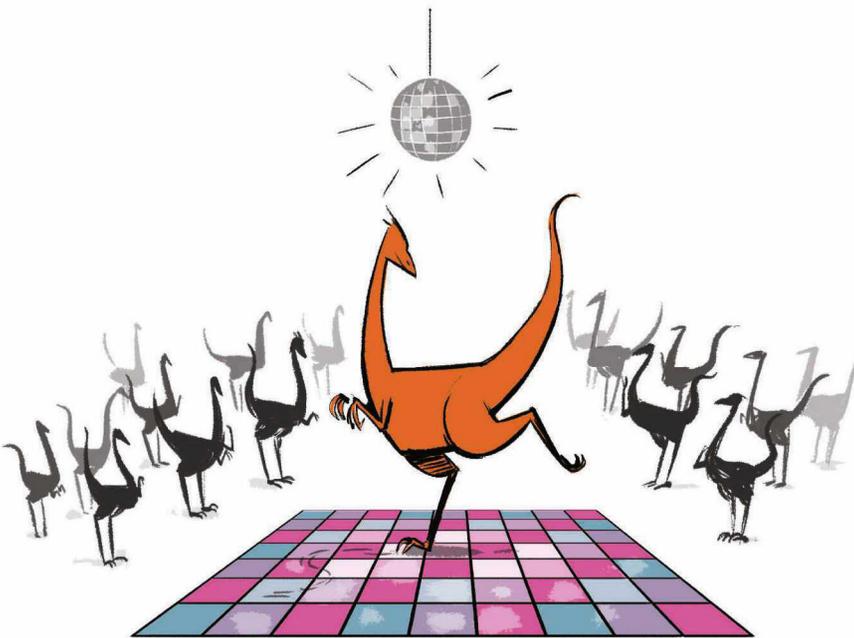
"This was a one-of-a-kind find,"

"It was definitely a 'eureka!' moment for me"

said Buntin, who worked with Lockley until his death in 2023.

"We were extremely excited, and it was a surreal moment looking at the drone imagery for the first time and noticing scrapes pop up all across the screen. It was definitely a 'eureka!' moment for me."

The exact species responsible for the markings is unknown, but based on nearby fossil footprints, Buntin pointed to *Acrocanthosaurus* – a *T. rex*-like predator – and ostrich-like *Ornithomimids* as likely candidates.



belly fat, high blood pressure, high blood sugar and low levels of 'good' (HDL) cholesterol.

Prof Emily Ho, co-author of the study and director of OSU's Linus Pauling Institute, told *BBC Science Focus* that the almond snackers lowered their cholesterol levels – including LDL cholesterol (the 'bad' cholesterol) – and improved their gut

health, with less inflammation and better gut bacteria.

"We didn't see the same benefits in the control group that consumed crackers as their snack," she said.

"The almond snacks didn't result in weight gain – we actually saw a modest decrease in waist circumference – and improved vitamin E status in people, a

nutrient that's often limited in the population." Vitamin E is essential for the functioning of various organs, nerves and muscles, and it can reduce blood clotting.

"[Almonds] are a nutrient-dense snack," Ho said, as they're also rich in magnesium, fibre, and polyphenols with antioxidant and anti-inflammatory properties.

NATURE

Killer whales filmed using tools for the first time

The marine mammals use kelp to groom each other

Researchers have discovered that endangered killer whales in the Pacific Northwest use tools made from kelp to groom one another – a behaviour never before seen in marine mammals.

In a new study published in *Current Biology*, scientists observed southern resident killer whales manufacturing tools by tearing off pieces of bull kelp and rolling them between their bodies during social interactions.

Drone footage captured whales pressing the kelp against their companions and using it to scrub off dead skin cells during prolonged grooming sessions.

“What I find most remarkable is that despite this apparently being a common behaviour – we see it most days we fly our drone over these whales – it hadn’t yet been discovered in this population, despite nearly 50 years of dedicated observation,” said lead author Dr Michael Weiss, research director at the Center for Whale Research in Friday Harbor, in the US.

The critically endangered southern resident population consists of fewer than 80 killer whales living in the Salish Sea, which lies between British Columbia and Washington State.

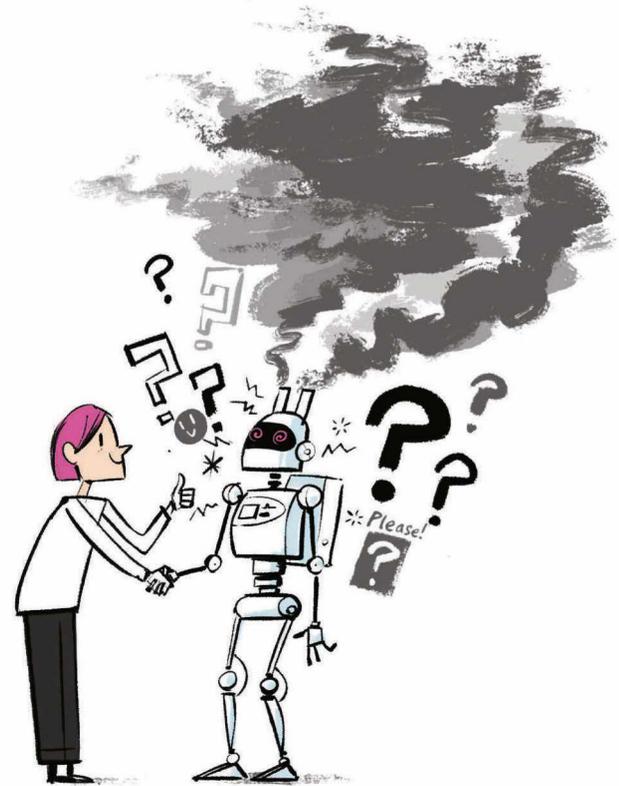
While tool use is well documented in primates, elephants and birds, it remains rare among marine animals.

Weiss and colleagues observed this behaviour across all age groups and social units, noting that whales were more likely to groom relatives or similarly aged partners.

Individuals with more dead skin were also more frequently involved, suggesting a hygienic function.

The findings highlight the unique culture of southern whales and underscores the importance of conservation efforts. It remains unknown whether this tool-assisted grooming is unique to this group or if it also occurs in other populations.

Weiss added, “To find that the whales were manufacturing tools, and using them in a way never before reported in marine mammals, was incredibly exciting.”



TECHNOLOGY

These are the worst ChatGPT prompts for the environment, study claims

Politeness perhaps *does* have a cost, as far as the planet’s concerned

Every time you ask ChatGPT a question, you’re using energy – but how much? A new study has revealed just how environmentally costly it is to interact with large language models (LLMs) and what users can do to reduce their carbon footprint.

Researchers in Germany gave 14 open source LLMs – ranging in size from 7–72 billion parameters – 1,000 benchmark questions and measured the CO₂ emissions generated during each response.

They found that models that use internal reasoning to ‘think’ through answers can produce up to

50 times more emissions than those that respond concisely. Meanwhile, models with more parameters – which, generally, produce more accurate answers – also produced more emissions.

But the models themselves aren't the only problem – the way users interact with them has huge implications too.

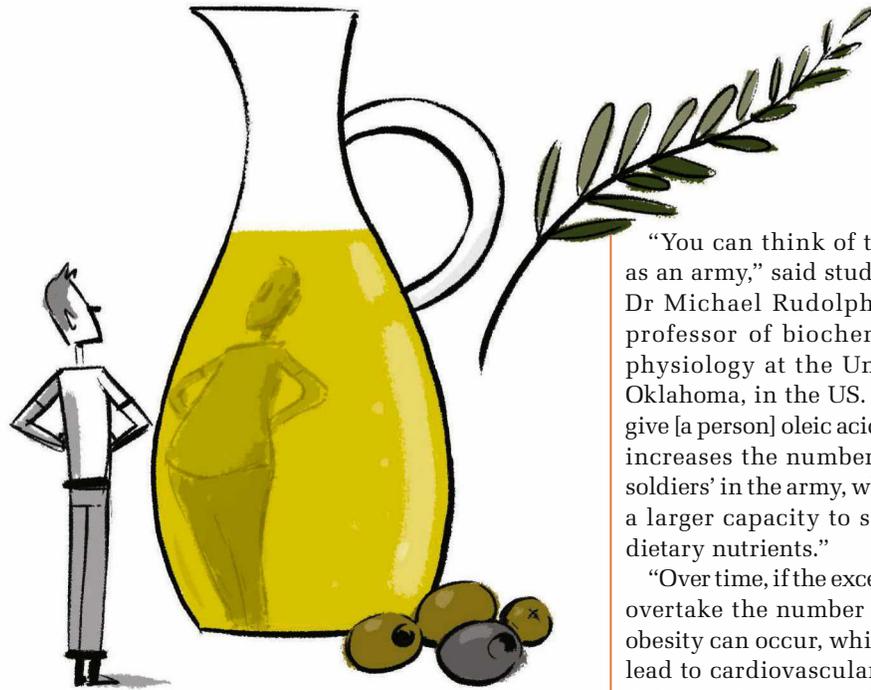
“Because people are being friendly and using ‘please’ and ‘thank you’, the LLMs are generating more extensive answers,” Maximilian Dauner, a researcher at Hochschule München University of Applied Sciences and first author of the study, told *BBC Science Focus*. “This means more words are generated, which means the model is executed for longer, which needs more power and emits more CO₂.”

He added: “If the model generates 10,000 words of really useful text or 10,000 words of nonsense, it doesn't matter. It's the same CO₂ emissions.”

This means users could reduce emissions by prompting artificial intelligence (AI) models to be brief, or by asking for bullet points instead of full paragraphs.

Dauner also pointed to changes that LLM companies can make. For example, he suggested that developing systems to select the smallest model needed to answer each question accurately could cut unnecessary emissions at scale.

“Because people are being friendly and using ‘please’ and ‘thank you’, the LLMs are generating more extensive answers”



HEALTH

Too much of this ‘healthy fat’ could be adding to your waistline

Olive oil is known as a ‘superfood’, but new research on mice suggests it could promote weight gain more than other fats

“You can think of the fat cells as an army,” said study co-author Dr Michael Rudolph, assistant professor of biochemistry and physiology at the University of Oklahoma, in the US. “When you give [a person] oleic acid, it initially increases the number of ‘fat cell soldiers’ in the army, which creates a larger capacity to store excess dietary nutrients.”

“Over time, if the excess nutrients overtake the number of fat cells, obesity can occur, which can then lead to cardiovascular disease or diabetes if not controlled.”

The scientists, from the universities of Oklahoma, Yale and New York, fed a variety of high-fat diets to mice, including olive oil, coconut oil, peanut oil, milk, lard and soybean oil.

They found that high levels of oleic acid changed the activity of two proteins – called AKT2 and LXR – which led to faster growth of precursor cells, which form new fat cells. The other fats didn't have the same effect.

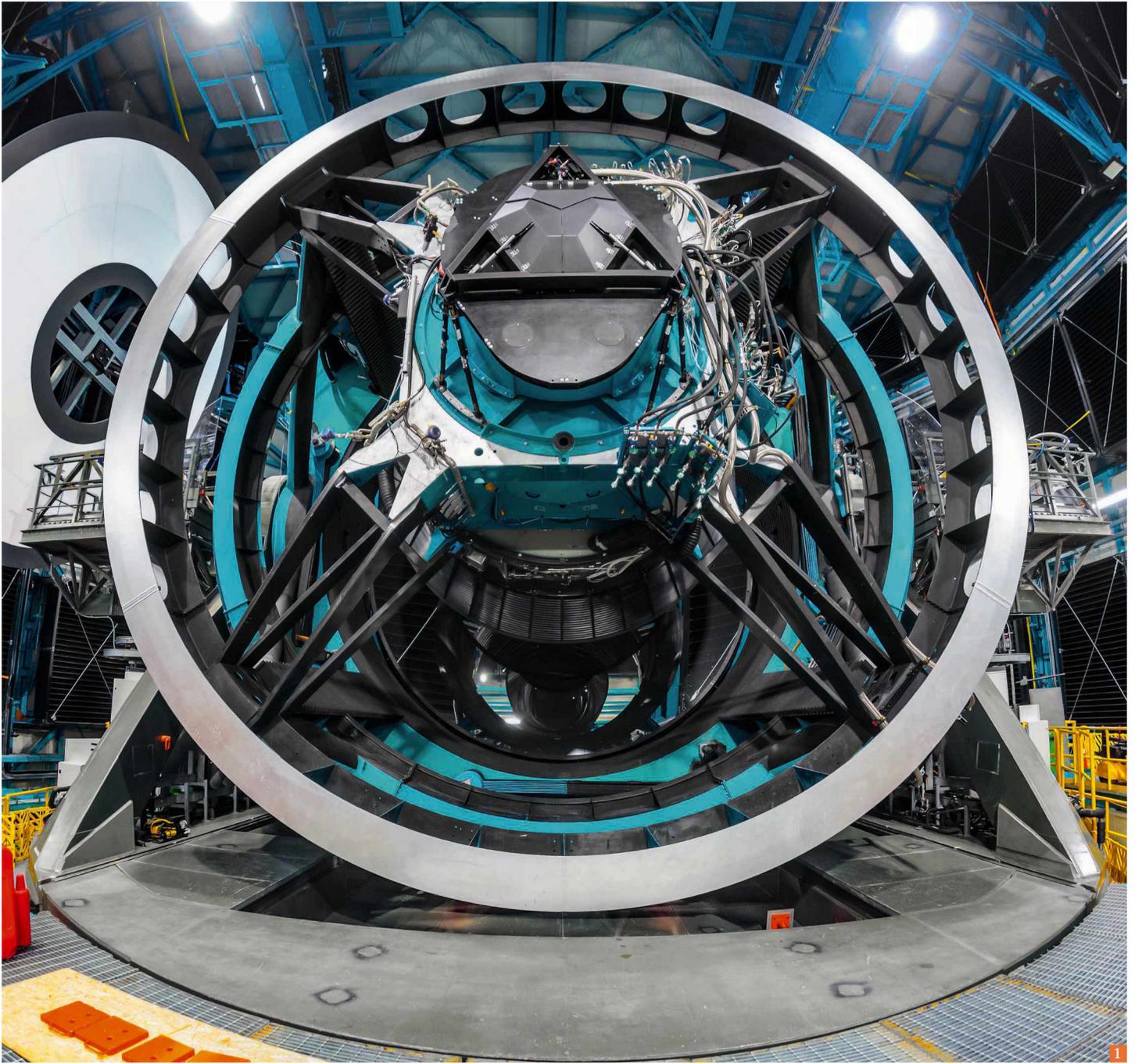
But Rudolph said the solution wasn't to abandon olive oil altogether. “I think the take-home message is moderation, and to consume fats from a variety of different sources,” he said.

“Relatively balanced levels of oleic acid seem to be beneficial, but higher and prolonged levels may be detrimental. If someone is at risk for heart disease, high levels of oleic acid may not be a good idea.”

However, previous research has linked oleic acid, often via olive oil, with longevity, healthy ageing, lower levels of inflammation and lower risk of obesity and heart disease. Also, given the new study was only carried out on mice, its findings may not directly translate to the effect of oleic acid on humans.

New research suggests that the fats in olive oil may lead to greater weight gain than those from other sources. The study, published in *Cell Reports*, found that the main fatty component in olive oil, known as oleic acid, may promote the growth of new fat cells.

Oleic acid is a type of monounsaturated fat, sometimes called omega-9. A major source of oleic acid is olive oil, but the fatty acid is also found in other oils – including rapeseed (canola) oil and sunflower oil – as well as foods such as nuts, meats, cheese, eggs and avocado.



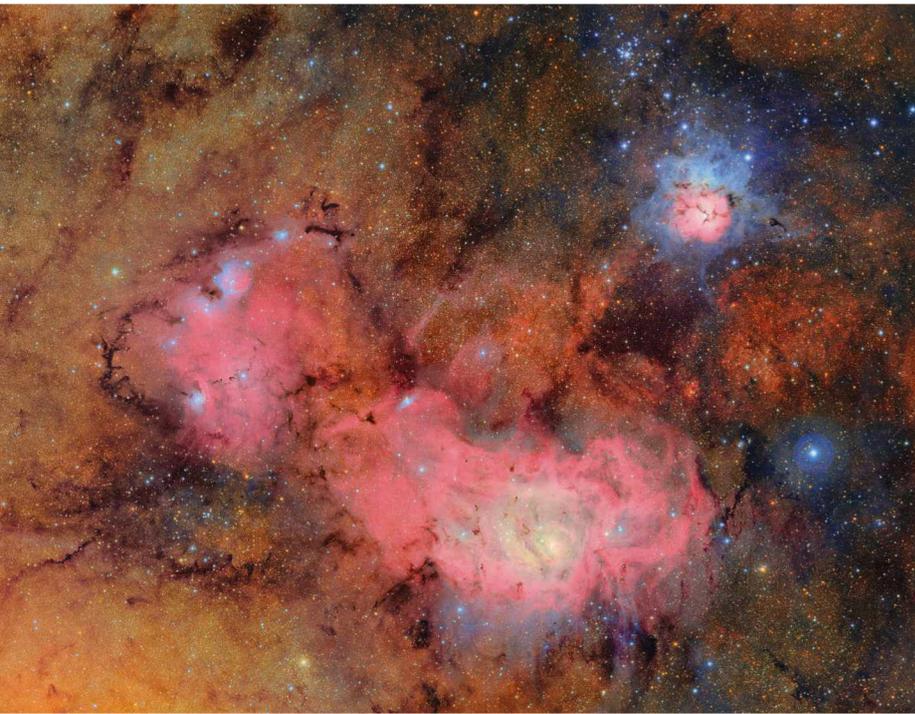
1. Inside the Rubin Observatory is the Simonyi Survey Telescope, pictured here during its initial calibration tests. The telescope features an 8.4-m-wide (28ft) mirror and is equipped with the largest digital camera in the world.

2. The 30m-wide (98ft) rotating dome that houses the telescope sits atop Cerro Pachón, a mountain in Chile 2,700m (8,900ft) above sea level.

3. The central pink area in this test shot shows the Lagoon Nebula (otherwise known as Messier 8), while the Trifid Nebula (also known as Messier 20) sits in the top right of the image. Both are active star-forming regions in the Milky Way where young stars are born. This colourful image was made by joining 678 separate, monochromatic exposures taken over the course of seven hours.

4. With remnants of their spiral arms still visible, three merging galaxies (in yellow, just above centre) are pulling dust, gas and stars from one another. With the two spiral galaxies (in blue, bottom right), these form just a small section of the Virgo Cluster. This is also just a small section of the full image. The pictures Rubin captures are so large that you'd need 400 ultra-high definition TVs just to display one at full size.

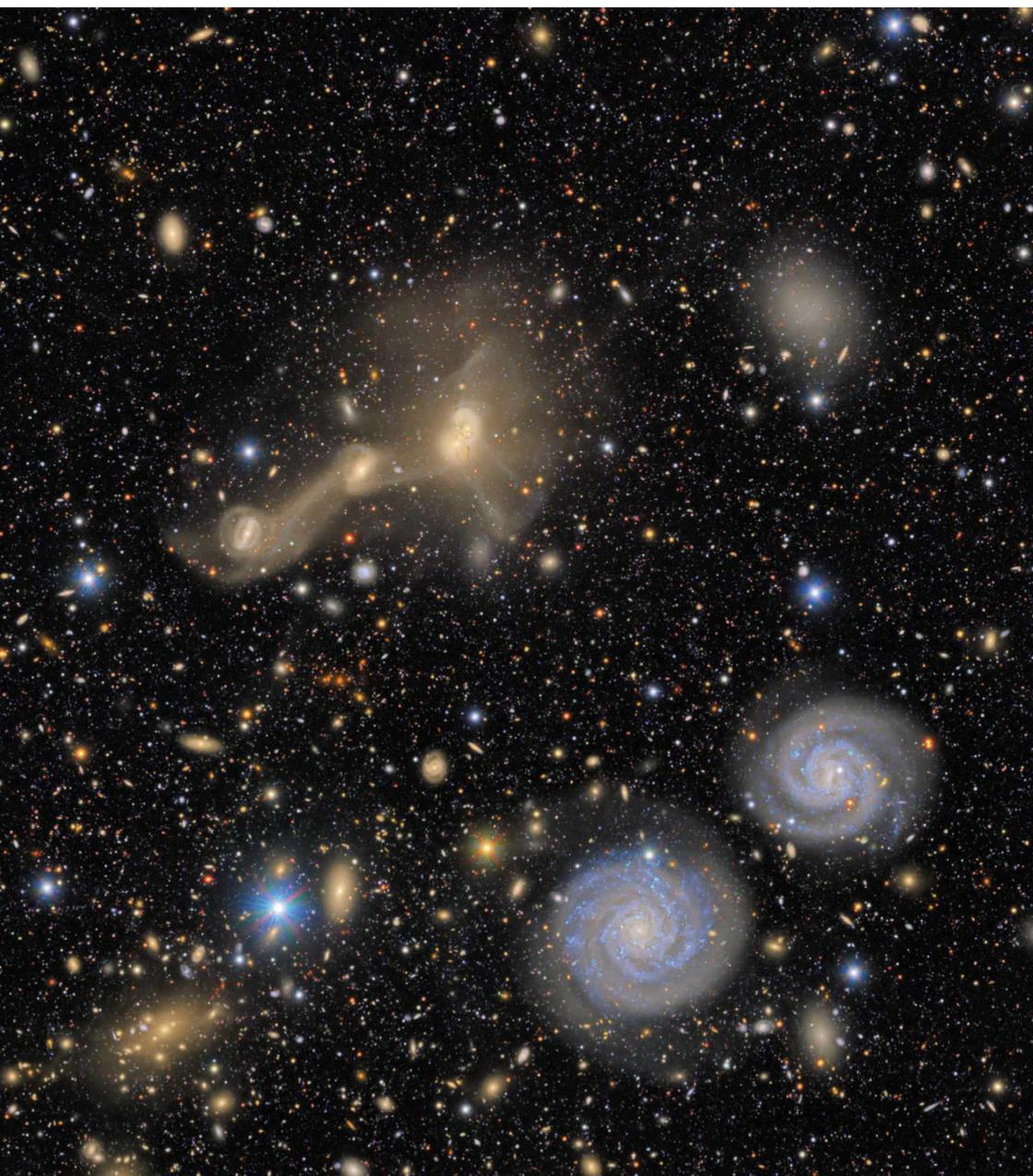




SPACE

Breathtaking first images from 'ultimate' telescope reveal new galaxies

The newly opened Vera C Rubin Observatory is on a mission to unlock the Universe's greatest secrets



In a remote mountain range in Chile, a newly unveiled observatory will soon begin mapping the sky. When its survey starts, the Vera C Rubin Observatory will spend every night for the next decade charting the cosmos. And it'll do so at speed – covering the full southern hemisphere sky every few nights by photographing a different part of the heavens with each shot.

Attached to the telescope housed within the observatory is a 3,200-megapixel camera (the world's largest). It's set to capture a total of 20 billion galaxies and another 20 billion stars to create an ultra-high-definition timelapse of the changing cosmos.

The wealth of data it collects could help scientists unravel some of the Universe's remaining mysteries. Charting the changing distribution of celestial bodies between each cycle of observations, for example, will help scientists measure the expansion of the Universe. And, by observing an effect known as gravitational lensing, they could also get closer to explaining dark matter.

