New Scientist

WEEKLY 11 October 2025

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THE RISING THREAT OF AI-CREATED BIOWEAPONS

HOW GENETICS IS REVEALING SUBTYPES OF AUTISM

THE UNIVERSAL LANGUAGE OF BIRDS

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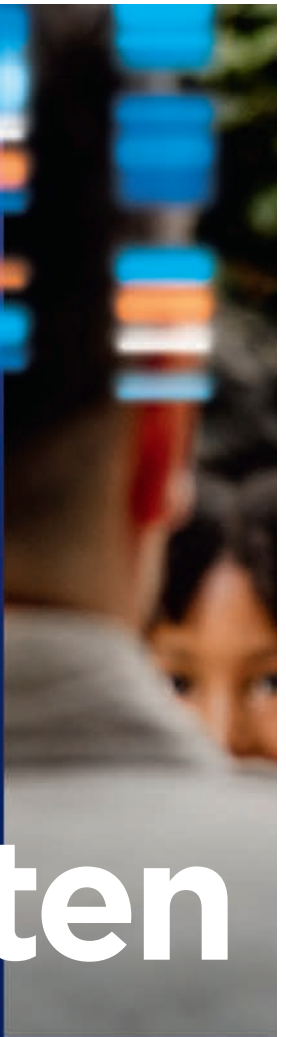

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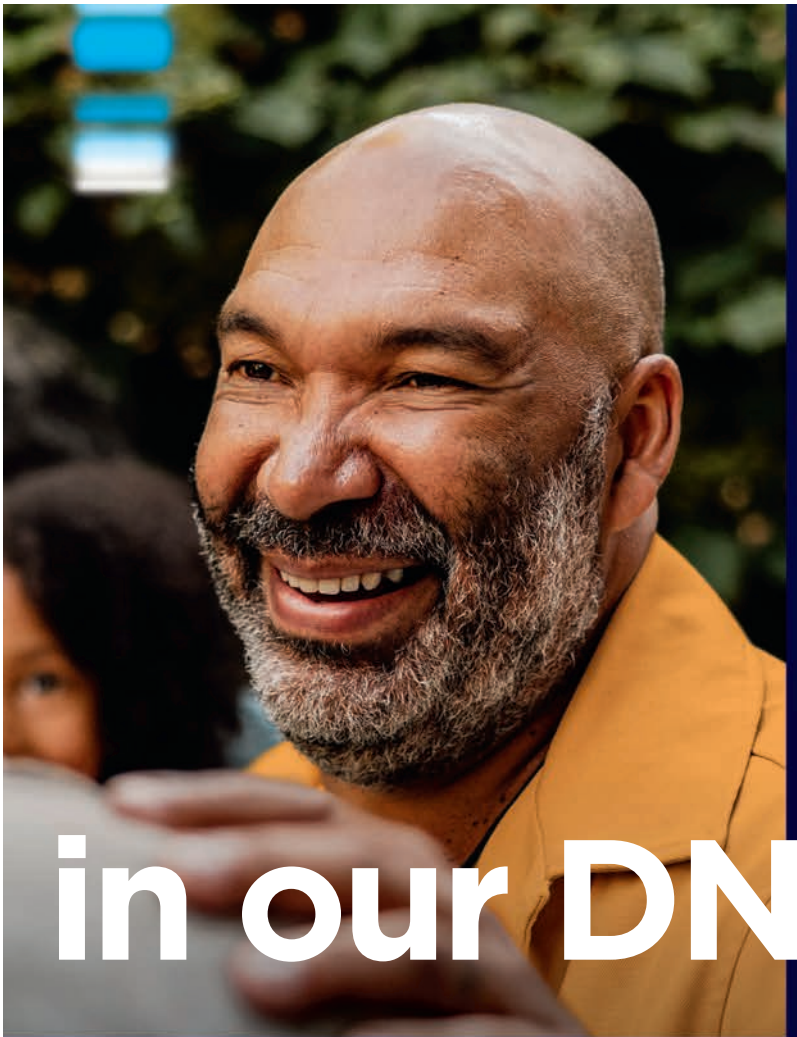

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Cover image: Matt Chinworth

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