Since the observatory was first proposed, back in the 1990s, scientists have been eagerly awaiting these first test images. Soon they'll be poring over a steady stream of photos packed with potential discoveries.

GEOLOGY

Mysterious 'surge' under Earth's crust could reshape world map, study claims

The pulsing will eventually rip Africa apart and create a new ocean

A heartbeat-like pulse has been discovered beating deep beneath East Africa – and it's ripping the continent apart. The strange thumping is caused by a rhythmic surge of molten mantle rock rising and falling under Earth's surface, according to a recent study in *Nature Geoscience*. The surges are so powerful that, over millions of years, they could split Africa in two and create a brand-new ocean.

The geological pulse was detected in the Afar Triangle, a region where three tectonic plates – the African, Somali and Arabian plates – meet beneath Ethiopia, Eritrea and Djibouti. Known as a tectonic triple junction, it's one of the few places on Earth where the planet's crust is being pulled in three different directions at once.

As these plates drift apart, they create deep cracks called rifts – places where Earth's crust is stretched thinner and thinner until it eventually breaks. It's within these rifts that the discovery was made.

"We found that the mantle beneath Afar isn't uniform or stationary – it pulses," said Dr Emma Watts, a research officer and geologist from Swansea University, who led the study.

To investigate, the research team collected volcanic rock samples from the region and analysed their chemical makeup. The rocks were all Quaternary in age (less than

"We found that the mantle beneath Afar isn't uniform or stationary – it pulses"

2.58 million years old) and from volcanoes that were active during the Holocene, which began 11,700 years ago at the end of the last Ice Age.

What they found was a kind of 'geological barcode' – a repeating pattern of chemical signatures, showing the magma plume rising and falling over millions of years.

In some places the barcode was more spread out than others, revealing that the rifts were channelling the pulsing magma. "The chemical striping suggests

ABOVE Canyons in the Afar Triangle signal the beginning of The Great Rift Valley – a 6,400km-long (4,000 miles) break in Earth's surface that crosses ten countries

the plume is pulsing, like a heartbeat," said Prof Thomas Gernon, from the University of Southampton, who also took part in the study.

These pulses, he explained, behave differently depending on the structure of Earth's crust. In places where the crust is thinner or where the rifting happens faster, such as along the Red Sea, the magma surges travel more easily, like a pulse travelling through an artery.

"We've found that the evolution of deep mantle upwellings is intimately tied to the motion of the plates above," said Prof Derek Keir, also from the University of Southampton and co-author of the study.

"This has profound implications for how we interpret surface volcanism, as well as earthquake activity and the process of continental breakup."



2000T

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A stylized, handwritten signature of 'Jack Ryde' in white ink, positioned in the bottom right corner of the advertisement.



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REALITY

THE SCIENCE BEHIND THE HEADLINES

CHECK



REVIEW

Our meat could soon be gene-edited. Should we be worried?

Genetically edited pork could be on the market within a year.
Here's what you need to know

BBC

For more fact-checking news, visit the BBC's Verify website at bit.ly/BBCVerify

From hot dogs to crispy bacon, American food favourites could be made of gene-edited meat as early as 2026. The US Food and Drug Administration (FDA) recently approved the farming of a specific kind of genetically enhanced pig, and regulators around the world may not be far behind.

Should we be worried? Will the pork be safe to eat? And how ethical is it to create these pigs?

The first thing you need to know is that not every gene-edited animal will be directly spawned from a lab. Rather, such livestock are bred from animals whose DNA has been edited – often when they were at the stage of being a single-cell or fertilised egg – to give them beneficial traits.

The second thing to know is that this gene editing isn't about making pork taste better – it's about protecting pigs from disease.

For instance, British company Genus has now farmed pigs with a genetic tweak that makes them resistant to porcine reproductive and respiratory syndrome (PRRS), a virus that attacks pigs' immune cells. PRRS can kill piglets, trigger miscarriages in



“This tiny change is enough to stop the virus taking hold”

pregnant sows and weaken pigs' immune systems, leaving them vulnerable to other infections.

These genetically edited pigs become even less of a novelty when you consider that there's no vaccine that provides effective protection against PRRS.

The stakes are enormous. In the US alone, efforts to control the spread of PRRS cost the pork industry an estimated \$1.2bn (£878m) every year.

And when the virus does break through, the consequences can be devastating. In 2006, a major outbreak in China infected over 2 million pigs and resulted in the deaths of 400,000 of them.

CRISPR BACON

How heavily are these pigs being altered and at what cost to their welfare? These are fair questions. But in reality, the change is surprisingly minimal.

To stop the PRRS virus in its tracks, scientists snipped out a small section of pig DNA – part of the CD163 protein, which the virus uses to enter pig cells.

Pigs with the edited gene are resistant to almost all known strains of PRRS, but are otherwise, Genus claims, “the same as conventional pigs”. And despite initial concerns that the virus could evolve to recognise and avoid the edited protein, that hasn't happened so far.

According to Dr Christine Tait-Burkard, a Research Fellow at the University of Edinburgh's Roslin Institute, who worked with Genus to develop the original gene-edited pigs, the natural CD163 protein they edited is “like nine beads on a string.” The edit removes only bead number five.

This tiny change, she explains, is enough to stop the virus taking hold, but not enough to affect the protein's other functions (these include helping dispose of damaged red blood cells).

As Tait-Burkard explains, the edit is one that could also be naturally present in some pigs. “The chances are that there's a pig somewhere in the world that's resistant to this virus,” she says. “But we just don't have the time to naturally breed this in. That's where we have to start using biotechnology to integrate it into the breeding herd.”

To make the edit, the researchers employed a gene-editing toolkit known as CRISPR, a Nobel Prize-winning technology now widely used in scientific research for its speed, precision and low cost. The CRISPR toolkit uses a ‘guide’ sequence to target DNA with protein ‘scissors’ – natural proteins, originally discovered in bacteria, that are capable of making the necessary cuts. Minor removals, like those in PRRS-resistant pigs, render certain genes inactive.

THE NEW NORM?

When they reach supermarket shelves, PRRS-resistant pigs are expected to be the first widely consumed gene-edited animals. They won't, however, be the first to reach US plates.

Hypoallergenic ‘GAL-safe’ pork, designed to be suitable for people with red meat allergies, was approved in 2020. And in 2022, the FDA gave the green light to so-called SLICK cattle – cows with an edit based on a natural gene variant found in tropical

ABOVE Unlike cultured meat (pictured here), genetically edited meat isn't produced in a lab, but comes from animals reared on farms

LEFT The PRRS virus is potentially fatal to piglets. But they could be protected with the help of genetic editing

“The current generation of CRISPR-edited food products only contain changes that could naturally occur within the species”

cows, which codes for shorter hair and greater heat resilience. Genetically modified, fast-growing ‘AquAdvantage’ salmon is also available in the US, but is mostly sold to restaurants.

The situation is slightly more complicated on the other side of the Atlantic. Currently, gene-edited foods can’t be sold in the European Union. And the Genetic Technology (Precision Breeding) Act provides a basis for the breeding of gene-edited food in England (but not the wider UK), though it’s only just being implemented for crops.

CHANGING TASTES

But even if legislation changes worldwide, will consumers be lining up to put gene-edited sausages and bacon in their shopping trolleys?

It’s not clear yet how the new gene-edited pork will be labelled. But Dr Katie Sanders, a food systems communication specialist at North Carolina State University, notes that, “there are a lot of folks who think that there’s greater potential for consumer acceptance” with these than compared to other genetically modified foods. She says this is partly because they’re considered more natural.

In the 1990s and 2000s, genetically modified crops generated headlines and consumer concern about ‘Frankenfoods’. Ultimately, though, many GM crops were approved and the majority of scientists consider

BELOW The traditional pork products available from a butchers may soon be joined by those made from genetically edited pigs



by **HAYLEY BENNETT**
Hayley is a science writer based in Bristol

them safe to eat. These modified crops often carry foreign DNA – ‘Bt’ corn, for example, contains a gene from the bacterium *Bacillus thuringiensis*, enabling it to make a protein that kills insect pests.

The current generation of CRISPR-edited food products, by contrast, only contain changes that could naturally occur within the species. Scientists aren’t inventing entirely new kinds of pigs.

Sanders and her colleague, associate professor Jean Parrella, from Texas A&M University, recently conducted a national survey of over 2,000 Americans to gauge how consumers feel about CRISPR-edited pork products. The results are awaiting publication, but Sanders says they suggest men are “more likely to express intent to purchase CRISPR-edited pork.”

Also more likely to express an interest are those living in urban areas (compared to rural areas) and those with lower-level educational qualifications (compared to those with degrees).

Asked how producers could convince more consumers to try gene-edited meat, Parrella says they’ll need to focus on “responsible use and ethical considerations around CRISPR applications”.

Early marketing for PRRS-resistant pigs suggests these considerations are already being taken into account. A division of Genus called The Pig Improvement Company (yes, really) is emphasising improvements to animal welfare, reduced antibiotic use and positive environmental impacts.

Assuming their message takes off, could more gene-edited animals be headed for our dinner tables? Maybe. Scientists at the Roslin Institute are currently working on edits to tackle other livestock diseases, including bovine diarrhoea virus.

But Tait-Burkard explains that engineering resistance to certain viruses, like bird flu, requires too many edits, or edits that would be detrimental to animal cells. She says that the protein they edited for pig PRRS resistance is just “a beautiful target”, the likes of which is hard to find.

For other productivity-related characteristics – such as increased milk production, or meat quality – farming has already developed efficient breeding techniques to achieve these goals. It’s therefore unlikely that expensive gene-editing technologies will be used to create ‘super’ meat anytime soon.

However, if gene editing can protect animals, reduce the use of antibiotics and ease environmental pressures – without compromising their welfare – it may soon become more normal than novelty.





ANALYSIS

Removing microplastics: possible, necessary or just the latest celebrity trend?

Services claiming to clear microplastics from people's bodies have begun to crop up. But how effective are they? An expert explains...

The actor Orlando Bloom recently made headlines when he reportedly paid £10,000 (\$13,600) to have his blood removed so that any microplastics in it could be separated and filtered out. His decision to pay for this drastic treatment highlights the growing worry over an unsettling truth: there's simply no avoiding these minuscule particles of plastic.

They're everywhere, from the top of Mount Everest to the inside of our brains, according to some studies. They're also all over the media and, understandably, the perceived danger of having microscopic flakes of plastic floating around inside us has raised public and scientific concern.

Microplastics are often linked to disease, but the testing for them and their effects is still at an early stage and no scientific consensus has been reached. So should we be worried about what they're doing to

our bodies? And should we be queuing up to get our blood 'cleaned'?

CONTAMINATED SAMPLES

The term 'microplastic' describes any plastic particle or fibre measuring less than 5mm (0.19in) in size. Typically, these particles are so small that we need a microscope to see them.

Scientists also use the term 'nanoplastic' to describe even smaller particles, which is less than 0.001mm (around 40 microinches). These are challenging to see even with advanced microscopes, but evidence suggests they could be released from plastic materials and into their surrounding environment.

Part of my research group's work has been to measure the levels of plastic and other particles in the air we breathe. In London, we've seen microplastics in the air pollution small enough to travel deep into our lungs.

ABOVE There's a growing concern regarding the amount of microplastics that may be accumulating in our bodies

To test whether microplastics are in the body, pieces of whole tissue or blood are processed and then filtered to concentrate any microplastic amounts. Then analysis can take place, either through a chemistry technique, which quantifies the amount of plastic in a sample, or a microscope-based physical chemistry technique – we count the number of plastic particles (and note their size and shape) in a sample.

Each method has its merits, but they both suffer from the same drawback: the modern laboratory is a hotbed for microplastic contamination. It's full of plasticware, plastic consumables and, of course, people. Because of this, the actual process of extracting and testing samples for microplastics can be a source of pollution itself. Often we see microplastic particles in samples that we'd previously thought were too big to be absorbed and distributed throughout the body.

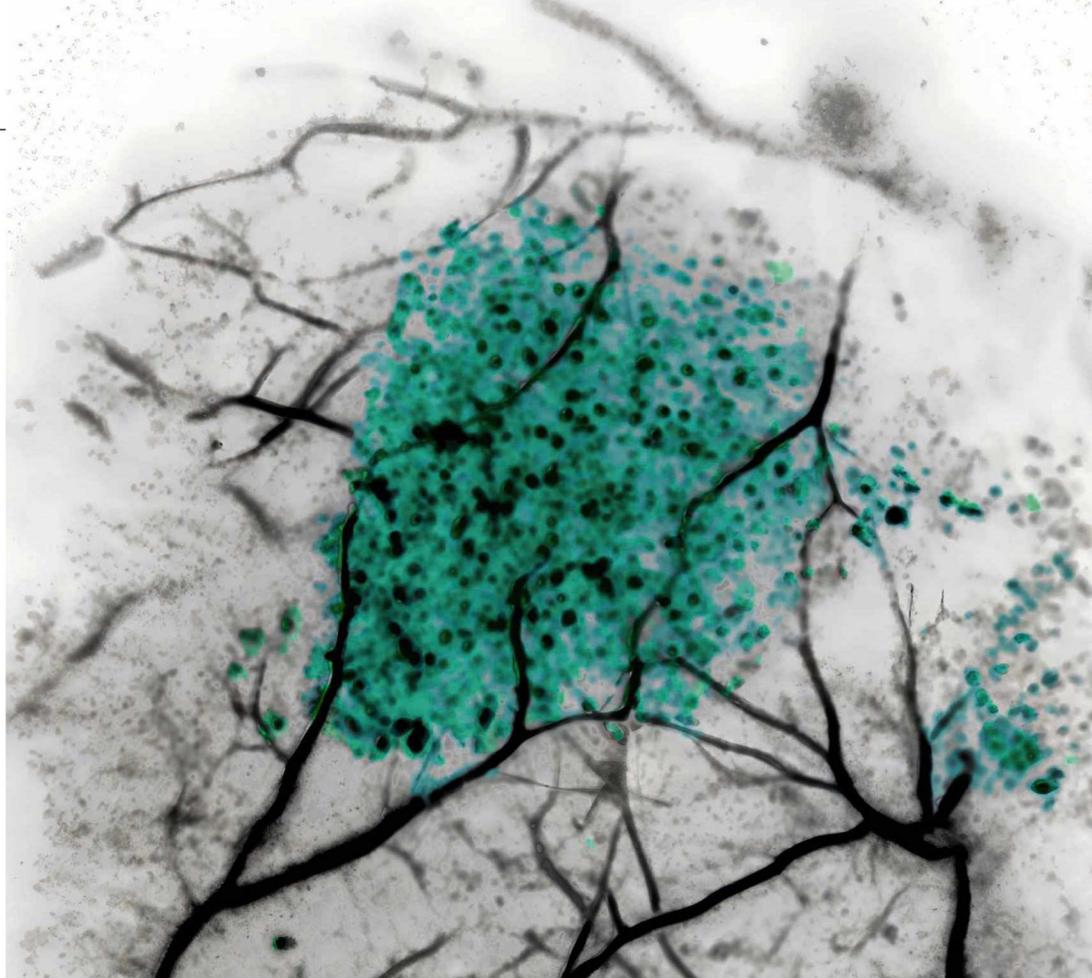
Some reports claim that humans could be ingesting as much as a teaspoon of plastic every day.

Generally speaking, particles smaller than 0.001mm (39.4 microns) can cross through the lungs and enter the bloodstream at the air-blood barrier. This is the thin layer of tissue in the lungs that separates air in the air sacs (alveoli) from blood in the surrounding tiny blood vessels (capillaries). In the gut, microplastics can cross into the lymphatic system – the body's waste removal structure. From here, the smallest particles enter the bloodstream while larger particles become trapped in the gut lining.

Contamination from the lab could therefore provide an explanation for the biggest pieces of plastic found in the body.

Another issue is that some of the biological components in samples generate similar signals to plastics. Specifically, fats interfere with the signals of polyethylene (aka polythene or PE) and polyvinyl chloride (PVC), which can lead to an overestimation of how present these plastics are if a sample isn't adequately processed.

With all this in mind, the high amounts of microplastics reported to be in our bodies are likely overestimated.



Amounts vary significantly from nanograms to milligrams depending on the study, location, tissue type, and analytical method followed.

In a recent rigorous study, a conservative estimate was made that there's around 0.15 micrograms – or 0.00000015g – of plastic per millilitre in our blood. To put that into perspective, that's less than the weight of a single human hair.

Still, it's also worth noting that this study only looked at polystyrene, as it's the only type of microplastic that's easy to test for.

NOT WHERE YOU'D EXPECT IT

Based on these levels, it's probably more important to focus on where the microplastics end up in our bodies, instead of how many of them are actually there.

But again, it's difficult to measure the amount of microplastics gathering in different parts of our bodies. One study, published in *Nature Medicine* this February, for example, suggested the brain is a hotspot for plastic, claiming that it accumulates, on average, 4.5 bottle-caps worth.

Not only are these levels relatively high, but the detected plastic is mostly comprised of polyethylene – one of the plastics that's difficult to measure around fat.

ABOVE This image, the first of its kind, shows the presence of microplastics (in turquoise) in the tissue of a living mouse

RIGHT Therapeutic apheresis machines are used in medicine to process the blood of patients suffering from conditions that involve blood abnormalities. The procedure has also been used to try and remove microplastics

“If there’s a large amount of plastic anywhere in the body, we’d expect it to be in [the liver]”

Hundreds of millions of tonnes of plastic are produced every year. Polyethylene is the main plastic in production globally – around 120 million tonnes are made annually, accounting for 25 per cent of all plastic. It makes sense that we'd see more of this type in the body, generally speaking. The brain is a fatty tissue, however, and false positives can't be ruled out here.

What's more, the study published in *Nature Medicine* suggests there's more plastic in the brain than in the liver, the organ responsible for cleaning the blood. If there's a large amount of plastic anywhere in the body, we'd expect it to be there.

Most published studies on microplastics in human tissue have also looked specifically at samples of whole tissue. This means we're missing important context about whether the microplastics are embedded within cells or are simply 'passing through'.

GROWING CONCERN

Whether we can measure them or not, there's a high level of public anxiety around microplastics. Around two-thirds of 30,000 survey respondents across 31 countries were concerned about microplastics in their bodies.

If you feel like you want to minimise your exposure to microplastic pollution, there are several changes you can make. These include opting for natural, fibre-based textiles in your home and clothing; avoiding plastic packaging wherever possible (especially where heating is involved); and travelling via quiet streets to avoid tyre wear particles from traffic.

But with microplastic release predicted to increase 1.5–2.5 times by 2040, it's inevitable that tech claiming to remove microplastic invaders from the body will start to appear.

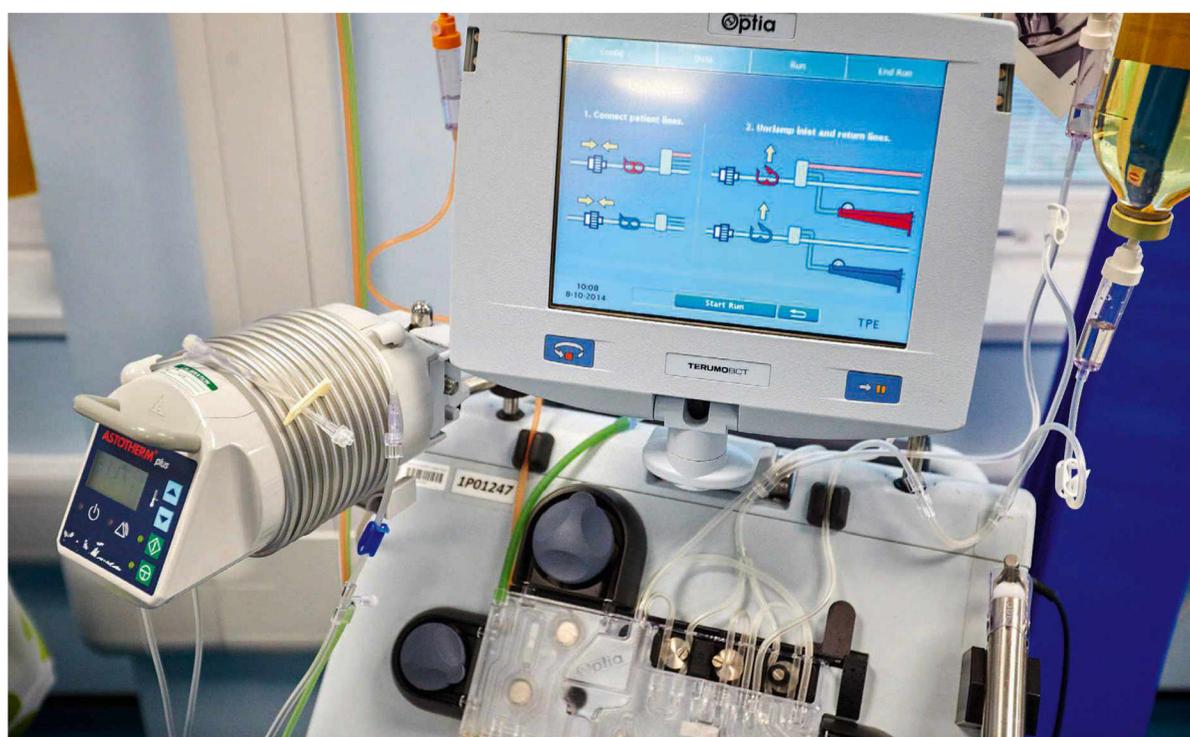
Therapeutic apheresis – a medical procedure that separates blood and selectively removes harmful substances before returning blood to the patient – has recently been commercialised to rid your blood of microplastics.

While there's no published work on this microplastic removal method, German researchers carrying out the procedure detected 'microplastic-like' particles in the plasma of patients. Without information on their lab controls and the sizes of the particles detected, it's difficult to interpret how meaningful the data is, though.

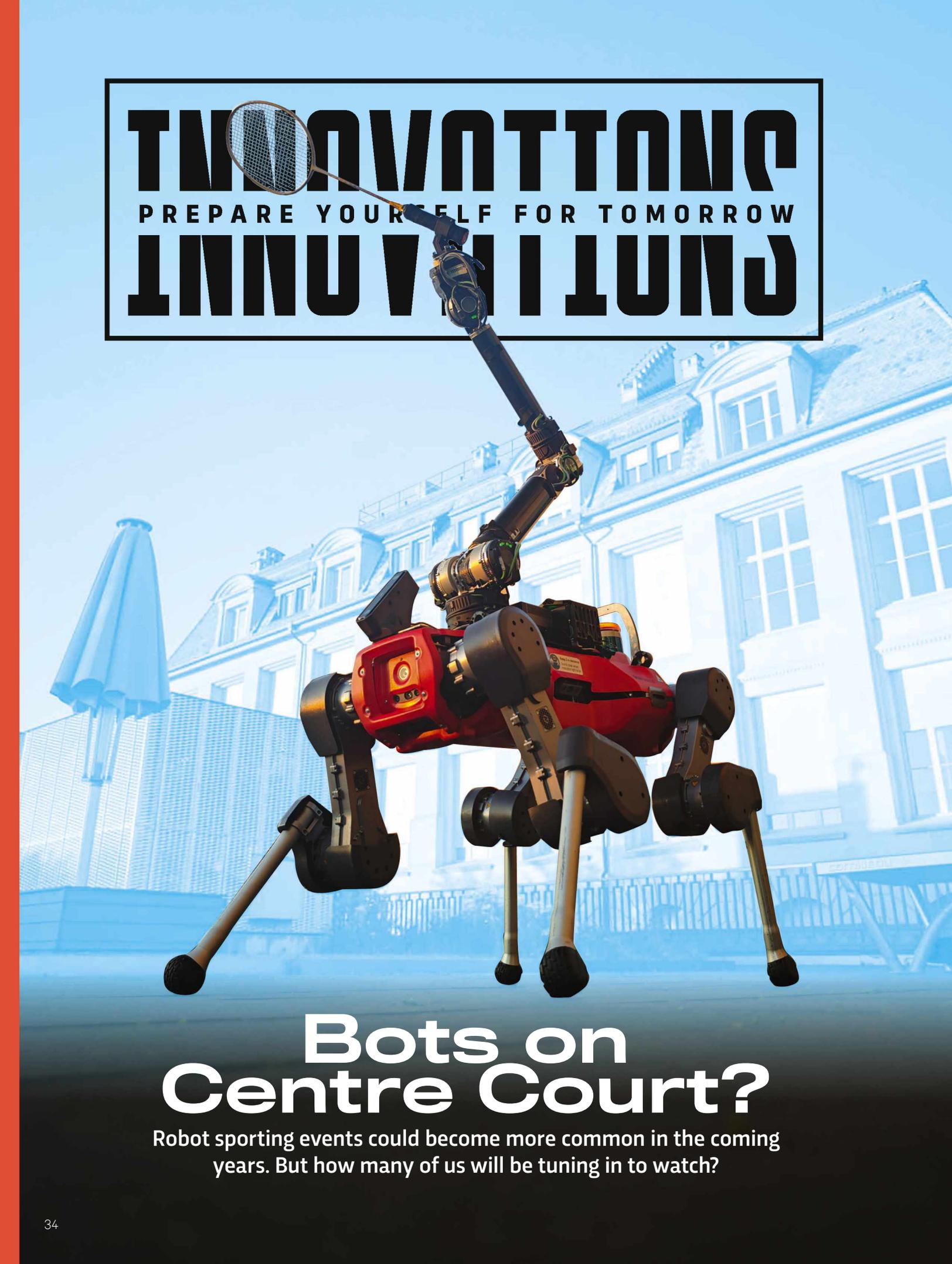
What's more, we don't know how microplastics act in blood specifically. We don't know whether they're freely moving around the body and circulating in our plasma, sticking to our red blood cells, or being engulfed by our immune cells in the bloodstream.

Without concrete evidence on the types of microplastics in our bodies, their journeys or their interactions within the body, it's almost impossible to interpret the health benefits of these 'blood cleaning' ventures.

With all this in mind, until there's been more research assessing the impact of microplastics on our bodies – until we can say where they are and what they're doing – I plan on leaving the blood cleaning services to the Hollywood crowd. **SF**



by **DR
STEPHANIE
WRIGHT**
Stephanie is an Associate Professor in Environmental Toxicology at Imperial College London, and leads the Microplastics Team in the Environmental Research Group at its School of Public Health.



TENNIS INNOVATIONS

PREPARE YOURSELF FOR TOMORROW

INNOVATIONS

Bots on Centre Court?

Robot sporting events could become more common in the coming years. But how many of us will be tuning in to watch?

Researchers at ETH Zurich in Switzerland recently taught the one-armed, four-legged ANYmal search and rescue robot to play badminton against a human.

Fans of the sport may be relieved to learn that ANYmal's skills are unlikely to oust humans from the court any time soon, but training the robot to track and strike the shuttlecock was a complex task and the results are impressive.

"We used methods like reinforcement learning, which is basically where you improve the behaviour of the robot through trial and error," explains the lead roboticist on the project, Dr Yuntao Ma.

"For badminton, perception is one challenge, agile control is another, and the third is to coordinate these two factors," he says.

This is far from the first time robots have been trained to play sports. They've performed dance numbers and gymnastics routines, run marathons and skied, played ping pong and learned to juggle. There's even a football RoboCup.

IT'S NOT ALL FUN AND GAMES

"Sports require skill," says Dr Raffaello D'Andrea, a professor at ETH Zurich who specialises in robotics and artificial intelligence (AI). "If you want to create robots that have dexterity or the ability to cope with the physical environment, you can use sports as a proxy for learning those tasks."

Sports also capture people's imagination and serve as an engaging way to demonstrate new technological advances. Watching a robot successfully return a shuttlecock is more exciting and relatable than a mundane task that requires the same type of action.

"If you play badminton, you know how hard it is to move and hit the birdie to someone else. It gives you a closer connection to the complexity of the skill," says D'Andrea.

These skills can then eventually be put to work in environments that are too 'dull, dirty, or dangerous' for humans, such as autonomous drones that have been trained to take warehouse inventories or the robots used in bomb disposal.

Ma believes that the key to developing truly versatile robots lies in finding ways to bring disparate research together. The recent rapid advances in AI and large language models look set to enable far more collaboration between different robotics communities.

"In traditional robotics, researchers usually focus on one task, like locomotion or navigation, but [large] language models offer ways to merge all these different skills. I think a more generic robot will be the next big thing," Ma says.

It may be a while, however, before we see robot all-rounders coming through, even though the cost of robots and their constituent parts has decreased dramatically in recent years, making it easier for researchers to build and test out

different capabilities.

While this affordability has, in turn, opened up the retail market, robots are still chiefly selling to business customers who know how to program them for specific tasks.

"There's a big difference between writing a research paper and putting out a video online [versus] doing a pilot with a client and rolling out a solution. There are tonnes of videos on the web, but there are very few rollouts," says D'Andrea.

Those solutions are far more likely to land in industry than the sports field, but anyone who even occasionally watches a match knows how much other technologies have already become part of the sporting world.

For instance, computer vision technologies like electronic line-calling (ELC) are replacing line judges in games such as tennis and cricket, but it's debatable whether this improves the spectator experience. For the casual punter, much of the joy of sports is in its human unpredictability.

WHAT WOULD BE THE POINT?

If a robot tennis player eventually takes Centre Court at Wimbledon, it might score as many match points as novelty points but, after a while, would anyone want to watch it? "People are entertained by watching sports because they connect to the athletes. Anything that replaces these athletes with robots is not going to be a success," says D'Andrea.

The same is likely true for anything where human emotion plays a central part. For more than two decades, the Japanese government has invested billions of yen in developing robots for use in residential care homes for the elderly.

While well-intentioned, uptake has been limited, and the evidence so far suggests the robots create more work for carers than they alleviate.

There's a difference between pushing the boundaries of technology and finding ways to test the limits of what robots can do, and applying those technologies in the wrong places.

So, for now, sportspeople can rest easy. "I think we have to be careful that we don't go too far for the sake of efficiency", says D'Andrea. "I would ask the question: why do we want to replace the people?"



TOP Cameras using Hawk-Eye tech replaced human line judges at Wimbledon

MIDDLE Robots compete in RoboCup in China

BOTTOM A resident of a Japanese nursing home plays with a nursing-care robot

by **CARRIE M KING**
Carrie is an Irish tech writer based in Berlin.

The next hot trend in COOKING TECH

From air fryers to spiralisers, kitchen gadgets come and go. But the newest multi-purpose countertop cookers are vying to be more than just the latest must-have consumer item. Thanks to their versatility, they're looking to be a viable alternative to the traditional stove and oven combination

by VICKY WOOLLASTON

Small but mighty

If you've ever wondered what makes restaurant food so juicy, it's likely to be steam cooking. Steam ovens are common in pro kitchens because they cook food quickly without drying it out. Steam carries more heat energy than dry air and as it condenses on the food, it releases this energy directly onto the surface, cooking food faster and more evenly. Smeg has built a steam cooker into a combi oven and made the whole thing small enough to sit on top of a counter. Inside, a water tank connects to a boiler system. Choose the steam function, and the



boiler heats the water and releases steam into its 30-litre cooking chamber.

You can also combine steam with fan heat for crispy roast joints, potatoes or bread, or use one of the oven's 10 other functions, including air frying, baking, grilling and defrosting. Its 33 automatic programmes can feel overwhelming, but clear controls and steam-cleaning keep it user-friendly. Compared to a regular oven, the Smeg's smaller cavity heats up faster and uses less energy. Smeg 10-in-1 Countertop Combi Steam Oven £849.95, shop.smeguk.com



A clear winner

There are several features that make the Daewoo stand out in the busy air fryer market. First, is its see-through glass cooking chamber, which gives you a 360° view of your food as it cooks (no need to open the drawer and lose heat while checking on your food).

Second, is its huge 12-litre cooking chamber, which can be enlarged to 17 litres with the extender ring. While larger countertop ovens like the Smeg and Gastroback offer more capacity overall, it's rare to find such volume in a dedicated air fryer. Most basket models top out at around 10 litres.

This space, combined with the adjustable racks, lets you roast an entire chicken or prepare a full meal in one go.

Finally, unlike standard air fryers that use a fan with a coiled metal heating element, the Daewoo pairs its fan with a halogen bulb, which heats up quicker than a coil. Also, the intense heat it generates means your food can be crispy on the outside and moist on the inside. But beware: it's easy to overcook your food. Also bear in mind that halogen air fryers are not always as energy efficient as regular basket versions. Daewoo Halogen Air Fryer Oven £39.99, daewooelectricals.com



Put a lid on it

Air fryers have always been efficient and versatile cooking appliances. But manufacturers have added so much functionality to them since they first appeared that some of the latest air fryers can all but replace a traditional stove-top and oven. Take the Ninja Foodi 9-in-1 for instance. As well as air frying, it offers eight other cooking modes, including pressure cooking, steaming, grilling, sautéing, dehydrating and yoghurt making. To handle these, it comes with two lids: a pressure lid and a crisping lid. The pressure lid seals the pot to create high-

pressure cooking, while the steam mode uses the same lid but with the vent open.

For things like air frying, roasting and dehydrating, the crisping lid's heating element and fan blow hot air around food to brown it. A bottom heating element provides gentle heat for slow cooking and yoghurt, or direct heat for searing and sautéing. It's a heavy appliance and takes up a lot of counter space, and switching lids mid-recipe can be fiddly. Still, its energy-saving potential is strong, but only when used for family-size meals. Ninja Foodi 9-in-1 Multi-Cooker £249.99, ninjakitchen.co.uk

Pizza without the flames

Wood-fired pizza ovens have been benefiting from style and structure updates in recent years and found their way into many more people's gardens as a result. But if you don't have a garden (or simply prefer to start cooking by flicking a switch rather than igniting wood), an all-in-one countertop oven could offer the quick cooking and fluffy-yet-crispy crusts you seek.

The Gastroback Design Oven Air Fry & Pizza has six heating elements, four at the top and two at the bottom, which can be controlled separately for different functions and precise heat control. Air frying, baking, roasting, dehydrating and defrosting use all elements coupled with the built-in convection fan.

The upper elements are for browning and grilling, the lower ones for reheating or cooking pastries, and you can use either for toasting bread and buns. Removing the racks and adding the rotating spit turns the Gastroback into a rotisserie oven, or you can use the ceramic pizza stone and

the top heating elements for pizzas. With its 22-litre cooking chamber, the Gastroback heats up faster than a larger, conventional oven. These energy savings are greatest when used for smaller dishes or quick meals, but it may be less efficient if used solely for toasting or reheating food that could be done with a smaller appliance.

The sacrifice you make for the Gastroback's countertop size is that it won't handle the kind of large dishes a more traditional, 60-litre oven can. And with so many functions and icons, not to mention accessories, getting to grips with using it can feel intimidating at first.

Gastroback Design Oven Air Fry & Pizza £229.90, gastroback.co.uk



EDITOR'S PICKS...

This month's smartest tech

WHY THE CHAISE-LONG FACE?

This sofa makes me hate my sofa, which is particularly vexing since I've only just finished paying for the thing. The Jasper from King Living, a company new to the UK, is a modular, steel-framed sofa that snaps together into multiple configurations (including a bed!). The structure uses a metal suspension system to support your weight (a bit like a car), so it should remain supple for as long as you own it – unlike the creaking, glued-together bits of tree and tape taking up space in my living room. The Jasper also has options for wireless charging surfaces, media consoles and reading lights, making my sofa look like it was designed on papyrus by candlelight. King Living Jasper Modular Sofa From £2,990, kingliving.co.uk





↑ ...A GOOD FOOTING

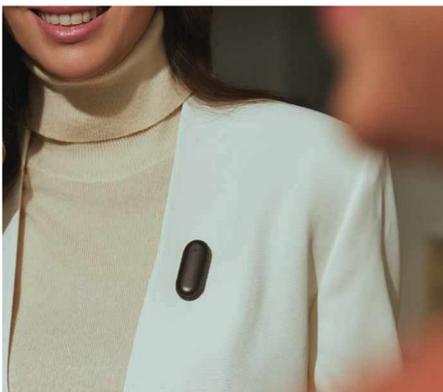
To my fellow wide-footed people, these are the shoes for you. Figures vary, but most studies put the number of us with feet wider than the shoes we squeeze them into at around 50 per cent. While Flower Mountain doesn't make shoes specifically for the broad-pawed, the company's clever design choices make these the most comfortable things I've ever put on my feet. Inspired by nature, the shoes use a cork insole, which is naturally antibacterial, moisture-wicking, and moulds to your foot over time. They're a hiking hybrid shoe, so the tread is tough and knobbly, the laces elastic and the uppers are made out of natural materials where possible.

Flower Mountain Yamano 3
From £195, flowermountain.com

↓ ...MIC DROP

Just in case you feel like you haven't handed enough personal data over to tech companies, you can wear this AI-infused recording device. At the push of a button, it will listen to your conversation, transcribe and summarise it for you. Inviting AI to your meeting to take notes is a fast-growing trend in offices, which makes a device like this the natural next step. As a journalist, this contraption could be a lifesaver at busy trade shows and conferences.

Plaud NotePin,
From £149.90, uk.plaud.ai



↑ ...MUCH ADO ABOUT NOTHING

These look like something an astronaut might wear on the space station. As is Nothing's way, these headphones are built from the ground up to try to give users the best trade-off between value and performance. There's pretty much every option when it comes to connectivity: hi-res Bluetooth, USB-C for lossless audio and even a traditional 3.5mm headphone port. The spec sheet promises an impressive 80 hours between charges (without noise cancelling on) and physical controls on the cans. We haven't had the chance to try a pair yet, but since they're engineered in partnership with British hi-fi stalwart Kef, our expectations are high.

Nothing Headphone (1)
£299, nothing.tech

↘ ...A SECURE GETAWAY

It's holiday season and it's time you upgraded your dinky luggage padlocks – you've probably lost the keys anyway. Cue the SmartLock



Tracking Device luggage lock, which works with Apple products using the company's Find My app, so it'll ping you if you lose your suitcase or you can't find it at an airport. It will send you the location (on a map) where it lost contact with your phone, and use nearby phones with Bluetooth to tell you where it might currently be. If you're in Bluetooth range, but can't see the lock, the app can get it to make a noise and will tell you what direction (and how far away) your lock is.

Key | SmartLock Tracking Device
£23, getkeysmart.com

↓ ...POOP SHOOT

Imagine the scene. It's the morning after the night before and you've just finished your morning ablutions. You head to the kitchen in search of something caffeinated when you get a text message: your toilet wants to talk about last night. No more takeaways or wine for a while, please. Throne, an AI-assisted camera that analyses poo from the underside of the toilet lid, will give you advice on your diet and hydration based on what it sees.

Throne
€399 (£343), throne-science.com



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DEAFNESS AND DEMENTIA... WHAT HAVE YOU HEARD?

by TOM IRELAND

THERE'S A LOT OF NOISE BEING MADE ABOUT A POSSIBLE LINK BETWEEN HEARING LOSS AND DEMENTIA. BUT WHAT DOES THE SCIENCE HAVE TO SAY?

In recent years, there has been a huge surge of interest in the link between our hearing and our chances of getting dementia.

Stories in the press have suggested that up to a third of dementia cases may be caused by hearing problems. TV doctors are telling viewers that having a hearing test can help prevent the syndrome, while adverts for hearing aids are claiming the devices can slow cognitive decline.

But, as so often is the case, the relationship between our hearing and our brain health is complex. And while there are clear benefits to treating hearing loss, the evidence that hearing aids can prevent dementia isn't quite what it seems.

FINDING A CONNECTION

Studies linking the decline or loss of senses to poorer cognitive ability date back to the 1990s, when a research project known as the Berlin Aging Study first found an association between declines in hearing or vision and declining brain or cognitive function. But recent interest in the link between hearing and dementia can be traced back to a major report called 'Dementia Prevention, Intervention and Care', published in *The Lancet* in 2017.

The widely-read report declared for the first time that hearing loss was the biggest 'modifiable risk factor' for dementia. In other words, something that contributes to our chances of getting the disease that we can do something about (unlike our genetics or family history). The report suggested that hearing loss might play a bigger role in dementia than poor diet, lack of exercise, poverty or social isolation – and that treating it could prevent as many as eight per cent of dementia cases worldwide.

Although the report acknowledged that the exact nature of the link was unclear, the idea that hearing loss actually *causes* dementia has since become hard-baked into public discussions of both health problems. With the number of cases of dementia predicted to triple by 2050, members of

the public and health professionals alike are desperate to find ways to reduce the prevalence of this harrowing cognitive condition – and hearing looks like it could be one of the easier risk factors to fix.

A COMMON PROBLEM

The trouble is, it hasn't actually been proven that hearing loss causes dementia, or how one might lead to the other. As many as two-thirds of people over 65 will experience hearing loss, meaning a huge proportion of people with dementia will have had hearing loss first. This large statistical association means studies like 'Dementia Prevention, Intervention and Care' rank it as a major risk factor,

even though it might not necessarily be an important factor to any one person.

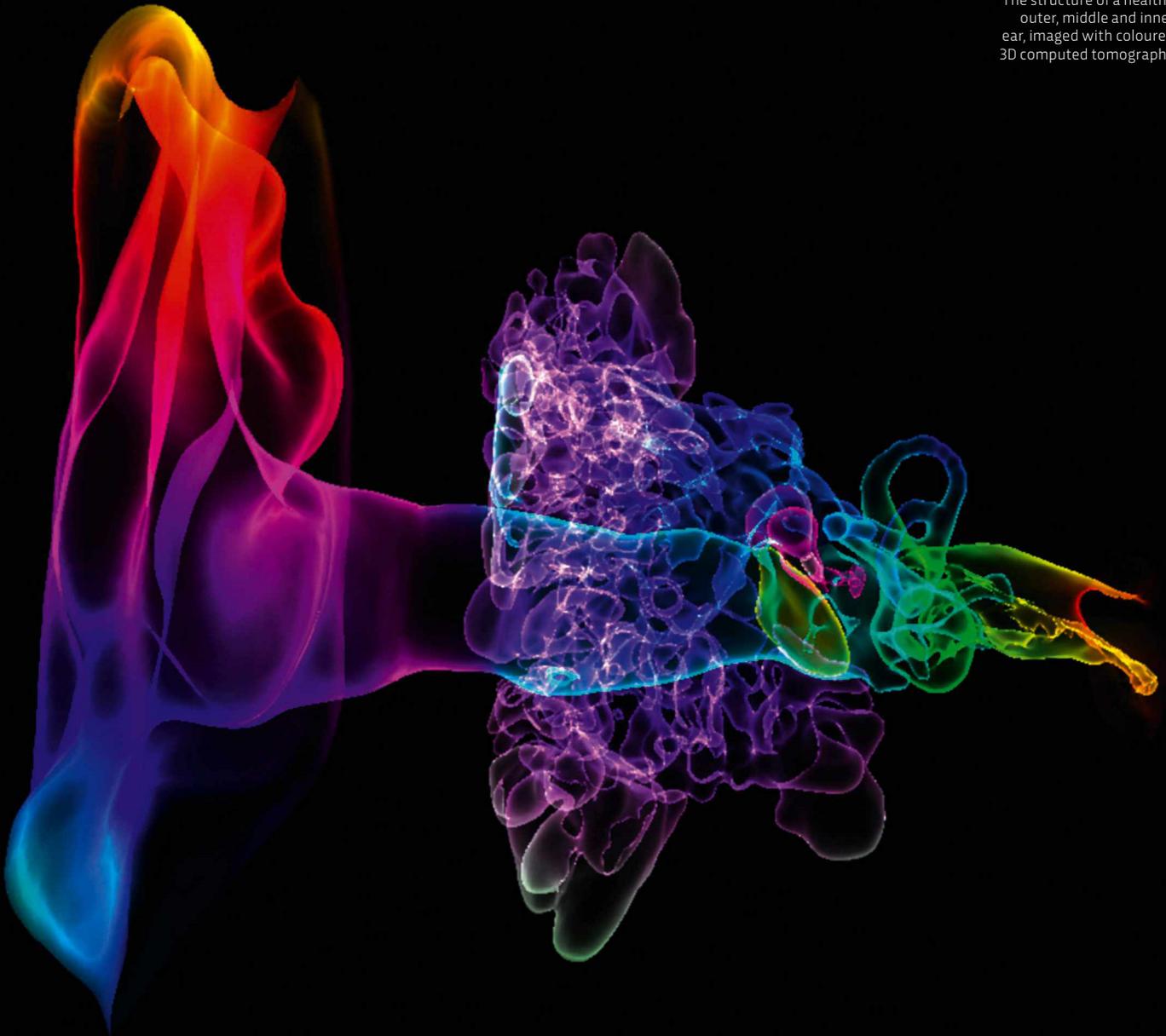
"Because hearing loss is so common, it appears to be the biggest risk factor," says Dr Jenna Littlejohn, a research associate at the University of Manchester specialising in dementia and hearing loss. "But that doesn't mean it's the main or most likely cause to you as an individual. It's misleading to people who don't know much about statistics or epidemiology."

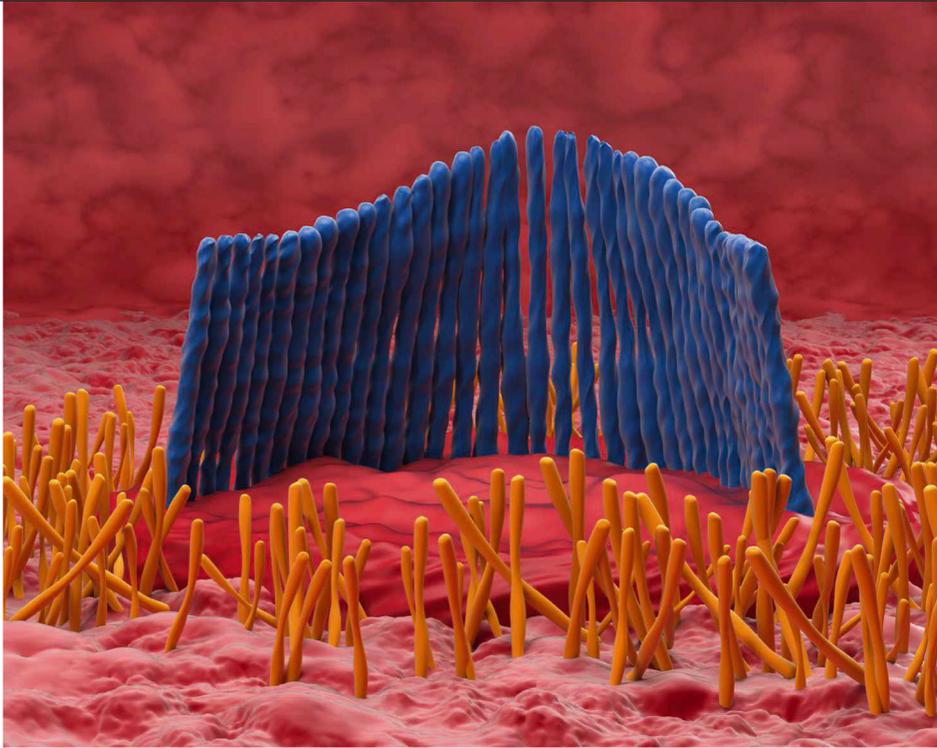
Hearing involves a complex sensory pathway that starts with the delicate structures of the outer and middle ear, continues into the sensitive organs of the inner ear, and then into the neural network that takes sound to the brain

and deciphers what's heard. Age-related hearing loss, known as presbycusis, is often caused by the slow breakdown of the fine hair cells that help convert vibrations of air in the middle ear into electrical signals, but can also be caused by the decline of function in any other part of the hearing pathway.

There are several theories as to how hearing loss might contribute to cognitive decline and dementia. The first, and most intuitive, is that not being able to hear properly causes people to avoid conversations and withdraw from social life, increasing their risk of depression and reducing the amount and variety of stimulation their brain receives. These

The structure of a healthy outer, middle and inner ear, imaged with coloured 3D computed tomography

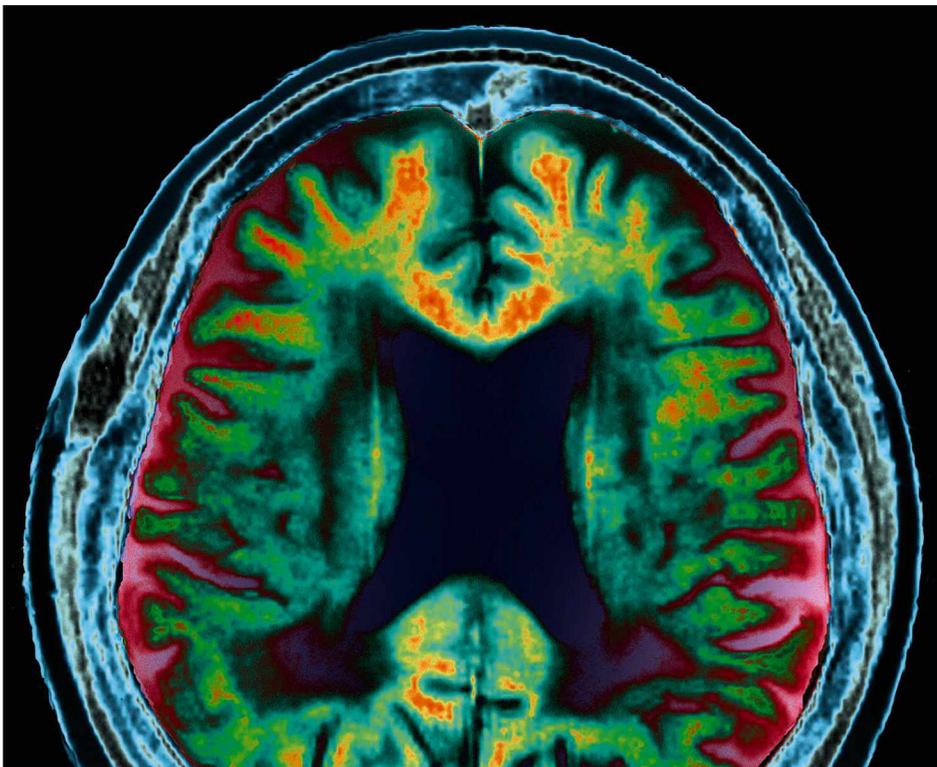




LEFT Stereocilia hairs (in blue) are found in the inner ear. They pick up vibrations caused by sound and convert the movement into signals that the brain interprets

BELOW LEFT An MRI scan of a brain with Alzheimer's. The condition destroys brain tissue, leading to abnormally deep folds and enlarged fluid-filled ventricles (centre, black)

“THE PHYSIOLOGICAL CHANGES IN THE BRAIN THAT CAUSE DEMENTIA CAN APPEAR UP TO 20 YEARS BEFORE A PERSON GETS A DIAGNOSIS”



factors – depression and low stimulation levels – are both known to increase the risk of dementia.

Another theory is that when a person has poor hearing, their brain has to do far more work to figure out what's being said – increasing the brain's 'cognitive load'. Listening, especially following speech, becomes an effortful and stressful process, which reduces the amount of resources the brain has for other processes, such as memory or reasoning. It's no surprise, then, that this results in worse scores on cognitive tests.

Others think there could be a more direct physiological link. For example, some studies have shown that age-related hearing loss results in a decrease in overall brain volume, or an increase in the rate that the brain shrinks with age. The 'use it or lose it' theory of development suggests that a lack of stimulation may cause the sound and language processing centres of the brain to wither. The knock-on effects on other parts of the brain then compound normal cognitive decline.

WHICH CAME FIRST?

But there are other possible explanations for the numerous studies that have shown that people with untreated hearing loss can be between two and five times more likely to get dementia, depending on the severity of the deafness.

One is the possibility that many people with hearing loss may have already had very early-stage, undiagnosed dementia, before being diagnosed many years later.

“The physiological changes in the brain that cause dementia can appear up to 20 years before a person gets a diagnosis, so in a study, it's hard to say for sure that a person's hearing loss truly preceded their dementia,” says Littlejohn. “It could even be that early, undiagnosed dementia is actually causing the hearing loss – what we would call reverse causation.”

Given that some of the early signs of hearing loss and cognitive problems are similar, people with hearing loss may also be more likely to be diagnosed as having some degree of cognitive decline. For example, if someone is having trouble keeping up with conversations or repeats things that have already been discussed, it could be caused by problems with their memory, but it could also be because they didn't hear it properly in the first place.

Even if studies are able to prove conclusively that more people get hearing loss first and then go on to get dementia later, there could be an unknown factor that's causing both. This issue might be, for example, a disorder that affects both the neurons of the ear and the brain, but becomes apparent in the ear first because it's so delicate and has a single, easily measurable function.

It's for these reasons that Littlejohn is sceptical that hearing aids could ever be used to prevent dementia on a grand scale: by amplifying sound, they only treat the symptoms, not the cause, of hearing loss. "If it's found to be the case that there's a physiological reason that hearing loss leads to dementia, hearing aids don't treat that underlying physiology," she says.

HELP FROM HEARING AIDS

Plus, the research from clinical trials is simply not that strong. The most commonly cited evidence that hearing aids can prevent dementia is a study known as the Aging and Cognitive Health Evaluation in Elders (ACHIEVE) trial. It followed almost 1,000 people in the US aged 70–84 for three years, comparing whether those who received regular hearing assessments had less severe levels of cognitive decline.

The findings that many researchers have focused on is that a small subset of people, marked as already having a high risk of dementia, appeared to have reduced levels of cognitive decline after receiving hearing aids. However, the main findings of the trial were actually negative: there was no evidence that using hearing aids reduced cognitive decline in the much larger, healthier group of people studied.

"For every study that's found that people do better with hearing aids, there are others that found there's no difference, or they do worse," says Littlejohn.

Interestingly, the most recent update of *The Lancet's* 'Dementia Prevention,



“FOR EVERY STUDY THAT’S FOUND THAT PEOPLE DO BETTER WITH HEARING AIDS, THERE ARE OTHERS THAT FOUND THERE’S NO DIFFERENCE, OR THEY DO WORSE”



LEFT Prof Kevin Munro of the University of Manchester

BELOW LEFT Hearing aids amplify sounds to make them easier to hear, they don't treat the cause of the hearing loss

hearing has a proven link to our quality of life, and hearing aids undoubtedly help keep us active, engaged, independent and therefore healthier as we age.

Kevin Munro, a professor of audiology at the University of Manchester, is trying to change the narrative about why people should get regular hearing tests. “Dementia frightens the life out of people, and reports like ‘Dementia Prevention, Intervention and Care’ want to paint a positive picture, to say that there are things that can be done,” he says. “But we have to be careful about how we explain this to members of the public. I get calls all the time now from people completely worried, saying ‘I’ve seen a poster saying untreated hearing loss causes dementia’, and ‘my doctor never told me this’... I’m spending a lot of time trying to undo this misinformation.”

Munro is concerned that people might be frightened into buying hearing aids or avoid hearing tests if they believe it will reveal dementia – or that health professionals will focus on hearing at the expense of other important risk factors. He’s now working with audiologists and hearing aid providers to help them communicate the complexities of this link more carefully.

Meanwhile, researchers like Littlejohn are designing more sophisticated studies to get a clearer understanding of how different types of hearing loss contribute to the many different types of cognitive decline and dementia people might get. Others are looking at how loss of sight seems to have a very similar effect on dementia risk as a loss of hearing. And a study published in June 2025 has suggested that sleep disorders might exacerbate hearing loss – with all of the same caveats above applying to this new, complex and understudied link.

The message Munro wants to get out there is clear: getting your ears tested, and any hearing problems sorted, will only benefit your happiness and health. But don’t bank on it as an easy way to save you from dementia in the future. →

Intervention and Care’ report, published in 2024, revised the relative role of hearing loss in dementia down, while those of other factors such as depression and diabetes have risen. The World Health Organization still doesn’t publicise hearing loss as a major modifiable risk factor at all. Instead, being physically active, not smoking, maintaining a healthy diet and avoiding harmful use of alcohol are all considered more important factors in reducing your chances of getting dementia.

Still, being able to hear properly remains an important part of staying healthy. Our



RISK MANAGEMENT

Your age and genetics are the biggest risk factors when it comes to dementia and, unfortunately, you can't do much about either of them. You can do something about your so-called 'modifiable' risk factors, however. To be clear, these risk factors don't necessarily cause dementia – they're just strongly correlated with the disease.

Generally, people in good physical and mental health are more able to withstand the slow, underlying damage that causes the symptoms of dementia.

Below you can find the top five* modifiable risk factors for dementia, all of which are ranked as higher relative risk factors for dementia than hearing loss.



DEPRESSION

Like other risk factors, the link between depression and dementia is complex. Depression might cause lifestyle changes that worsen dementia risk (like substance abuse or social isolation), or there might be a more direct cause. People may also be more likely to be depressed when in the early stages of cognitive decline.

TRAUMATIC HEAD INJURY

There's good evidence that a major injury to the brain increases the risk of dementia later in life. Many neurologists say that wearing a helmet when cycling is one of the best things a person can do for their brain health.

DIABETES

Diabetes is one of a cluster of risk factors related to cardiovascular health that increase dementia risk. Poor diet, high cholesterol, obesity, heart disease, infrequent exercise, diabetes and stroke are very closely linked to one another and all raise the risk of dementia.

LESS EDUCATION

It's unclear why people with higher quality education, and higher educational attainment, have a reduced dementia risk. It may be that they go on to do more mentally stimulating jobs and activities, which has a protective effect on the brain, or it may be linked to poverty/lifestyle in those with low education levels.

INFREQUENT SOCIAL CONTACT

Another risk factor where the nature of the link is unclear. Does infrequent social contact cause depression, which then increases dementia risk, or does it more directly cause dementia through a lack of mental stimulation? Or is the link due to people socialising less when their brain starts to decline?

*Based on relative risk – the likelihood of developing a disease in an exposed group compared to an unexposed group

by TOM IRELAND

Tom is a freelance science journalist and editor of *The Biologist*, the bi-monthly magazine of the Royal Society of Biology.



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THE OTHER

We're discovering there were more characters, and more acts, in the tale of how *Homo sapiens* spread across the globe

by DR REBECCA WRAGG SYKES

HUMANS

The BBC Two logo, featuring the letters 'BBC' in a grid above the word 'TWO' in a larger, bold font.

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It all used to be so simple. The story of how we – that is *Homo sapiens*, today's humans – emerged from Africa and spread across what's become Europe and Asia was a neat, straightforward narrative.

It began around 50,000 years ago when our brains experienced a lightbulb moment of advancing cognition and creativity, stimulating our ancestors to journey beyond our cradle continent. When they reached Eurasia, around 40–30,000 years ago, they encountered another group of humans, a distinct type we now refer to as Neanderthals.

Shortly after that, the Neanderthals disappeared and we, *H. sapiens*, stood alone in their place, monarchs of a planet devoid of competitors.

This 'Out of Africa' story allowed us to frame ourselves as the successful colonisers, the evolutionary winners, the masters of the planet. But the past few decades of archaeological developments have shown us that it probably didn't happen like that.

We still believe, based on current fossil and DNA evidence, that Africa was where our species first emerged, before spreading farther afield. Almost everything else, however, has changed.

Today, we're looking at a chronicle of human evolution that's a lot less simple, but far more interesting. This

new perspective is one where Earth was, until recently, considerably more crowded with hominin relations than we imagined – a place where our species wandered more widely, and earlier, than previously thought, and now looks more like an accidental survivor than pre-destined conqueror.

UNKNOWN, BUT FAMILIAR RELATIVES

To understand all this, it helps to go back a bit. By the mid-20th century, a hundred years of astonishing discoveries and scientific study had recast the place of humans in nature.

“THE STORY OF *HOMO SAPIENS* WAS MORE OF A PUZZLE THAN WE FIRST THOUGHT”

Rather than something entirely distinct from other animals, we seemed instead to be the result of an extended evolutionary experiment.

This recasting began with the placing of Neanderthals in our genus *Homo*, after the first remains were found in Germany in 1856, forcing us to recognise unknown-yet-familiar relations. Then, in the 1890s, came *Homo erectus*, a much more 'primitive'-looking relative found in East Asia. They were followed by *Homo heidelbergensis* in Europe and, by the 1920s, the first of the diminutive, more chimpanzee-like australopithecines from Africa.

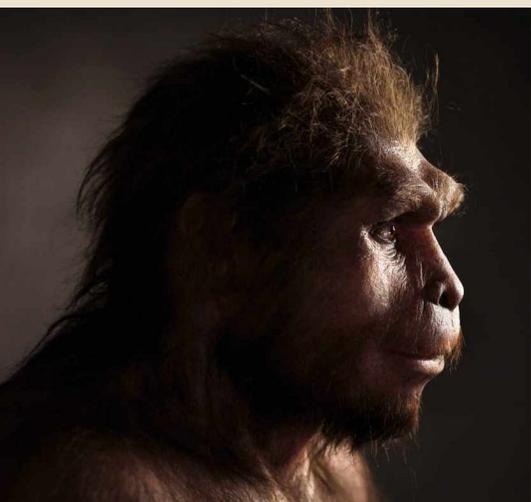
The early 1930s saw Neanderthals identified in the Levant region of the eastern Mediterranean, at Tabun Cave (within then-British Mandatory Palestine), while at a site called Skhūl in the same region, around the same age, there were skeletons that looked much more like *H. sapiens*, even though their stone tools were virtually identical to those of Neanderthals. With no means to date such discoveries (radiometric methods wouldn't emerge until the 1950s), contrasting theories to explain the Skhūl findings began to swirl. Was this evidence for a single, contemporary yet highly variable population; some kind of regional branching; or even interbreeding? Only one thing was clear: the story of *H. sapiens* was more of a puzzle than we first thought.

A LONGER, MORE COMPLICATED HISTORY

Further pieces of the puzzle were unearthed towards the end of 20th



“ALMOST NONE OF THESE EARLY ADVANCES INTO EUROPE LED TO PERMANENT SETTLEMENT”



LEFT A reconstruction of *Homo erectus* based on fossil evidence found in Indonesia, which dates back to between 1.3 and 1 million years ago

century and during the start of the 21st. The 1990s saw a skull similar to the Skhūl remains, but dating to around 150,000 years ago, found in Ethiopia's Herto study area, and the past 15 years have seen fossils twice that age excavated from Jebel Irhoud, Morocco. By integrating these with other remains from 350–100,000 years ago, a new vision of the emergence of *H. sapiens* has developed.

While past debates focused on whether we evolved in East or South Africa, a new model proposes that *H. sapiens* didn't have a single 'homeland'. Instead, we gradually evolved from diverse roots within a large 'meta-population' that extended across much of the continent, and within which distinctive traits like our globe-shaped skulls developed.

This move towards a 'slow-cook' materialisation of our species in Africa between 350-200,000 years ago happened alongside a lengthy accretion of discoveries of *H. sapiens*



in Eurasia. With each new find, researchers reconfigured their understandings.

Evidence for an early *H. sapiens* presence in the Levant began to grow in the 1970s. Archaeologists had returned to a site in Israel originally excavated in the 1930s, named Qafzeh, and found skeletons, but also clear signs of burial rituals involving pierced shells and pigments.

At that time, the idea that the Qafzeh and Skhul sites might not be much older than about 40,000 years was uncontroversial. But when pioneering dating methods that could be used on materials older than radiocarbon dating (which has a limit of around 55,000 years) were applied, it turned out that the Qafzeh bones dated back to around 90,000 years ago. The Skhul remains were yet older still, well beyond 100,000 years. Their location in the most obvious pathway out of Africa meant that the antiquity of humans in Eurasia had effectively doubled.

Yet without other similarly ancient *H. sapiens* sites on the continent,

ABOVE LEFT

Neanderthals (depicted here) had been established in Europe long before *Homo sapiens* arrived

ABOVE A cast of one of the skulls with *Homo sapiens*-like features found at the Skhul site in Israel

ABOVE RIGHT Mount Carmel in northern Israel hosts a number of caves, including Tabun and Skhul, which contain remains of early humans

these finds were largely viewed as evidence of a temporary excursion from Africa, rather than a colonisation by a different species. And however prevalent *H. sapiens* may have been in the area at that time, they were soon replaced by Neanderthals.

Fast-forward to the present, however, and the Skhul and Qafzeh findings now look less like anomalies and more like one act in a much longer drama of hominin population dispersals going back 2 million years (see ‘The first explorers’, p54).

Even more surprising, almost none of these early advances into Eurasia seem to have led to permanent settlement or a genetic legacy in living humans.

EVIDENCE ELSEWHERE

While much attention has focused on Africa, Europe and the Levant, the potential for an ancient presence of *H. sapiens* farther east into Asia and beyond has also begun to accumulate.

The Lake Mungo site, in Australia, has a reputation for smashing expectations concerning the antiquity of human presence on that continent. When it was found in the 1960s, it was expected to date no further back than 20,000 years, aligning with the belief that the major expansion of *H. sapiens* into Eurasia only happened around 10,000 years earlier.

Yet this was shown to be a huge underestimation: dating for the male ‘Mungo 3’ skeleton is around 45–40,000 years ago. This information, coming in the early 2000s, seemed to establish an extremely rapid movement of *H. sapiens* across Eurasia and was further reinforced when archaeological remains from the Madjedbebe rock shelter, in Australia’s Northern Territory, were dated to 65–55,000 years ago.

Where did those early Australians come from? At least one East Eurasian hominin contemporary of Neanderthals has been identified – the Denisovans – but tracing the presence of early *H. sapiens* in this region is tricky. The implications from Australia are that north-western Sahul (the ancient landmass that connected Papua New Guinea, Australia and Tasmania when sea levels were low enough) must have been reached well before 50,000 years ago.

But East Asia is a vast area where researchers are still working to establish solid anatomical identifications



and dating for a number of hominin remains. At present, there are claims of remains from Lida Ajer in Sumatra (dating back to around 73–63,000 years ago) and Tam Pà Ling in Northern Laos (dating back to around 77–50,000 years ago). China also appears to possess a number of sites containing *H. sapiens*-like bones ranging from 120–70,000 years old, but many uncertainties exist.

In 2018, a fragment of finger found in Saudi Arabia pointed to *H. sapiens* being present there around 90–86,000 years ago. The discovery hints that

ABOVE A map showing the broad direction of *Homo sapiens* dispersals beyond Africa

BELOW Profs Rosa Huguet (left) and Juan Luis Arsuaga examine a fragment of jawbone found at Sima del Elefante, in Spain, which may be the oldest remains of a human ancestor yet discovered in Europe

early movements beyond Africa flowed through more than one route: landwards through the Levant, but also along coastal paths around the Persian Gulf. We have no DNA for any *H. sapiens* remains dating beyond 50,000 years ago, however, meaning it's difficult to determine how all those ancient populations relate to each other.

Complicating things further is the fact that even older *H. sapiens* fossils keep being found. A bone from the Misliya Cave, in Israel, has been dated to around 180,000 years ago, while a skull cemented into rubble inside a fissure in Greece's Apidima Cave dates back over 210,000 years. These remains are astonishingly old and most researchers interpret them as clues that more than one dispersal of *H. sapiens* occurred.

RIPPLES BEFORE THE WAVE

But for the time period after 70,000 years ago, we're beginning to discern details. Most significantly, genetics from early *H. sapiens* remains, combined with those from living humans, tell us that everyone today with ancestry from outside Africa descends from a population that likely dispersed between 60–50,000 years ago. Some hints in the DNA might indicate another, slightly older dispersal before 70,000 years ago, but if so, it contributed only a tiny amount to the ancestors of Australasians.

But the idea that there were perhaps many 'ripples' before the wave of *H. sapiens* remains important and this is where the latest findings have been crucial. None of the individuals from the five sites where we've recovered DNA and which date to before 40,000 years ago were directly ancestral to us (they contributed little or no genetic legacy to people today).

THE FIRST EXPLORERS

Along with new insights into early *Homo sapiens* dispersals from Africa, our understanding of who the earliest Eurasian hominins were and when they lived has also shifted. The 2022 discovery of facial fragments of skull (below right) from Sima del Elefante, in Spain, put hominins in Western Europe extremely early. The exact date is yet to be established, but it's very old – it was found 1.2m (4ft) below another fossil from a different species (*Homo antecessor*) dated to 1.2 million years ago.

Researchers classed the face as '*Homo affinis erectus*', recognising that it resembles, but isn't identical to, known examples of this ancient and widespread population, itself found in East Asia by around 1.7 million years ago.

All this, together with yet another distinctive fossil population from

Dmanisi, Georgia, dating to 1.7 million years ago, and stone tools from geological deposits in China that may be more than 2 million years old, makes it undeniable that there's a deep and dynamic history of hominin dispersals well before *H. sapiens* evolved.





ABOVE A reconstruction of the population of early *Homo sapiens* from which the Ranis and Zlatý Kůň individuals came: the earliest genetically-identified so far from Eurasia

In a strictly biological sense, these were ‘failed colonisations’, overturning simplistic narratives of our evolutionary dominance where humans simply needed to move into a given area in order to permanently settle it.

Something else surprising that’s become increasingly important in the past 20 years is the fact that reproductive contact between hominin species (‘admixture’) appears to have been rather common. Current data points to a number of periods where early *H. sapiens* moving outwards from Africa from 180,000 (if not before 200,000) years ago encountered other kinds of hominins who had been living in Eurasia for thousands of generations already and, in some cases, forged intimate relations with them.

The evidence for the earliest phases is less clear and relies on signals deep within the genomes of those other species, including

by **DR REBECCA WRAGG SYKES**

Rebecca is an archaeologist and author. She’s an honorary research associate and honorary fellow at the Universities of Cambridge and Liverpool.

Neanderthals. But whenever we study early Eurasian *H. sapiens*’ genetic information from between 50–40,000 years ago, we find there’s already some ancestry from Neanderthals or Denisovans. In some cases, more than one phase.

The earliest so far was found in closely related individuals from the German site of Ranis and Zlatý Kůň in the Czech Republic, where the contact happened some 80 generations before those individuals lived. The most recent and closest is from an individual at Peștera cu Oase, Romania, who had a Neanderthal ancestor approximately five generations prior to their birth. The dating for Peștera cu Oase is believed to be not much greater than 40,000 years ago, remarkably close to the disappearance of Neanderthals, suggesting that intimate social dynamics were still occurring very late.

In 2025, amid this rapidly evolving research, a new analysis of the first of the skeletons found at Skhūl in the 1930s identified a number of physical features of the skull and jaw that don’t fit *H. sapiens*’ anatomy. It suggested something that a number of experts had long suspected: some of those early populations living in the Levant and West Asia already had a genetic ancestry from even earlier contact with Neanderthals.

Further details will have to wait until it’s possible to extract genetic material, but it feels strangely fitting that this clue to humanity’s diversity and deeply blended history had been there at Skhūl, staring us right in the face almost from the very beginning.

SURPRISES TO COME

The complex tapestry of *H. sapiens*’ histories we’ve explored through their bones and genomes doesn’t even touch on the archaeological evidence, which is just as tangled.

The earliest population dispersal seems to have been achieved with technologies essentially the same as those of Neanderthals. But around 60,000 years ago, the cultural evidence associated with Eurasian *H. sapiens* changes. One current model proposes that at least three archaeological pulses are evident between 50–42,000 years ago in Europe, with the earliest appearing at Grotte Mandrin, France, where minuscule stone points are likely to have been dart or arrow-tips.

DNA has yet to be extracted from the Grotte Mandrin site, so we’re not sure how the remains there relate to later populations, like those found at Ranis, in Germany. Moreover, the *H. sapiens* associated archaeology at Grotte Mandrin (known as ‘Néronians’) disappears soon after, and Neanderthals re-occupy the site for another 15,000 years. It serves as yet another counterpoint to those old myths of our assumed superiority.

Perhaps even more disruptive to the stereotypes of culture and cognition that led to our dominance have been recent findings around the oldest representational paintings in the world. The depictions of pigs, cow-like creatures and negative handprints were found in an Indonesian cave, rather than a European one, and they’ve been there for at least 51,200 years.

At present, the identity of the ancient artists in Indonesia remains a mystery, but as with everything in this extraordinary field of study, more revelations undoubtedly lie just around the corner. Maybe the most important thing we’ve found out in the 160 years of research on human origins is that we should expect to be surprised. **SF**



HEALING WITHOUT SCARS

Healing a wound without leaving a scar is something we could all do while in the womb. But unlocking this ability after birth has proven impossible. Until now...

by HAYLEY BENNETT

Plastic surgeon Dr Michael Longaker was an undergraduate at Michigan State University in 1979. Now renowned for his work on scarring, back then Longaker's interests lay more in sports than scientific research – that year he played with basketball superstar Earvin ‘Magic’ Johnson on his college team, the Spartans. “I had no background in research, at all,” he says, “I was forced into the lab.”

After his medical degree, he reluctantly took up a one-year research post in the lab of paediatric surgeon Dr Michael Harrison, who was carrying out life-saving operations on babies in the womb. He started seeing something surprising: when these babies were born, they didn't have any scars from their surgeries. So Harrison said to Longaker, “Why don't you look at how we heal before we are born?”

Longaker's reservations about research were soon forgotten. He operated on foetal lambs and other unborn animals, becoming caught up in the idea of ‘scarless healing’ in the womb. His one year in the lab became four.

Harrison's group wasn't the first to report scarless healing. The same year Longaker played with ‘Magic’ Johnson, an American

pathologist published a paper about a baby boy born at an Illinois hospital when his mother was only 20 weeks pregnant. The baby was sadly stillborn and, due to a rare condition where the amniotic sac gets wrapped around the foetus, suffered leg and finger amputations. But his wounds had healed without scars.

These discoveries in scarless healing led scientists to wonder: if we can heal without scars before we're born, is there some way of switching that ability back on outside the womb? This question has occupied Longaker's thinking for four decades. Today, at Stanford University in California, he says he gets “hundreds of emails a month” from people asking about their scars. He's made it his life's work to help them.

“IF WE CAN HEAL WITHOUT SCARS BEFORE WE'RE BORN, IS THERE SOME WAY OF SWITCHING THAT ABILITY BACK ON OUTSIDE THE WOMB?”

Outside the womb, scars are the price we pay for healing. Many of the 100 million scars people worldwide develop every year serve as painful reminders of past traumas, whether in the kitchen, operating theatre or war zones. In the UK, for example, five million people live with scars that cause them emotional or physical distress. But, according to Longaker, scientists are now closing in on a solution to the problem. “We're standing at a threshold,” he hints. “We've laid a lot of track.”

WHEN SCARRING BEGINS

Back in Harrison's lab, they still had to understand where perfect healing ended and scarring began. Meanwhile, in the UK, cell biologist Prof Paul Martin, then at University College London, was doing parallel work in mice, which have a short, 21-day gestation.

“Our work was completely complementary,” says Martin, another stalwart of the scarring community, who met me in his office at the University of Bristol. “As they were doing that in sheep and patients, we were doing it in mice. We found a stage in mouse development when you could wound a mouse and it didn't scar – until embryonic day 14.”

In essence, it's not until later in gestation (24 weeks in humans) that the process leading to scarring actually begins to

“HUMANS ARE TIGHT-SKINNED ANIMALS, MORE LIKE PIGS THAN DOGS OR CATS, SO OUR WOUNDS ARE DIFFICULT TO CLOSE”

develop. Then, for the rest of our lives, we scar. The process begins with the body plugging the gap by forming a clot, which later becomes a scab, and dispatching immune cells to fight off infection.

After that come the ‘repair crews’: cells carrying fibrous proteins, mainly collagen, to patch over the wound. As the repair progresses, some of these cells contract to zip up the wound, with the collagen being linked and reorganised to pull on the tension lines. This whole routine works to seal the wound, but the systems are flawed.

Problematic scar tissue is often the result of repair crews on overdrive laying down too much collagen in tightly packed bundles rather than the loose basket-weave-like structure of ordinary skin. Humans are already tight-skinned animals, more like pigs than dogs or cats, according to Longaker, so our wounds are difficult to close. “The forces required to close [an] incision are much stronger than the scar it’s forming,” he says, explaining that scars grow “wide and thick” to avoid being pulled apart. Yet, even with all that extra collagen, he notes, scar tissue is never quite as strong as normal skin.

The two types of raised scars, keloid and hypertrophic, are both caused by excess collagen production, while indented atrophic scars (like those caused by acne) are the result of a lack of collagen. For anyone with large scars, such as from widespread burns, the impact isn’t just cosmetic because as the scarred skin contracts, it restricts movement. Scars on the face, for instance, can impact speech and eating.

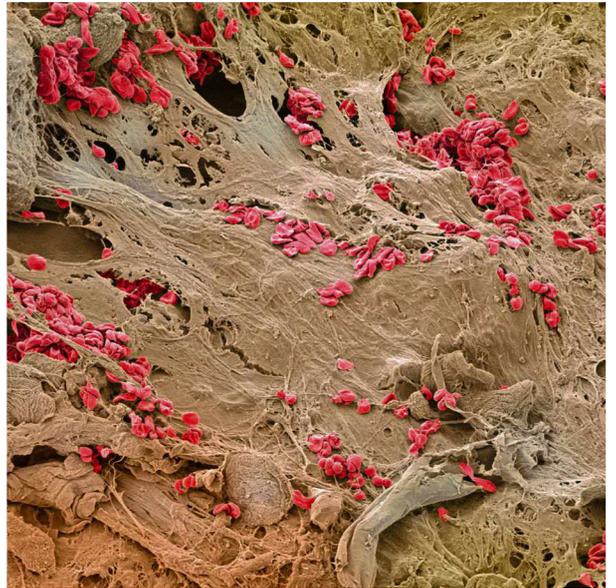
FINDING THE RIGHT TOOLS

The foetal healing work suggests that all this misery could be avoided if only scientists could locate the biological buttons to deactivate scarring. “What we’ve been trying to figure out for 30 years is what the buttons are,” says Martin. “And it looks like there are several.”

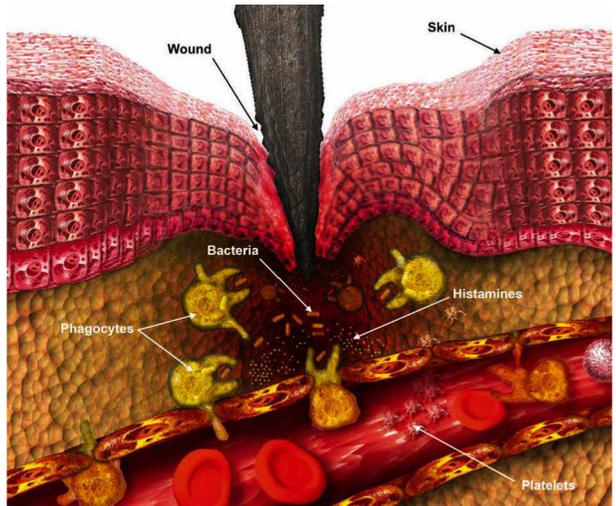


ABOVE Cell biologist Prof Paul Martin

RIGHT A healing wound on the skin, as seen under a scanning electron microscope. The red blobs are blood cells trapped in a mesh of the protein fibrin, which helps to form a clot and prevent further bleeding



BELOW Damaged tissue releases histamines, which cause nearby blood vessels to become porous. Phagocytes pass through vessel walls to attack the bacteria brought in through the wound, while platelets approach the wound to clot and seal it



BIG TIME IMAGES, SCIENCE PHOTO LIBRARY X3, GETTY IMAGES



In the early days, however, scientists simply didn't have the molecular tools to track them down. Surgeons and dermatologists did what they could to help. Since the 1980s, for example, lasers and other 'energy-based devices' have been used to treat scars with heat – in theory, the body perceives the heat damage as a type of controlled injury and responds by replenishing or reorganising the collagen. It's by no means a quick fix, often requiring multiple treatments, and there's no obvious right time to intervene.

"Since many scars improve over time, a conservative 'wait-and-see' approach has traditionally been taken," explains Hye Jin (Leah) Chung, associate professor of dermatology at Harvard Medical School, Boston. However, she adds that, based on emerging data, some experts now think earlier treatment may help. Getting good results depends on matching the device

ABOVE Too much or too little collagen (illustrated here in its triple-helical molecular form) during the healing process can result in different types of scar tissue

ABOVE RIGHT Surgical incisions and stitches typically result in fine lines around scars, but various factors, including your genetics and skin tension can cause the wound to heal as hypertrophic (raised) scar tissue



type and its settings to the scar and skin type, taking extra care in people with darker skin or a history of keloids (raised scars that overgrow), who may be more prone to complications.

Other options include steroid injections, microneedling to stimulate the body's healing response and loaded dressings filled with therapeutic agents. Surgical scar revisions can improve the appearance of scars, although Longaker says the results tend to be disappointing, so he avoids doing them. There's a multi-billion dollar market for anti-scarring lotions and potions, some of which are supported by very thin evidence, while others, like those based on onion or green tea extracts, have shown some degree of benefit in trials.

None of these solutions reliably solves the problem, however, leading scientists to keep searching for the switches that turn off scarring. And, gradually, using modern cellular, molecular and genetic techniques, they're tracking them down.

CLOSING THE GAP

Recent years have seen a renewed focus on fibroblasts, the collagen-carrying cells of repair crews. Once considered a uniform bunch, fibroblasts became more interesting to scarring researchers in 2015, when Longaker's team showed they come in different versions – including one that activates in scarring. "It gets angry and activated," says Longaker. "And it starts to make collagen." The 'angry' fibroblasts (aka Engrailed-1 lineage positive fibroblasts), Longaker's team found, activate during development, making up just one per cent of skin-associated fibroblasts in 10-day-old mouse embryos, but 22 per cent six days later. And, crucially, destroying them in adult mice reduces scarring.

So, how do you get the angry fibroblasts to calm down? Fibroblasts don't operate in isolation and are pushed and pulled into action by other triggers

“THE HEALED TISSUE HAD HAIR FOLLICLES AND SWEAT GLANDS, WHICH ARE USUALLY MISSING IN SCARS”

within what you might call the wider ‘woundiverse’. For instance, they receive signals from the infection-fighting immune cells that colonise the wound early on. Scars, in fact, don’t even form without immune cells – genetically engineered adult mice that lack them heal perfectly, like embryos. And guess when, during embryonic development, immune cells start showing up at wounds? Right around the time that scarring begins.

This timely association between the immune response and fibroblasts is no coincidence, according to Martin, who, while explaining this link, enthusiastically pretends to be a macrophage – a crucial immune cell. “I’m a macrophage and you’re a fibroblast,” he says. “If I’m an aggressive, pro-inflammatory macrophage, I’ll say to you, ‘Make a scar’. If you’re the right sort of fibroblast, you’ll respond and make a scar... It’s more complex than that, but essentially, macrophages coming into wounds talk to fibroblasts and tell them to make scars.”

Of course, we can’t simply turn off our immune systems to stop scarring. So Martin, Longaker and others continue to explore the woundiverse for more selective targets; buttons they can press that specifically target the angry fibroblasts or some aspect of the chain of events leading to scarring, without shutting down other essential systems. One fibroblast-activating molecule called transforming growth factor beta (TGF- β), for example, has long been a target of scarring researchers. Tellingly, different versions of TGF- β are active before and after birth, but simply providing the one that’s active in embryos hasn’t worked out.

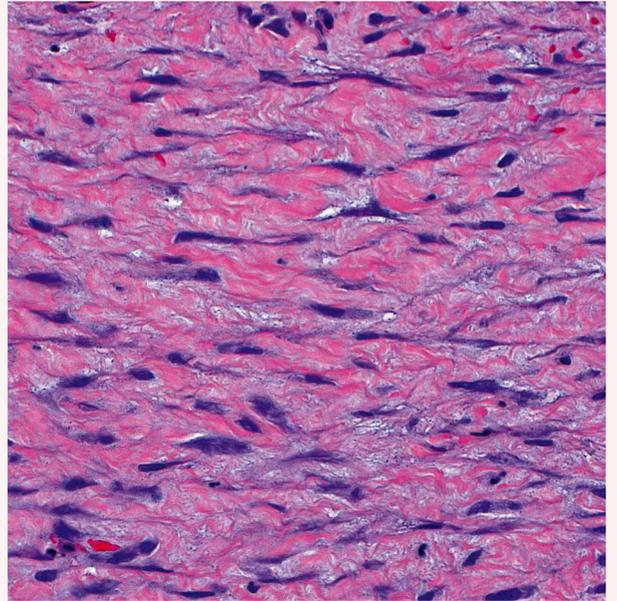
Now, researchers are trialling scar-reducing gel dressings loaded with a natural protein, called decorin, that binds to a version of TGF- β that’s more active after birth. Though, as materials scientist Prof **Liam Grover from the University of Birmingham** explains, it might be acting on other components of the scarring system, too.

“Decorin is a very sticky molecule,” he says. “My view is that it makes the wound environment busy, sticks to a load of stuff and effectively reduces the likelihood of those molecules inducing [scarring].”

Right now, the team is beginning trials in burn patients, but Grover says it’ll take a couple of years

RIGHT Fibroblasts (in blue), among collagen fibres (in pink), seen under a microscope

BELOW Prof Liam Grover of the University of Birmingham



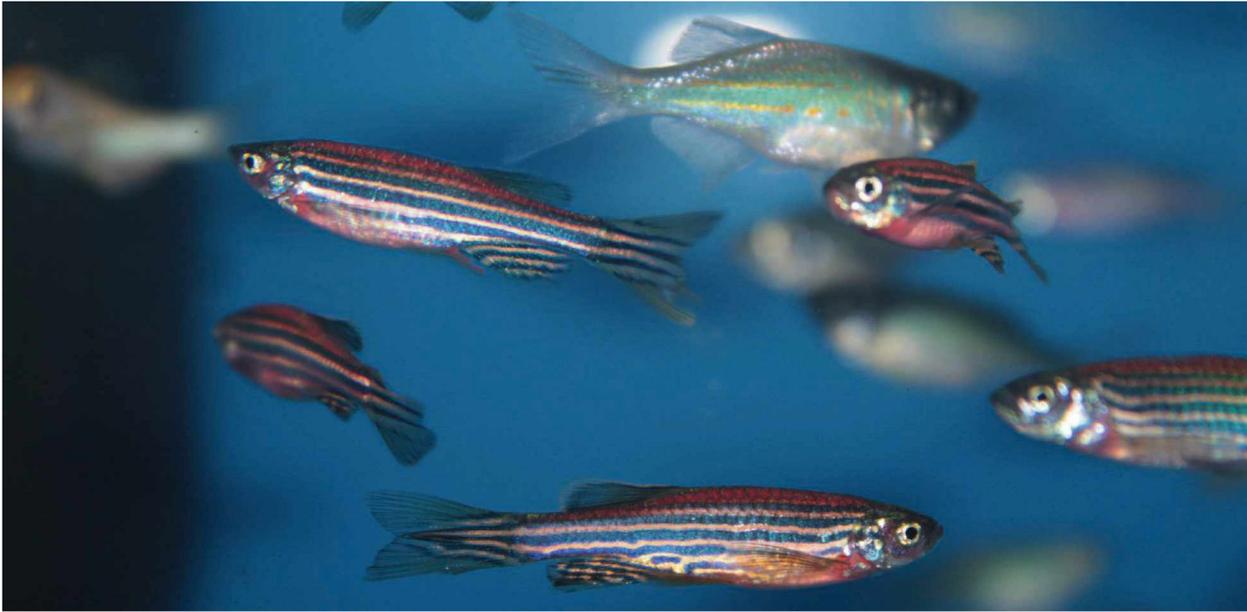
to know if the dressings work, due to how long scars take to form.

Even as he waits, though, Grover is trying another approach to identifying new anti-scarring molecules: generating them with artificial intelligence (AI). Partnering with computational scientists at the University of Warwick, Grover suggested molecules within the woundiverse that he would like to block. The Warwick team looked at the shape of these molecules, then asked AI to generate thousands of structures for potential inhibitors. Through computer modelling, these have been narrowed down to six, all of which are smaller (so easier to make) than decorin, and likely cheaper and more stable, but so far they’re untested.

Meanwhile, Longaker’s team is on the verge of clinical trials for an injectable drug based on another small molecule, verteporfin, which is conveniently already approved for treating the eye disease macular degeneration. In 2021, the researchers showed that verteporfin targets a molecule called yes-associated protein (YAP), which appears to be sensitive to tension changes in wounds and prompts the angry scar-forming fibroblasts into action. While its mechanisms are still not fully understood, Longaker says he always suspected tension had a part to play. “I knew it had to do with physical forces, because in early gestation, the skin is gelatinous and in the last trimester, it becomes a barrier – tight,” he says. “We [have now shown] that how fibroblasts sense forces, and tension is critical to activating them.”

By deactivating YAP, the researchers got wounds to heal without scars in adult mice. The healed tissue had hair follicles and





ABOVE Zebrafish have translucent skin which allow scientists to observe collagen being laid down in real time, cell by cell

BELOW LEFT A dressing impregnated with decorin to help reduce scarring

sweat glands, which are usually missing in scars – “everything normal”, according to Longaker.

Then, in early 2025, they repeated the feat in pigs, an important milestone as their skin is so similar to ours. The plan now is to trial verteporfin as a single injection alongside surgery for cleft palate scar revision, although the team is due to publish a paper in which they’ll claim it also works to ‘rescue’ months-old scars.

What’s more, there are other molecules involved in sensing tension and forces, including one called focal adhesion kinase (FAK). Longaker’s long-time collaborator Prof Geoffrey Gurtner, now at the University of Arizona, is developing dressings filled with FAK-blocking molecules that reduce scars by encouraging the actions of gentler, pro-regenerative fibroblasts.



SEEING THROUGH SCARS

Another way to hone in on potential new targets and treatments is to watch scarring in real-time. Over the years, Martin has developed ways of visualising scarring as it happens. But not in pig or human skin.

Referring to one of the images displayed on his office wall, he demonstrates the stunning details he’s able to uncover in zebrafish, by following cells and molecules with fluorescent tags. Zebrafish skin is translucent, so it’s possible to watch collagen being laid down as it happens, as well as observe the effects in fish whose scarring systems have been genetically manipulated.

The same studies in opaque pig or human skin would be useless. The actions of genes identified in humans can still be visualised in Martin’s fish, however. The team has been hunting down genes associated with reduced scarring by looking at differences in how people scar – leaning on data from large genetic studies in the UK and Brazil. “In Brazil, 90 per cent of mums have C-sections and in some you can barely see where the scar is, whereas others have a massive keloid scar,” Martin says. It’s those whose scars are barely visible that Martin is especially interested in.

So, it’s been a worldwide effort – and a slow creep towards solutions – but it seems like scarring scientists are edging ever closer to reactivating the perfect healing that we were all capable of in the womb. “It isn’t a trivial problem,” Martin says, pointedly. “Which is why, I guess, it hasn’t been sorted quite yet.” Fixing it might affect our ability to tackle a whole range of related conditions, from liver cirrhosis (scarring of the liver) to cancer. Perhaps not coincidentally, certain types of fibroblasts play a role in cancer – as do scarring proteins like YAP – and there are similarities between solid tumours and scar tissue.

Longaker, for his part, is well aware of the implications. For now, it’s one step at a time. “I will not stop.” **SF**

—
by **HAYLEY BENNETT**

Hayley is a science writer based in Bristol, UK.



SCIENCE-BACKED WAYS TO IMPROVE YOUR MEMORY

BY DR CHRISTIAN JARRETT

Forgetfulness doesn't have to be an inevitable part of life. Like going to the gym to stay fit, there are habits you can adopt to keep your memory sharp



Memory is the gift that guides us through life – from finding our way around to recognising our family and friends. We rely on our memories to maintain the story of who we are, allowing us to lead coherent, meaningful lives. “No memory means no rudder with which to navigate life,” says Dr Kailas Roberts, a psychiatrist and author of *Mind Your Brain*. Given the immense value your memory holds, it makes sense to nurture, aid and protect it.

At a basic neurological level, your memories reside in the connections between neurons – in your synapses, of which you

have hundreds of trillions. So it’s not that your brain lacks the capacity to remember everything (researchers have found that, on average, ordinary people remember about 5,000 faces, which is plenty). It’s more that lots of things you might want to remember don’t make it into your long-term memory in the first place.

The good news is there’s a range of techniques you can use to shift information from your brain’s short-term cache to its long-term archive. In neurological terms, this involves processing them in the brain’s

hippocampus before they’re distributed across the neocortex.

The even better news is that using these techniques – along with looking after your memory and overall health – can help keep it stronger for longer. Like any organic system, the brain undergoes cellular and chemical changes over time that can affect function and, in worst-case scenarios, can develop into dementia. Staying healthy by eating well, exercising and getting good sleep can help, but there are also some more unusual things you can do to give your memory a boost...

1

PRACTISE ACTIVE RECALL

Whether it's a shopping list or vocab sheet, when you're trying to get information to stick, it's tempting to read it over and over. Countless studies have shown this is ineffective. It's far better to review the material and then try to recall it, for instance by attempting to reproduce it or having a friend test you. This is known as active recall or retrieval practice.

The act of trying to recreate the information helps strengthen the relevant neural pathways in your brain. "Retrieval practice is... a way to give the brain cues that tell it that information is likely to be important in the future," says Elizabeth Kensinger, Professor of Psychology and Neuroscience at Boston College. Testing yourself this way also highlights what you can and can't recall, so you can devote more attention to the things you're struggling to remember.

The timing of when to revisit the material is crucial, though. Repeatedly studying the same material in one sitting is called 'overlearning', which isn't much use. It's far better to wait and revisit the material after a delay.

How much of a delay depends on when you want your memory to be at its best. Cognitive psychologists recommend revisiting after 30 per cent of the time you wish your memory to peak. So if you have a test in 30 days, aim to re-study and re-test yourself on the material in about 10 days' time.

There are also benefits to pre-testing – quizzing yourself on the material before you've actually studied it. Many studies have shown it can boost your later memory of the material. Psychologists are still nailing down the precise mechanisms behind pre-testing's benefits, but it's thought to partly be due to the way the initial questions spike your curiosity and guide your attention when you later memorise the information.

So the next time you have something to memorise, try this: quiz yourself on how much you know already, then study and review the material and test yourself on it again, then, schedule a follow-up study and re-test session using the 30-per-cent rule.



2

USE A MIND PALACE



If there's a list of things you need to remember in the correct order, a powerful technique for doing so is known as a 'mind palace' or the 'method of loci'. It works like this: as you review each item you need to remember, convert it into a meaningful image and mentally place it in a specific location along a route you know well from real life. It could be a route through your home or the one you follow to work. Once you've placed the items, you just need to imagine yourself walking along the route to see where each one is to recall everything in order. Your powerful spatial memory should support your recall of any harder-to-remember items.

"The mind palace combines three things that the hippocampus prioritises," says Kensinger. "It relies on a spatial map and navigation, on mental imagery, and on the creation and retrieval

of associations. This combination makes it a particularly powerful mnemonic device."

If you want to get even more advanced you can merge images, combining multiple elements into a single, more vivid memory. Memory champions, like Joshua Foer, have used this technique to memorise the order of a shuffled deck of cards in minutes.

You could use this technique to help you remember information in a speech or revise for an exam. "In my memory clinic, it's a technique that's taught... to improve the ability of those with memory difficulties to manage day-to-day life," says psychiatrist Dr Kailas Roberts. "These familiar places are less prone to erosion than more short-term memories and so anchoring the latter with the former can be very helpful."



MAKE YOURSELF LAUGH

In the 1970s researchers showed the benefit of humour in lectures – students better remembered the same material when it was presented in a funny lecture compared to a serious one. But it only worked when the humour related to the information, suggesting that the advantage stems from how it leads us to pay more attention to the material.

According to Prof Shelia Kennison, an expert on the cognitive effects of humour, when memories are encoded "physiological arousal increases when we experience a strong humour response. The brain changes occur because the humorous content is usually a bit surprising, unexpected and then funny, which leads to a pleasure response involving dopamine and the pleasure centres of the brain." In other words, when you find something funny it prompts mental and neurochemical changes that make it more likely you'll remember the material later.

To take advantage of this effect, aim to see the funny side of anything you're trying to remember. Experiment with amusing acronyms, convert any material you want to remember into humorous mental images or give funny names to the items on your shopping list.

4 DITCH YOUR SAT-NAV

One change you can make to help protect your memory is to stop relying so much on sat-nav. Growing evidence suggests that habitually using sat-nav, rather than your own sense of direction, diminishes your spatial memory abilities over time.

A study by researchers at McGill University tested the spatial memory of 50 drivers who varied in how much they used sat-nav. In one task they had to remember the location of objects in a virtual maze. The drivers who relied on sat-nav more performed worse at this and in other tests that rely on the hippocampus (the brain structure that's key to memory and learning).

The researchers retested some of the participants a few years later and these results suggested greater use of sat-nav harms spatial

memory, rather than people with poorer spatial memories being more likely to use sat-nav.

Findings like these suggest if you rely heavily on sat-nav, not only will it affect your ability to find your way around without tech, but that you'll also be at a disadvantage using techniques that rely on spatial memory, such as the memory palace.

The good news is that your spatial memory is highly adaptable depending on how much you use it. If you make a commitment to rely more often on your own navigation skills, then you can rebuild your spatial memory abilities. It might be daunting to ditch the sat-nav for long journeys, but you could start small by trying to resist using tech when finding your way around your local area.



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5 LEARN A LANGUAGE (OR ANY NEW SKILL)

You needn't stop at learning to navigate without your sat-nav – research shows that picking up new skills more broadly supports memory, helping to strengthen what's known as your 'cognitive reserve'. This is a kind of protective intellectual resource that allows your brain to keep functioning even when it's affected by ageing or illness. "We should be doing things that



are unfamiliar – these seem particularly effective at promoting new neuronal circuitry that might allow us to function at a higher level even when pathology affects the brain structure,” says Roberts. One place to start could be learning a new language.

Distinguished Research Professor of Psychology at York University, Ellen Bialystok has conducted many studies showing that being bilingual can protect against the risk of developing dementia. One paper published in 2007 showed that older bilingual participants developed symptoms of dementia on average four years later than their monolingual peers. This is likely because managing multiple languages strengthens the executive control networks in your prefrontal cortex – the same brain networks that support working memory and attention.

Bialystok cautions that learning a second language later in life isn't the same as being bilingual, which typically means growing

up with two native languages. That said, she has also conducted research showing preliminary benefits of later language learning. For example, a study from 2021 showed that after 16 weeks of using a language-learning app, older adults benefited from various cognitive gains, such as 'executive function' (the ability to pay attention to what matters) and working memory accuracy (effectively juggling information in short-term memory).

“If there is an effect,” Bialystok says, “it's not because learning another language in older age makes you bilingual, but because learning a language is a difficult, engaging, stimulating activity and those things improve brain function.”

If you don't like the idea of learning a new language, there are alternatives. The thing to bear in mind is to choose an intellectual or learning task that's challenging. Anything from learning new card games to a musical instrument should do the trick.

6

GET SOCIABLE

Another important way to nourish and protect your memory is to socialise more often. It's probably the most natural form of brain training available.

A study published in 2020 followed thousands of middle-aged and older participants over several years. Those who engaged in more social activities showed

less mental decline. The more different social activities they engaged in – such as seeing friends, volunteering, attending clubs – the greater the apparent protective effect.

Another huge study, this one published in 2022, involved over 29,000 older participants. Socialising at least twice a week was one of the key lifestyle factors that protected them against memory decline over the ensuing years.

Prof Charan Ranganath is a director of the Dynamic Memory Lab at the University of California at Davis. He and his fellow researchers are still figuring out the mechanisms underlying the protective effects of socialising, but one possibility is that it helps with preventing depression and dealing with stress, both of which can be harmful to memory.

"Another possibility," he adds, "is when people are in strong, social relationships, they can develop skills to compensate for any natural brain changes that might be

taking place that might normally reduce cognitive functioning."

The message from this line of research is that aiming to socialise at least twice a week with varied activities will help to protect you from memory decline. And there's no reason why you can't incorporate this with some of the other steps. For instance, you could go to evening classes to learn a new language – this will give your brain a good workout, and while there, you can chat and forge new friendships. At the same time, you could use testing and memory techniques (such as the mind palace) to help you learn new vocabulary, further exercising your memory muscles. Just don't forget to turn off your sat-nav and find your own way to class. **SF**

by DR CHRISTIAN JARRETT

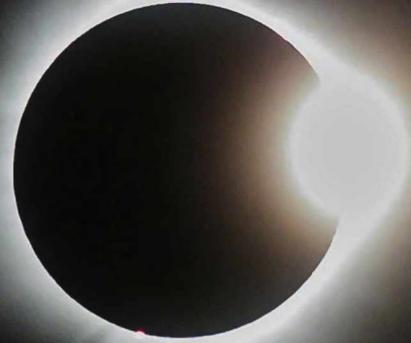
Christian is a cognitive neuroscientist and the author of Be Who You Want: Unlocking the Science of Personality Change (Robinson, 2021).





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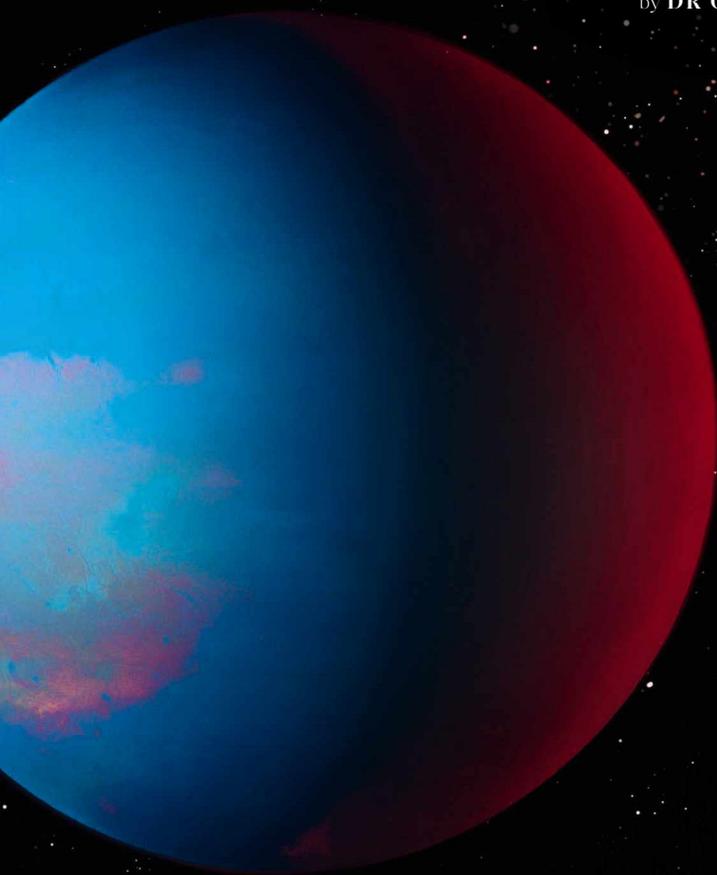


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THE PLANETS THAT SHOULDN'T EXIST

With sapphire waterfalls, lava rain and orbits around dead stars, these distant worlds push the limits of what's possible

by DR GEORGE DRANSFIELD



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by **DR GEORGE DRANSFIELD**
George is an exoplanet huntress at the University of Oxford and a presenter on The Sky at Night.

Isn't it amazing that astronomy – humanity's oldest science – continues to generate such a delightful amount of new knowledge? Seeing as we've been studying the motion of the stars for a good long while, you'd be forgiven for thinking that, by now, we would be long past the point of saying "Astronomy? Completed it, mate."

Fortunately, the Universe is vast and unknowable. However big our telescope mirrors and however sensitive our detectors, there will always be some light that's too faint to see and signals that are too weak to detect. This is good; for one thing, it means I still have a job; more importantly, however, it means the sky is still full of wonder.

Planets are one such wonder. The word 'planet' comes from the Greek 'planētēs', meaning 'wanderer'. They were so named because our closest planetary siblings in the Solar System appeared to wander across the night sky. Alas, detecting our distant planetary cousins – the exoplanets that lie beyond the Solar System – takes far more effort than glancing skyward once the Sun has set. It requires enormous telescopes, long observing campaigns and a lot of computing. But believe me when I tell you, it's worth the effort.

Exoplanet detection is booming. At the time of writing, astronomers have discovered almost 6,000 of them and we think that most stars have them. But of course, in a field characterised by so many discoveries, occasionally truly extraordinary things turn up. There have been planets that flirt with the line separating science and science fiction; planets that force us to revisit our theories of how they form; and planets that, in all fairness, feel like they shouldn't exist. Planets like the 10 that follow...



THE PLANET TOO BIG FOR ITS STAR

TOI-6894 b

The discovery of TOI-6894 b was only announced in June this year and it presents a genuine challenge to our understanding of planet formation. Its star is a tiny red dwarf (roughly 20 per cent the size of the Sun), but TOI-6894 b is almost as big as Jupiter.

It's a problematic combination because our current best theory of planet formation says that very small stars can't have very big planets. The planet-forming discs around nascent red dwarf stars simply don't have enough material. And yet, here is TOI-6894 b. It's not the first problematic pairing of this kind to be found, but it is a record breaker: TOI-6894 b's star is the smallest known to host a giant planet.

TWO SUNS ARE BETTER THAN ONE

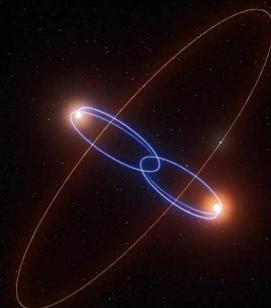
2M1510 (AB) b

The '(AB) b' part in this exoplanet's name tells us something crucial: it's circumbinary, meaning the planet orbits a double star system.

Roughly 50 per cent of stars in the Milky Way are in binaries of some sort, but 2M1510 (AB) b orbits both stars at once. That's uncommon in itself, with only 16 circumbinary systems discovered to date. But there's more. This isn't just any binary, it's a binary pair of failed stars known as brown dwarfs and that really is a rarity. Only one other pair like it has ever been found.

But wait, there's still more. The planet is on a polar orbit. This means it's orbiting at 90° to the plane the brown dwarfs are orbiting in, looping over the top of them. It's

the first of its kind ever detected. Astronomers had an inkling that they might be a thing since we've found protoplanetary discs in polar orbits, but for the first proper one to be found orbiting a pair of brown dwarfs is wild.



WORLDS BUILT FROM THE ASHES OF A DEAD STAR

PSR B1257+12 b, c and d



Exoplanets PSR B1257+12 b and c were the first to be discovered, back in January 1992, with d being found a couple of years later. This system really set the scene for the field, because it's ridiculous.

The planets orbit a stellar remnant called a pulsar – a rapidly rotating neutron star. Neutron stars are very dense, have very strong magnetic fields and emit all sorts of electromagnetic radiation. But PSR B1257+12 b – the first exoplanet discovered – is still the lowest-mass planet ever detected. Plus, there's the fact it was found at all, as planets orbiting pulsars are rare. Only 0.5 per cent of these long-dead stars are thought to host planets. That's because the process of becoming a neutron star is such a violent end-of-life affair that there's almost no chance any existing bodies would've made it through the tumultuous late stages of stellar evolution.

PSR B1257+12 b, c and d are probably the result of a second round of planet formation. It's kind of nice that their star decided to have a second crack at parenthood in later life. It's never too late!

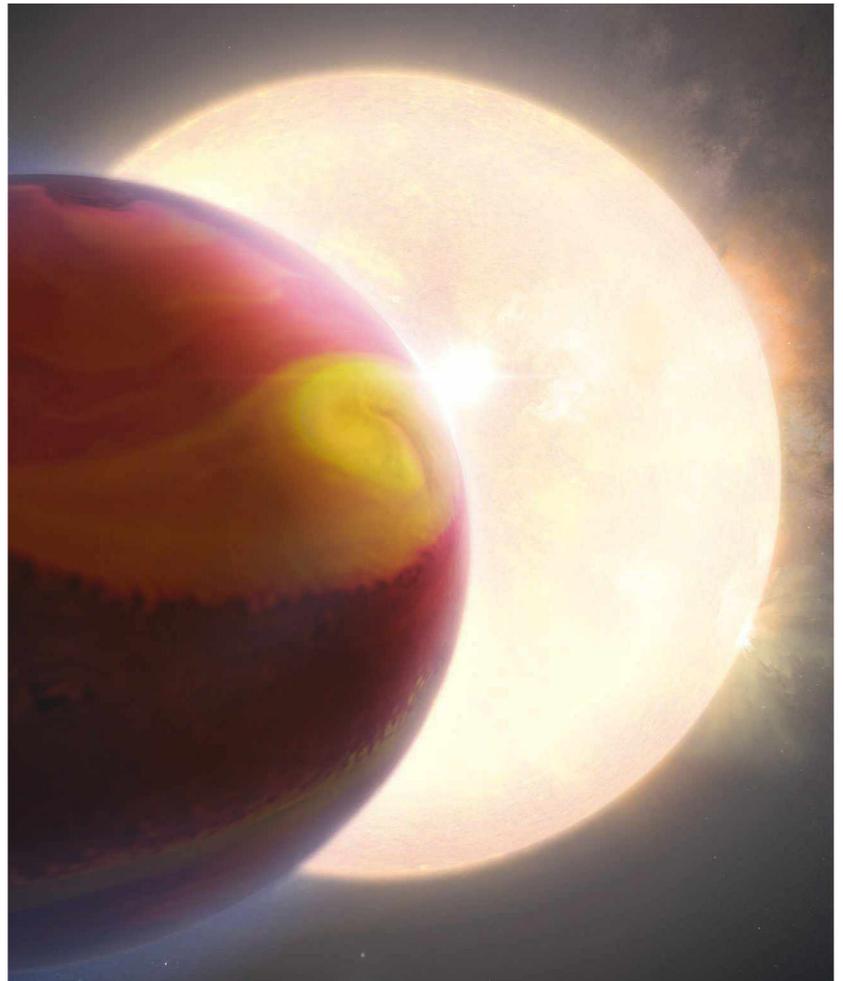
SAPPHIRE RAIN OVER A BOILING PLANET

WASP-121 b

The first exoplanet discovered orbiting a regular star – 51 Peg b – is a kind of planet we don't have in the Solar System. It's a hot Jupiter. These planets are so named because they're gas giants (like Jupiter), but much closer to their stars. They're silly enough, what with their super-inflated sizes, blisteringly hot temperatures and painfully short orbits, but WASP-121 b is actually an ultra-hot Jupiter. So the extreme conditions are just a touch more extreme.

For one thing, WASP-121 b orbits its star in little more than 24 hours, but it doesn't actually have days because it's tidally locked – the same side always faces the host star, so it has a permanent nightside and dayside. The sizeable temperature difference between the two hemispheres (1,500°C-ish/about 2,730°F) causes wind speeds of over 16,000km/h (10,000mph). It's hot enough on this planet to vaporise iron, aluminium and titanium. Clouds containing these elements and their oxides can then be blown from the toasty dayside to the cooler nightside, causing rain of iron and gemstones, including sapphires.

There's an episode of *Doctor Who* where the Doctor visits a spooky planet called Midnight and goes on an ill-fated train ride to see some sapphire waterfalls. Planets like WASP-121 b somehow make even the most bonkers sci-fi locations seem plausible.



THE DANCING PLANET WHERE YOU MIGHT NOT GET A BIRTHDAY

TOI-4504 c

If you have one planet orbiting a star and there's absolutely nothing else in the vicinity, you can likely get a full understanding of the system, with enough observational data.

Things get trickier if you add one more planet in, as now you're into '3-body problem' territory – so-called because going from two to three celestial bodies in a system means it's no longer possible to get a full solution for the orbits via mathematical equations. In most cases though, it's possible to get a decent approximation. Unless, of course, the two planets are in a special little dance called a 'mean motion resonance' (MMR).

An MMR (not the life-saving vaccine) means the planets' orbital periods are very close, in a ratio like 2:1 or 3:2, and it leads to frequent

gravitational interactions between the bodies. As is the case with TOI-4504 c: it's locked in a resonance with its neighbour, completing two orbits for every one by its counterpart.

The result of these gravitational kicks? The length of a year isn't fixed. In fact, in this record-breaking case, a year can vary in duration by up to 2.4 per cent. Can you imagine if that happened on Earth? A year could vary in length by eight days either way. People born in late December would never know if they were getting a birthday or not!

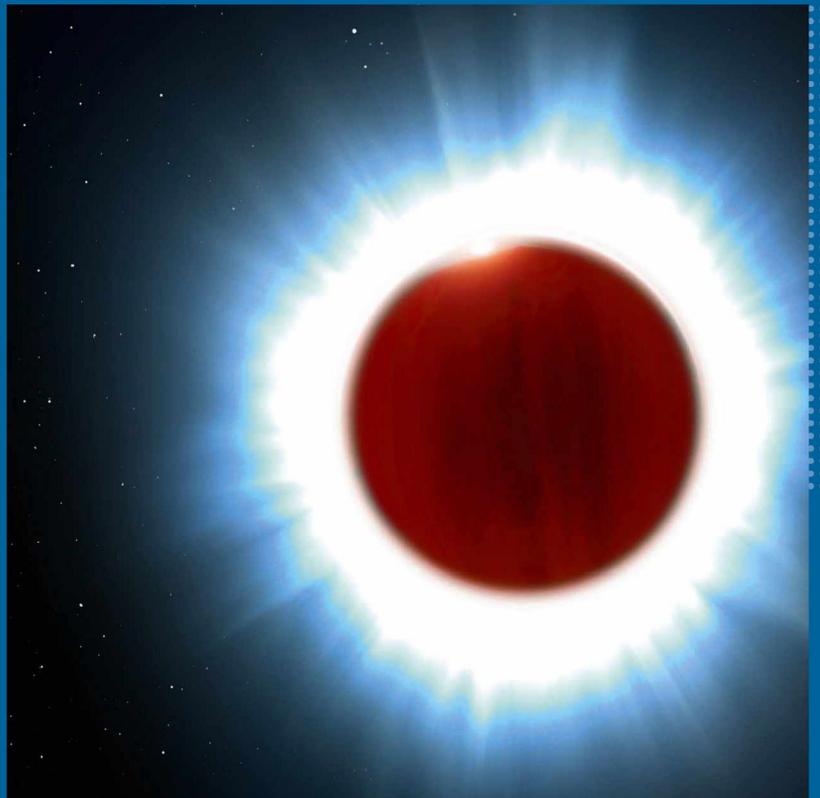
HOTTER THAN THE SURFACE OF A STAR

KELT-9 b

No list of extraordinary exoplanets would be complete without KELT-9 b, the second ultra-hot Jupiter to make this list.

Its parent star is one of the hottest stars known to host a planet and, typically, we wouldn't expect to see planets orbiting anything at the upper end of the temperature scale. Hot stars live fast and die young, burning through their nuclear fuel so quickly that planetary formation doesn't really stand a chance. But here's KELT-9 b, defying the odds.

The result is a planet so hot that, at over 3,700°C (6,700°F), it's actually hotter than most stars in the Milky Way. That's because roughly 75 per cent of our galaxy's stellar population are red dwarfs with typical temperatures under 3,200°C (5,800°F).





HELL ON (ANOTHER) EARTH

55 CANCRI e

We've known about this planet for more than two decades and it's been a conundrum the whole time. 55 Cancri e is a super-Earth, meaning it's a bit larger than our home planet. But if you're picturing a slightly enlarged version of here, complete with greenery and oceans, think again. It's a literal hellscape.

55 Cancri e orbits in just 18 hours – this means it's very close to its star.

So close, in fact, that the star's gravitational forces are continuously pulling the planet's surface apart. It's such a horrendously violent place, that it's thought to rain lava there. In fact, this planet is so close to its star that the intensity of the radiation it receives is immense, so much so that astronomers thought there was almost no chance of it harbouring an atmosphere. Atmospheres don't generally get on with outrageously high temperatures; they tend to escape.

Imagine, then, astronomers' collective surprise when new observations from the James Webb Space Telescope revealed that 55 Cancri e appears to have a tenuous atmosphere containing carbon dioxide and/or monoxide. "How?," we all asked. Constant replenishment, apparently: the gases evaporate from magma oceans on the surface, keeping that atmosphere nicely stocked.

WHERE IN THE WORLDS ARE ALL THE MOONS?

PDS 70 c



The PDS 70 system has something that absolutely should exist, but has so far eluded us: evidence of exomoons. Moons are fairly ubiquitous in the Solar System, with Saturn and Jupiter boasting about 350 between them. Mars has two of them and we've got one of our own. Even demoted dwarf planet Pluto has a posse of them. So, there's no reason to believe other planetary systems wouldn't also be riddled with them. But astronomers don't have the proof to back up that belief.

There have been plenty of 'potential exomoons', and countless journal articles on how it might be possible to spot them, but there's not a single confirmed moon around any of the nearly 6,000 known exoplanets. There's still hope, however, thanks to PDS 70; an infant star system, still in the throes of formation.

In the primordial muck of this particular corner in the vastness of space, you'll never guess what they've spotted around planet PDS 70 c. An exomoon? Well, no... not quite. But astronomers have detected a moon-forming disc. No smoke without fire, and no moon without moon-forming discs.

ROGUE PLANETS

Rogue planets, also known as free-floating planets (a less cool, but more informative name), are the planetary orphans of our galaxy. So far around 100 of them have been discovered, but it's thought there could be as many as a trillion of them in the Milky Way. That would mean rogue planets outnumber stars by about 20 to 1. It's a baffling thought because... well, where are they all coming from?

There are two ways rogue planets form. The more massive ones (a few times heavier than Jupiter, say) are thought to form in a similar way to stars – from an interstellar gas cloud collapsing under its own gravity. To get a new star out of this process, the resulting ball of gas and dust would need to be hot and dense enough for hydrogen fusion to kick in. When it fails, we're left with a brown dwarf or a free-floating gas planet.

The less massive rogues would've formed in a cushy planetary system only to be kicked out by one of their siblings during a close encounter.

A PLANET BOILING AWAY TO NOTHING

BD+054868A b

Unfortunately, BD+054868A b isn't long for this world. It has been flying a bit too close to its sun – this rocky planet is literally boiling away. Conditions have become so incomprehensibly hot, that the rock is being vaporised and the resulting plumes of material have formed a comet-like tail around the star.

The system was discovered in February 2025 and while it's the fourth disintegrating planet to be found, it's the first time one has been detected around a star bright enough for some proper follow-up observations.

In astronomical terms, it'll all be over soon for BD+054868A b, as the more material it loses, the faster it'll meet its demise. Best estimates suggest that it'll all be over in about two million years. **SF**

×

THE BIG QUESTION

—

Can you live longer by eating less?

From fasting to low-protein diets, the evolving science of dietary restriction might just offer the key to slowing ageing

by DR ANDREW STEELE

The idea that eating less might make us live longer has been around for thousands of years. Even Hippocrates, the Ancient Greek physician, argued that, “When a patient is fed too richly, the disease is fed as well. Any excess is against nature.”

Scientists have now spent decades testing whether his advice holds true. The first striking evidence came in the 1930s, when American nutritionist Dr Clive McCay found that rats fed a restricted diet lived almost twice as long as those who were allowed to eat what they liked. And they weren’t struggling on, too hungry to muster the energy to die. These rats were, in fact, healthier in their old age, with better-looking lungs and kidneys and no cancer (until the rats’ food supply was increased again right at the end of the experiment).

In the intervening century or so, we’ve found that cutting back calories

“Reduced food intake might push a biological button inside our cells, telling them to hunker down”

can have life- and health-extending effects across the tree of life: from single-celled fungus yeast, to nematode worms, flies, spiders, grasshoppers, guppies, trout, mice, hamsters and dogs.

Why? The theory is that reduced food intake might push a biological button inside our cells, telling them to hunker down. If snacks are scarce, it makes little sense to burn calories by, for example, gearing up for reproduction. This is an energetically expensive process with the

added disadvantage that your offspring would be born into a world without enough food.

Instead, evolution would prefer that an animal in this situation preserves its energy and reproduce another day. Instead, the body slows the ageing process, improving the odds that you’re still biologically young and fit enough to reproduce when food returns.

TRIMMING THE PROTEIN

While there’s a decent weight of evidence for calorie restriction in animals, data in humans are harder to come by. Funders, ethics committees and participants are understandably reluctant to sign off on the forcible adoption of multi-decade meal plans.

The biggest trial to date was the so-called CALERIE trial (Comprehensive Assessment of Long-term Effects of Reducing Intake of Energy – see what they did there?), where participants aimed to cut back their intake by



Eating less has previously been recommended to reduce waistlines and obesity-related diseases. Now, studies are revealing it could also help you live longer

25 per cent for two years. (In practice, the average reduction was just 12 per cent – an indication of how hard diets like this are to maintain, even with a lot of help from scientists.)

Two years is obviously far too short a time to determine if it made people live longer, but they did lose an average of 8kg (17.6lb), and saw modest reductions in LDL cholesterol, blood pressure, blood sugar and markers of inflammation.

There's another question that's perhaps even more important if you want to put this idea into practice yourself: what exactly should you be cutting back on? Recent research suggests that we actually need to eat less of the current health influencer darling: protein.

For instance, one study from The University of Sydney suggested mice on a low-protein diet lived about 30 per cent longer than those fed protein-rich chow.

It might even get more specific than that. Proteins are made up of 20 chemical building blocks called amino acids, and

cutting back on one or more of them can be enough to increase lifespan. Research has found that cutting back on 'branched-chain' amino acids (BCAAs, named after the shape of their chemical structure) can make male mice live 30 per cent longer (why it doesn't work in female mice is unknown). Cutting back specifically on isoleucine, another amino acid, helped male mice live 33 per cent longer (but female mice just 7 per cent).

Research into other amino acids, however, shows that it's a delicate balance. Take methionine, for instance. Mice fed a diet containing 0.15 per cent of this amino acid lived a whole 10 per cent longer than mice eating a more typical 0.4 per cent methionine diet. Mice in the same study were also fed 0.1 per cent methionine and died early, often with rectal prolapse – I think I'd rather die of old age than run the risk of that happening.

Recent work has switched from restricting dietary components to trying

to optimise them instead. The challenge is that, with 20 amino acids, the number of combinations rapidly becomes overwhelming.

Even if you wanted to try just 'high' and 'low' amounts of each amino acid in combination, that would require over a million experiments.

THE DNA DIET

Scientists have tried to sidestep this problem by looking into our DNA, which contains the instructions for building proteins. The LEGO bricks that make up proteins are amino acids. What if we provide an organism with a diet whose amino acid ratio directly mirrors the proportions found in the DNA?

An initial study in fruit flies found that those on the DNA-matched diet grew bigger, grew faster, laid more eggs and lived longer than the flies who were fed regular food.

Follow-up work has taken place in mice – when fed the ideal dietary amino

acid ratio found in their DNA, they grew bigger faster, and the male mice had more muscle and better sperm production. But we don't yet know whether these mice will also live longer.

What might be happening biologically when protein is cut from a diet is unclear, but scientists are starting to pull back the curtain. Like straightforward calorie restriction, it seems to slow down the ageing process pretty broadly.

A new paper published in May 2025 even suggests low-protein diets could reduce damage and mutations in DNA. The suggestion isn't that protein directly causes mutations, but that its effect on an organism's metabolism results in the production of 'free radicals' that can cause damage to DNA and other molecules in our cells. Mutations in DNA are known to cause cancer and have long been suspected of having a more general role in the ageing process.

The idea that dietary changes could indirectly affect something as fundamental as the rate of these chemical 'typos' appearing in our DNA is worth exploring.

LIVE AND LET DIET

So, should you start cutting back on protein? While the animal data is suggestive, results in humans are more mixed. One 2014 paper found that people eating less protein lived longer than those with a high-protein diet: a 50-year-old eating less than 45g (1.6oz) of protein per day could expect to live around four years longer than one eating 90g (3.2oz) daily.

Giving general advice is tricky, though: in the over-65s, the same study found the reverse effect. One reason could be that we tend to lose muscle mass with age, and eating extra protein makes it easier to pile on the lean pounds.

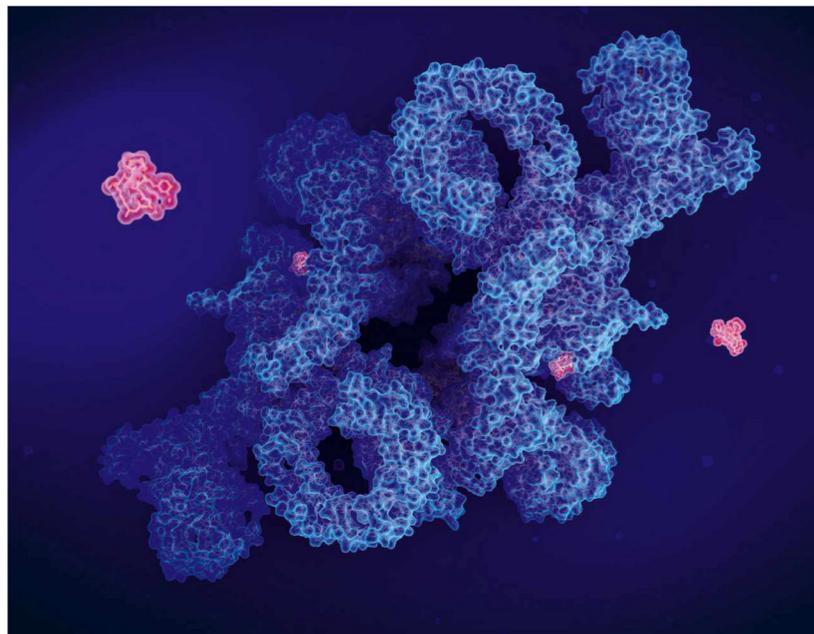
The scientists also found that those eating more plant protein didn't see this increased risk of death in mid-life. This has led some to argue that the risk increase has more to do

“Should you start cutting back on protein? While the animal data is suggestive, results in humans are more mixed”



by **DR ANDREW STEELE**

*Andrew is a London-based scientist, writer and presenter. He is the author of *Ageless: The New Science of Getting Older Without Getting Old* (Bloomsbury, 2020).*



Rapamycin (red) switches off a protein called mTOR (blue), which is closely linked to ageing

with eating excess meat – especially red and processed forms – rather than protein in general.

Another possibility is that plant proteins tend to be lower in certain amino acids, including methionine, so it might be that people who eat more veg are already enjoying a bit of methionine restriction as a result of their diet.

Unfortunately, there haven't been any human studies on purposely restricting amino acids yet. But it would be really interesting to try this in people – perhaps not with protein powders, but by finding some combination of dietary protein sources that match up to our DNA's requirements, making it easier to implement in everyday life.

Finding this could help sidestep the side effects of dietary restriction: people cutting back on certain foods report hunger (unsurprisingly!), feeling cold, a lower sex drive, irritability and slower wound healing. As the old longevity science joke goes, dietary restriction might not make you live longer, but it will certainly *feel* like longer.

A BETTER PILL

Perhaps the solution doesn't lie in the fridge, but in the medicine cabinet instead. A drug called rapamycin, for instance, activates a cellular recycling pathway (one that also occurs during dietary restriction), making mice live up to 60 per cent longer.

Diabetes drugs that lower blood sugar are another way to emulate eating less and they also extend the lifespan of mice. And, of course, GLP-1 agonists such as semaglutide (Ozempic) seem to prevent a whole range of conditions at once, in large part by directly reducing how much people eat.

Could one or more of these medicines help us all stay healthy without needing to observe a decades-long diet?

As someone who wants to live a long, healthy life but doesn't want to be a 'hangry' 100-year-old, I hope the clinical trials start soon. **SF**

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Q&A

YOUR QUESTIONS ANSWERED

LLEWI EVANS, MONMOUTHSHIRE

CAN PLANTS COUNT?

It depends on what you call 'counting'. Can plants enumerate 1–10 on their root tendrils? No. But scientists say certain plants can 'count' and even do simple maths because they possess uncanny abilities to keep tabs on insect invaders and their own food stores.

Venus flytraps, for example, famously snap their leaves shut when they sense a bug, or something else, moving on them. But they only do this if whatever it is moves twice within about 15–20 seconds. The movements are sensed by fine 'trigger' hairs on the leaves and translated into electrical pulses, carried by waves of charged atoms (ions) flowing through the plant. When an electrical pulse is triggered twice, the leaves snap shut.

But, as a group of international scientists showed in 2016, the botanical fly-baiters are able to tally higher than two. They wait until they've sensed at least three electrical pulses before they start producing the chemicals needed to





DR ALASTAIR GUNN
Astrophysics



PETE LAWRENCE
Astronomy



DR NISH MANEK
The human body



PROF PETER BENTLEY
Artificial intelligence



HAYLEY BENNETT
Botany



DR CHRISTIAN JARRETT
Psychology



DR HELEN SCALES
Marine biology



LUIS VILLAZON
Thought experiments



DR HELEN PILCHER
Animals

"TO KEEP THEMSELVES ALIVE AT NIGHT THEY HAVE TO SET A SUSTAINABLE RATE OF STARCH CONSUMPTION"

digest their prey, presumably to avoid wasting their energy on lucky escapees.

Even before this revelation, though, scientists were suggesting that thale cress (*Arabidopsis thaliana*), an inoffensive cousin to cabbage that's widely used in plant studies, could do something akin to division. During the day, plants use sunlight to build up their food stores (starch) via photosynthesis. But to keep themselves alive at night, they have to set a sustainable rate of starch consumption (starch divided by time) by gauging how much starch they're storing in their leaves and combining this information with their circadian sense of time.

Experts argue we shouldn't label these curious counting abilities as 'intelligent' or as evidence that plants have some primitive form of brain. They're just doing what they need to survive. But it's surprisingly sophisticated. **HB**



WRITE IN

The writer of next issue's Question of the Month receives **two hardback popular science books: *Out of this World and into the Next* and *The Thinking Machine* worth over £40!**

ALBERT LEWIS, LONDON

WHY DO DOGS LOVE TO PLAY WITH TRASH?

While they may snooze on our sofas and visit the grooming parlour, never forget that dogs are descended from grey wolves.

Our pampered pets have inherited the wolves' keen sense of smell and scavenging tendencies, making 'playing' with rubbish a favourite pastime for some. Wild wolves also roll in strong-smelling substances, such as faeces, to mask their scent when they're hunting.

So, watch out. If your dog is prone to bin-raiding, you may find them rolling in this morning's nappies, too! **HP**



KATE STOPFORD, VIA EMAIL

SHOULD WE BE GETTING BANANA FACIALS?

As someone who has trouble even looking at a banana without being a tiny bit sick in their mouth, I'd say no. But skin experts would encourage a healthy dose of scepticism around banana facials, too.

TikTok influencers have been extolling the benefits of antioxidants and various minerals in banana peel. It's true that the peel contains the antioxidant lutein, which has been shown to enhance skin tone. In studies, however, lutein was given as an oral supplement. The idea that you can transfer nutrients into your skin just by rubbing the peel on your face is, quite simply, bananas. **HB**



NATURE'S WEIRDEST CREATURES

THE HORSESHOE CRAB

Millions of years before dinosaurs began roaming Earth, strange-looking creatures were scuttling across the seabed. They looked like they were wearing spiked helmets, with little eyes on top and a sharp tail sticking out the back. The horseshoe crab still exists today and belongs to an order of animals known as Xiphosura, from ancient Greek words meaning 'sword' and 'tail'. Despite their name, they're not actually crustaceans, but more closely related to spiders.

Fossilised horseshoe crabs have been found dating back to the Upper Ordovician, around 450 million years ago. Since that time, their descendants – four living species – have barely changed their appearance, and they're often misleadingly called 'living fossils'.

Despite their ancient origins, horseshoe crabs play an important role in the modern world. Most people have, at some point, crossed paths with a life-saving dose of the horseshoe crab's vivid blue blood. The blue colour comes from the oxygen-carrying pigment haemocyanin, an equivalent to the red haemoglobin in vertebrate blood.

Crucially, their blood also contains powerful immune cells called amebocytes, which are highly sensitive to dangerous toxins produced by bacteria. Endotoxins are ubiquitous in the environment and aren't easily removed by sterilisation. If vaccines contain endotoxins, this can lead to a potentially lethal reaction historically known as 'injection fever'.

In the past, batches of vaccines were tested by injecting them into live rabbits. If any of them developed a fever, this showed the vaccines were contaminated. In the 1960s, marine

biologists in America noticed the horseshoe crabs' blue blood instantly coagulated when exposed to fever-inducing endotoxins. This protects horseshoe crabs from invading bacteria by forming clots around them. And it has also proved useful for humans.

Now, instead of injecting rabbits, hundreds of thousands of live horseshoe crabs are taken from the sea every year and lined up to have up to a third of their blood drained, to use to test for endotoxins in intravenous drugs and medical implants.

"MOST PEOPLE HAVE, AT SOME POINT, CROSSED PATHS WITH A LIFE-SAVING DOSE OF THE HORSESHOE CRAB'S VIVID BLUE BLOOD"

Demand for blue blood recently soared amid the race to develop COVID-19 vaccines.

Not all horseshoe crabs survive this blood-letting ordeal. Around 15–30 per cent die, leading conservationists to call for the blood tests to be replaced by synthetic alternatives. In the 1990s, researchers in Singapore developed a process for creating synthetic endotoxin-detecting compounds based on horseshoe crab DNA. There are now several versions of the replacement compound that mimic the reaction without using any horseshoe crab blood. Regulators were slow, but the new compounds were approved for use in Europe in 2016 and the United States in 2024. Now, pharmaceutical companies are increasingly turning to the synthetic alternatives.

This is good news, not just for horseshoe crabs, but also other species that depend on them. Each year, thousands of horseshoe crabs crawl onto sandy beaches along the east coast of North America, especially Delaware Bay near Philadelphia, to mate and lay eggs. A single female lays around 4,000 eggs. Many will become vital food for migrating birds, such as the red knot, stopping off on their epic flights between South America and the Canadian Arctic. **HS**

MARLOWE FOX, VIA EMAIL

IN AN AVERAGE LIFETIME, HOW LONG DO WE SPEND BLINKING?

A commonly cited figure is that we blink an average of 12 times a minute while we're awake and each blink lasts about a third of a second. So that's 11,520 blinks in a 16-hour day, taking up just over an hour. So in an 80-year lifetime, you'll spend three and half years blinking. That's had us thinking – what else do we waste our lives on?

▶ We yawn about nine times a day as an adult, even more when we were younger (a 12-week foetus yawns 25 times a day). That's at least two weeks of yawning in your life.

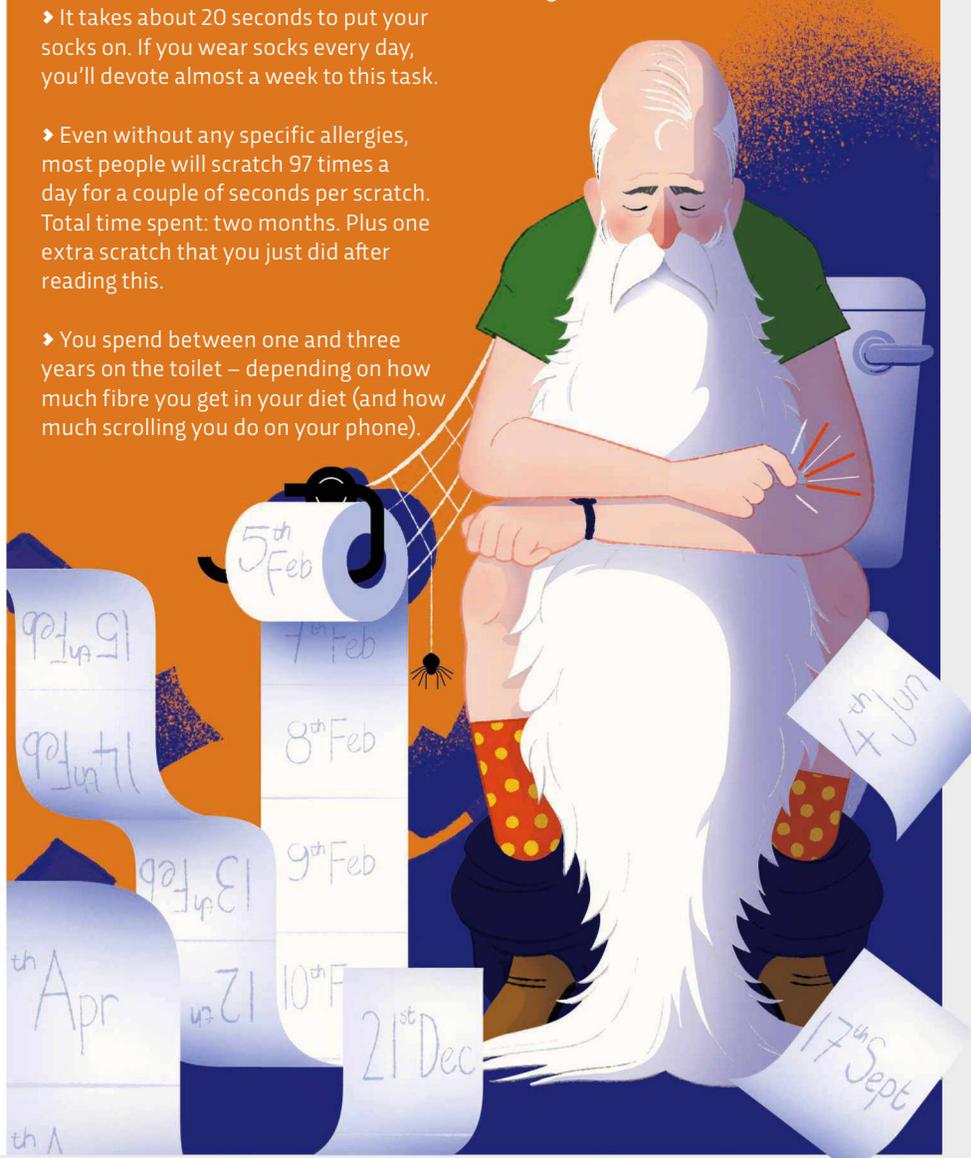
▶ It takes about 20 seconds to put your socks on. If you wear socks every day, you'll devote almost a week to this task.

▶ Even without any specific allergies, most people will scratch 97 times a day for a couple of seconds per scratch. Total time spent: two months. Plus one extra scratch that you just did after reading this.

▶ You spend between one and three years on the toilet – depending on how much fibre you get in your diet (and how much scrolling you do on your phone).

▶ You'll also spend just under three years travelling in a car. This means some people spend more time sitting on a loo seat than a car seat.

▶ You swallow at least 500 times a day. Mostly this happens when you aren't actually eating, just continuously cycling saliva from your mouth to your stomach to your bloodstream and back to your mouth. Some studies have measured normal swallowing rates as high as 1.32 times per minute. That's almost 2,000 times a day and would add up to a year and nine months of swallowing in an average lifetime. **LV**



NEAL MYERS, LINCOLN

HOW SHOULD YOU TALK TO SOMEONE WHO HAS JUST LOST A LOVED ONE?

Suffering a bereavement is one of the hardest experiences anyone can go through in life. Receiving love and support from others can make a huge difference, so it's wonderful that you want to be there for someone who's grieving and that you're thinking carefully about how to help them.

Everyone grieves differently, which is part of what makes it so difficult to know what to say and do. When emotions are raw, simply being there and offering your love and time might be what they most need. Bear in mind that research suggests we find it more difficult to empathise with others than we might think. Don't assume you know how they're feeling. Gently try to enquire how they are.

If you're unsure whether they want to be left alone or not, give them options. Rather than texting "Let me know what I can do", try something like "I could come over later, if you like?". For close relationships, showing up with a prepared meal or offering to help with practical tasks might be really appreciated, but always give them an opt-out (you could offer to leave a meal at the door, for instance, rather than coming in). Also, rather than rushing in with



ERICA MORRIS, VIA EMAIL

WHAT WILL SPACESUITS OF THE FUTURE LOOK LIKE?

Spacesuits are important if you leave Earth's protective atmosphere. Human-size miniature spaceships, they provide protection against intensive solar radiation, extreme temperatures, low pressure from the vacuum of space and impact from micrometeorites. On the Moon, there's also the problem of highly abrasive lunar dust, which can destroy bearing joints in suits and degrade their materials.

A spacesuit should allow excellent freedom of movement for the wearer, who may often have to go on spacewalks outside their ship to perform delicate equipment repairs. It also helps if it's quick to put on, in case there's an emergency. And it should also feature a full life-support system to maintain internal air and temperature. An astronaut may have to wear a spacesuit for many hours, so it needs to cater for food, rehydration and other bodily functions...

Over the years, there have been a lot of different designs, not all of them exactly fulfilling these criteria. Back in 1962, a bizarre hard-shelled suit known as the Gimmman was briefly tested. Looking like a cross between a dustbin and a blender, it had extremely limited freedom of

movement. Other hard-shelled 'AX' suits were tried, resembling futuristic suits of armour and often made of aluminium with rotary joints, but none ever made it on a mission – they were just too bulky and had too many joints to seize up. Instead, most real spacesuits were made from flexible, multilayer composite fabrics with hard shells limited to areas such as the head and upper torso.

Future suits may be more robust. Researchers are currently attempting to develop new self-healing materials so that damage will never be a problem for long missions to Mars. But perhaps the most exotic is the BioSuit proposed by Prof Dava Newman (pictured) at MIT. Astronauts would don a stretchy fabric suit,

which when activated by an electric current, shrinks embedded shape memory alloy

coils to become skin-tight for the ultimate in unrestricted movement, not to mention space-chic. Alternatively, the suit with the most yuck-factor is one with a proposed FO-RO (forward and reverse osmosis) unit.

Much like the Stillsuit from *Dune* – you guessed it – this suit recycles the astronaut's pee back into drinking water. **PB**



"IF THE GRIEVING PERSON SIGNALS AT FIRST THAT THEY WANT TO BE LEFT ALONE, DON'T ASSUME THAT WILL ALWAYS BE THE CASE"

advice or to positively reframe the situation, try to offer emotional support first. Really listen to what they say; be curious about how they're feeling and what they need right now. If it feels appropriate, you could use techniques that are associated with what psychologists call "active listening", such as paraphrasing or echoing back to the person what they've told you about their feelings, to show that you've really heard them.

As time passes and you get the sense that their emotional pain isn't so intense, it might be okay to switch to what psychologists call 'cognitive advice'. That could involve helping your grieving loved one find ways to express their grief and to feel more hopeful about the future – for instance, by adapting their life and routines in positive ways.

If the grieving person signals at first that they want to be left alone, don't assume that will always be the case. Check in with them periodically in a non-judgmental way. Having withdrawn at first, they might find it difficult to re-engage, so you could make it easier for them by reaching out occasionally.

Psychologists say it's often helpful to find ways to express our grief and one way to do that is with the help of others. For instance, it could be reminiscing together about a lost loved one or planning acts of remembrance for them by celebrating meaningful anniversaries or visiting special places. So when the time is right, this is another way you can be there for your friend or loved one, offering to join them in remembering and celebrating the life of the person they've lost.

Remember, there's no right or wrong way to grieve and the timeline for feeling better is different for everyone. However, if your loved one is still severely affected by their loss after more than six months, they might benefit from professional support – an option you could raise with them gently and tactfully. **CJ**

GETTY IMAGES, PROFESSOR DAVA NEWMAN/MIT/GUILLEMO TROTTI/DOUGLAS SONDERS PHOTOGRAPHY, PETE LAWRENCE

ASTRONOMY FOR BEGINNERS

TOP TIPS FOR OBSERVING PERSEIDS UNDER MOONLIGHT

- Use a comfortable platform like a recliner
- Hide the Moon from view behind a fence or building
- Avoid looking at bright lights (phone screens, for example)
- Look at areas of sky away from the Moon
- Look approximately two-thirds up the sky
- Meteor rates naturally increase after 1am BST
- Best nights are likely to be 9–15 August
- 12–13 August is the predicted peak night
- Be patient, under moonlight rates will appear to be significantly reduced

HOW TO SEE THE PERSEID METEOR SHOWER

WHEN: AUGUST

Meteor showers occur when Earth passes through the fine dust debris strewn around the orbit of a comet. This happens when Earth is in a similar position in its orbit every year, and meteor showers repeat on an annual basis. The dust distribution tends to be sparse in the outer regions of the stream, densest towards the centre before trailing off again.

Earth begins to pass through the wide dust stream of comet 109P/Swift-Tuttle from around 14 July, a passage that concludes around 1 September. Meteor rates are very low throughout most of this period, but as we encounter the densest part of the stream around 12 August, rates rise to a crescendo, producing a zenithal hourly rate (ZHR) of around 100–150 meteors per hour.

The ZHR of a meteor shower represents the rate expected under perfect conditions, a situation that's rarely met. Consequently, the actual number of meteors seen, the visual hourly rate, is often significantly lower, but at least a

high ZHR indicates that good activity is possible. One of the biggest factors affecting the actual number of meteors seen is how dark the sky becomes. Unfortunately for 2025, a big, bright Moon won't allow the sky to get very dark at all, casting a light veil across the sky that'll hide many of the fainter trails, leaving you with a view a little like the image above.

Not to be defeated, there are ways to reduce the Moon's effects. Sheltering behind a fence or building so the Moon can't be seen directly helps, as will looking at the part of the sky where the Moon isn't! One small blessing is that the Moon will be relatively low during the peak period, which helps. So, pull up a recliner, look away from the Moon and you should see some brighter Perseid meteors. You just need a lot more patience. **PL**



by PETE LAWRENCE
(@Avertedvision)

Pete is an astronomy expert and presenter on The Sky at Night.

WATCH THE SKY AT NIGHT ON BBC FOUR AND BBC IPLAYER

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ROBIN MASON, MANCHESTER

IS THERE ANYTHING ON EARTH THAT COULD WITHSTAND CONDITIONS ON MARS?

Mars is a pretty horrible place for any creature used to life on Earth. The average surface temperature is -63°C (-81°F) and doesn't reach above freezing anywhere except right on the equator, during the summer. The atmospheric pressure is equivalent to Earth's at an altitude of 35km (almost 115,000ft) – well above the cruising altitude of commercial aircraft. And this thin atmosphere is nearly all carbon dioxide, with just the merest trace of oxygen. Then there are the radiation levels, which are 400 times higher than on Earth, plus the lack of liquid water anywhere, except for occasional, very salty, trickles.

Despite this, there are a few Earth organisms that have shown some capacity to withstand these conditions. The European Space Agency ran a series of experiments from 2008–2016 in which a variety of organisms and seeds were given simulated Martian conditions while aboard the International Space Station. Tardigrades, fungi and some bacteria survived for over a

year, but only when in a dormant state, such as a spore or cyst. Some lichens and algae were able to go further, demonstrating some actual metabolic activity if they were partially shielded from the radiation. On Mars, this might be possible if they were buried in the soil or sheltering in cracks in the rocks.

In 2024, Chinese researchers showed that a variety of desert moss (*Syntrichia caninervis*) was able to withstand Martian conditions. But again, 'withstanding' is a long way from actually thriving. The moss *recovered* after a week in simulated Mars conditions and was able to grow normally again, but the researchers couldn't find any evidence that the moss was metabolically active, for example by producing oxygen, while it was in the Mars environment.

But wait, it gets worse. Martian soil contains perchlorates, which are rather nasty oxidising agents that are toxic to cells and cause DNA damage. And when they're exposed to the ultraviolet light that shines on Mars, they become even more reactive.

The Chinese experiment didn't include perchlorates in their simulated Mars environment; if they had, it would have probably killed the moss outright. There are some fungi that can survive perchlorates and a few species of bacteria that can even use it as an energy source and break it down to harmless byproducts. But these species also require water and warmer temperatures to live and grow.

Here on Earth, when we preserve something, we use a variety of methods to kill bacteria and fungi, or prevent their growth. We put food in the freezer, dehydrate it, sterilise it with UV light, pickle it in brine and other salts, or seal it in a container under a vacuum or with an inert gas to remove the oxygen. Mars, is all these things at once! If we were trying to sterilise the planet, we would struggle to do a better job than Mars has already. **LV**



SAM RUSSELL, VIA EMAIL

WHAT'S THE STRANGEST SATELLITE IN SPACE?

Current estimates suggest there are over 12,000 artificial satellites in orbit around Earth. Many of these perform specific tasks such as monitoring Earth's environment, aiding communication and navigation, spying, and so on. Some objects are merely defunct satellites or flotsam and jetsam from previous launches. But a tiny fraction of these artificial satellites are (or were) distinctly odd.

Last December, an experimental satellite was released from the International Space Station. 'LignoSat', built by Kyoto University for JAXA (Japanese Aerospace Exploration Agency), was partly constructed of wood – honoki magnolia to be precise. Equipped with various sensors, the 10 x 10cm (4 x 4in) satellite was designed to test the wood's ability to withstand the conditions of space.

Perhaps the strangest satellite is one that may not exist. A popular conspiracy theory holds that an extraterrestrial craft, known as 'Black Knight', is in orbit around Earth – likely inspired by a NASA photo of space debris taken during a Space Shuttle flight in 1998. **AG**



LANEY FOX, STAFFORD

HOW DO I KNOW WHEN TO LET GO OF PAST GOALS OR DREAMS?

Many of us harbour deep ambitions that are an essential part of how we see ourselves – perhaps you fantasised about becoming a successful novelist or professional athlete, or to settle down and start a family. At the same time, it's difficult to escape the ubiquitous message, echoing through many popular psychology books and emblazoned on so many cushions and kitschy wall posters – that if we want to achieve our dreams, we mustn't give up; we must be gritty and stubborn and determined.

But what many of us find is that reality comes knocking. You simply don't have the time to write a novel, not when you're working hard to pay the bills. Maybe you developed a health condition that means you can't ever be a professional athlete. The relationship cards you've been dealt mean you can't start a family.

Some goals are unattainable no matter how hard we try. In these circumstances, grit won't help. You need a construct that psychologists call 'goal adjustment capacity' – the ability to judge when it's in your interest to pivot from an unreachable dream to a different one. There's no simple calculus to tell you when to make this switch. But being adept at goal adjustment involves being realistic about the price you're paying for pursuing your current dream.

Also, remind yourself that giving up a goal doesn't make you a failure; it's not a judgment on you as a person. Loosening your fixation on a past dream always opens up new opportunities. **q**

CASSIE DAVEY, VIA EMAIL

WHY DO MORE PERIMENOPAUSAL WOMEN GET DIAGNOSED WITH ADHD?

The increase in ADHD diagnoses among peri- and postmenopausal women is likely due to a combination of hormonal changes and better recognition of how ADHD presents in women.

During perimenopause and menopause, women experience significant fluctuations in oestrogen and progesterone, which not only affect reproductive functions, but also influence brain chemistry. As oestrogen levels decline, women may find it harder to manage underlying ADHD symptoms, such as inattention or emotional dysregulation. Traits that were previously manageable can become more pronounced, leading women to seek help.

But hormones aren't the only factor – increasing awareness is also playing a major role. ADHD was historically considered a 'boy's disorder', primarily defined by hyperactivity and disruptive behaviour. Women, however, tend to exhibit more subtle symptoms such as forgetfulness, daydreaming and internalised struggles, which are often overlooked or misattributed to other causes, like anxiety. Today, clinicians and the public are better at recognising ADHD in women, particularly as awareness spreads through social media and patient advocacy. This might help to explain why we're diagnosing more ADHD overall, not just in perimenopausal women.

For many women, perimenopause is a time of reflection, leading them to connect longstanding struggles with ADHD. This convergence of hormonal changes and better recognition makes this an important time for women to seek support and diagnosis. This time of life can feel like a perfect storm, but with the right guidance and treatment, women can hopefully gain a new sense of control and wellbeing during this transformative stage of life. **NM**



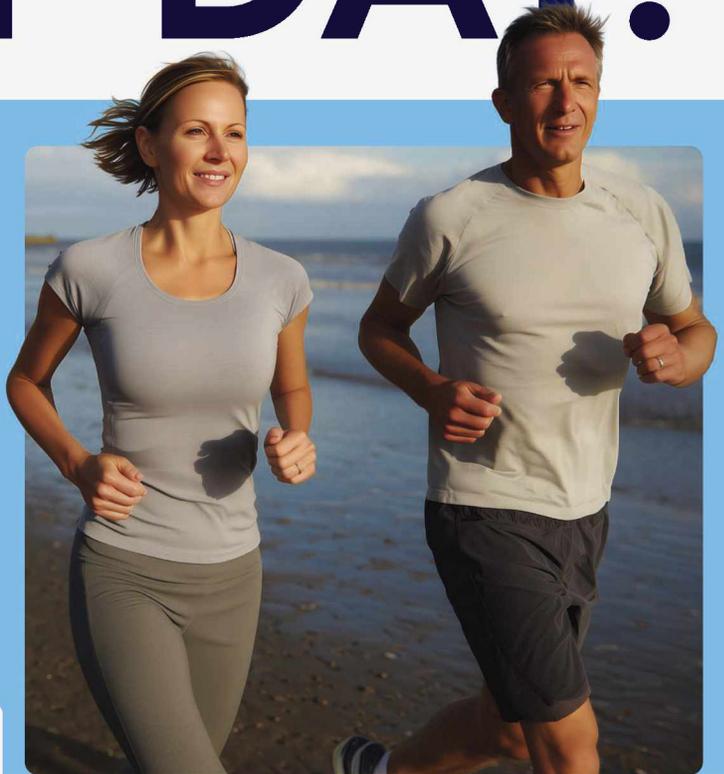
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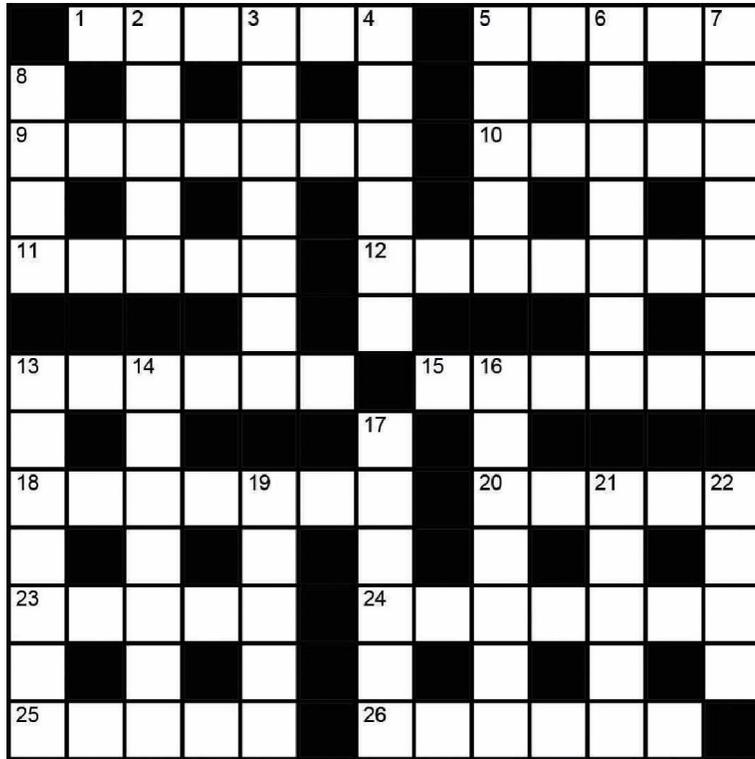
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CROSSWORD

PENCILS AT THE READY!



ACROSS

- 1 Persist at some length as a harridan (6)
- 5 Graduate with this vowel-less subject (5)
- 9 Room next to first musician (7)
- 10 Nonsense without last spin (5)
- 11 Swagger, revealing a bit of reinforcement (5)
- 12 Required former pupil to glide about (7)
- 13 Wept about former queen getting tin mixture (6)
- 15 The first mistake causes fear (6)
- 18 Pass glee off in university (7)
- 20 Chairs, as set out (5)
- 23 Charitable types getting rid of new openings (5)
- 24 Strange about fellow, in trouble, getting metal (7)
- 25 Learn layout of the kidneys (5)
- 26 Evergreen, heartless talk (6)

DOWN

- 2 It makes a straight line for the sovereign (5)
- 3 Girls worried about the first additive - you can't eat it (7)
- 4 Negative turned into an impulse (6)
- 5 Perfect sitter (5)
- 6 Piglet's friend has right to set off (7)
- 7 Large broadcaster outside is modest (7)
- 8 Unusual case for experts (4)
- 13 Entertainer heard to choose an entrance (7)
- 14 Obstacle, having nothing on tongue (7)
- 16 Each back from one direction (7)
- 17 Non-imperial crime solved, having time (6)
- 19 Please leave, taking a stand (5)
- 21 Animated a veil badly (5)
- 22 Total zero at sport (4)

ANSWERS

For the answers, visit bit.ly/BBCFocusCW
Please be aware the website address is case-sensitive.

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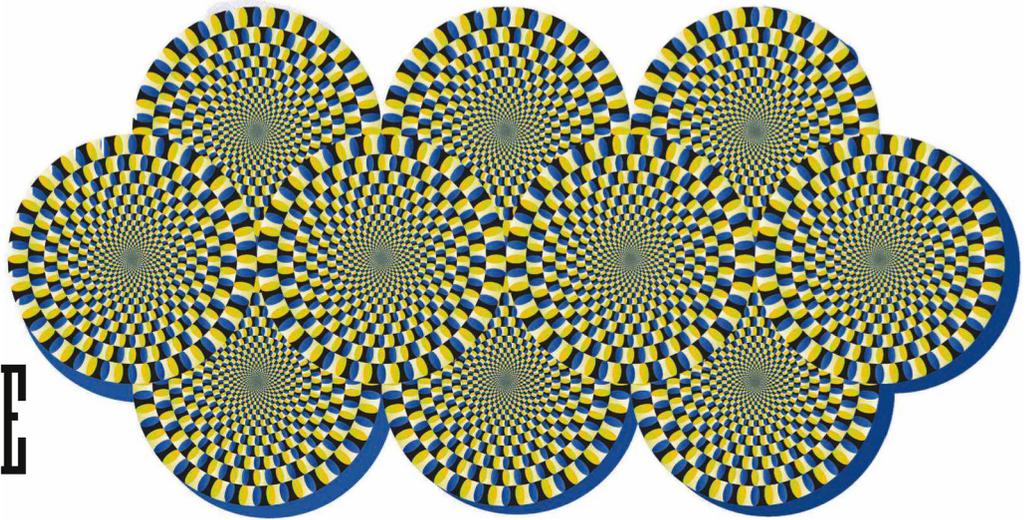
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ALAMY

EYES ON THE PRIZE

A strange visual trick can speed up learning and boost performance



Take a look at the image on the page here. Weird, right? It looks like the pattern is rotating, especially when it's in your peripheral vision, or when your eyes make tiny movements over the picture.

Now look again, and this time try to steady your gaze. Fix your vision at a set point and try not to move your eyes. Two things will happen: the illusion should stop moving and, when it does, you'll have successfully completed your first session of 'quiet eye' training. Congratulations!

You may be wondering what the point of that exercise was. Well, quiet eye training is a potent, fast-track way to improve different motor skills. Sportspeople, surgeons, soldiers and pilots all use it to hone their abilities. It works by exploiting the way people control their eyes in order to guide a physical action, like a golf putt or a penalty kick at the European football championships this summer (no pressure, ladies...).

"There's a period of time that occurs immediately before the critical movement of the skill in which essentially the eyes shut down," says Prof Sam Vine, a researcher at the University of Exeter. "They become extremely 'quiet'."

This period is short – less than a second in some cases, over two seconds in others, but for those whose eyes are still and quiet just

a fraction longer, there are benefits. "The earlier you close down and steady the eyes prior to the movement you're performing, the better you perform the skill," Vine says.

The phenomenon was first observed in the 1990s by Vine's colleague Prof Joan Vickers. She noticed that golfers whose quiet eye was longer took more accurate shots. Since then, Vine and others have shown the same is true in a remarkable range of motor skills across different sports, from football and rugby to shooting and basketball. And it gave them an idea.

"If this is a characteristic of expertise, we wanted to know if we could essentially cheat learning by teaching novices to adopt this strategy and see if it speeds up the time it takes them to learn a skill," Vine says. It does. "We've tested it in pretty much every sport skill you can imagine."

Quiet eye training works beyond sport, too. It's used in military settings, as well as for drivers and pilots. In medicine, research has shown that it can improve a surgeon's dexterity and even surgical outcomes. Meanwhile, Vine has used it as a kind of developmental therapy for children with dyspraxia.

"Some of our best work is in showing that people with dyspraxia have a reduced quiet eye," Vine says. "Quiet eye training can be a really powerful method for allowing them to learn complex skills that they've otherwise struggled with."

One of the curious things about the quiet eye phenomenon is that, despite it clearly working, researchers don't have a full picture of how. "We still have a lab team who are essentially

trying to understand exactly what quiet eye is, where it happens in the brain, how it works," Vine says.

From the research to date, the attention centres of the brain play a part, and quiet eye seems to optimise the flow of information through the eye at a critical moment. This might lead people to "self-organise" their bodies more accurately, making them more skilful.

It also makes you perform better under pressure. "Back in 2009, we published a paper which was the first to show that if you make somebody anxious, you essentially disrupt and reduce the duration of their quiet eye under pressure," Vine says. Having a longer natural quiet eye may prevent that from happening, for example, helping a footballer score a high-pressure penalty.

For pros, training is admittedly more complex than staring at an optical illusion. Vine works as a quiet eye consultant with Olympians, soldiers and others. He uses eye-tracking technology and well-honed drills, but says that anyone can give the basics a try.

"One of the beautiful things about quiet eye training is that it really isn't rocket science. It's fundamentally quite simple as a concept and enabling the person to buy into the simplicity of it is often what's so powerful."

Another drill you can try is simply to focus on your target for an extended period of time before you take the action. It could be the centre of a basketball hoop or the top right corner of a goal. Remember to keep your eye as still as possible and then repeat, repeat, repeat. You should quickly notice an improvement. **SF**

by **IAN TAYLOR**
Ian is a freelance science writer and the former deputy editor of BBC Science Focus.

"QUIET EYE TRAINING IS A POTENT, FAST-TRACK WAY TO IMPROVE DIFFERENT MOTOR SKILLS"

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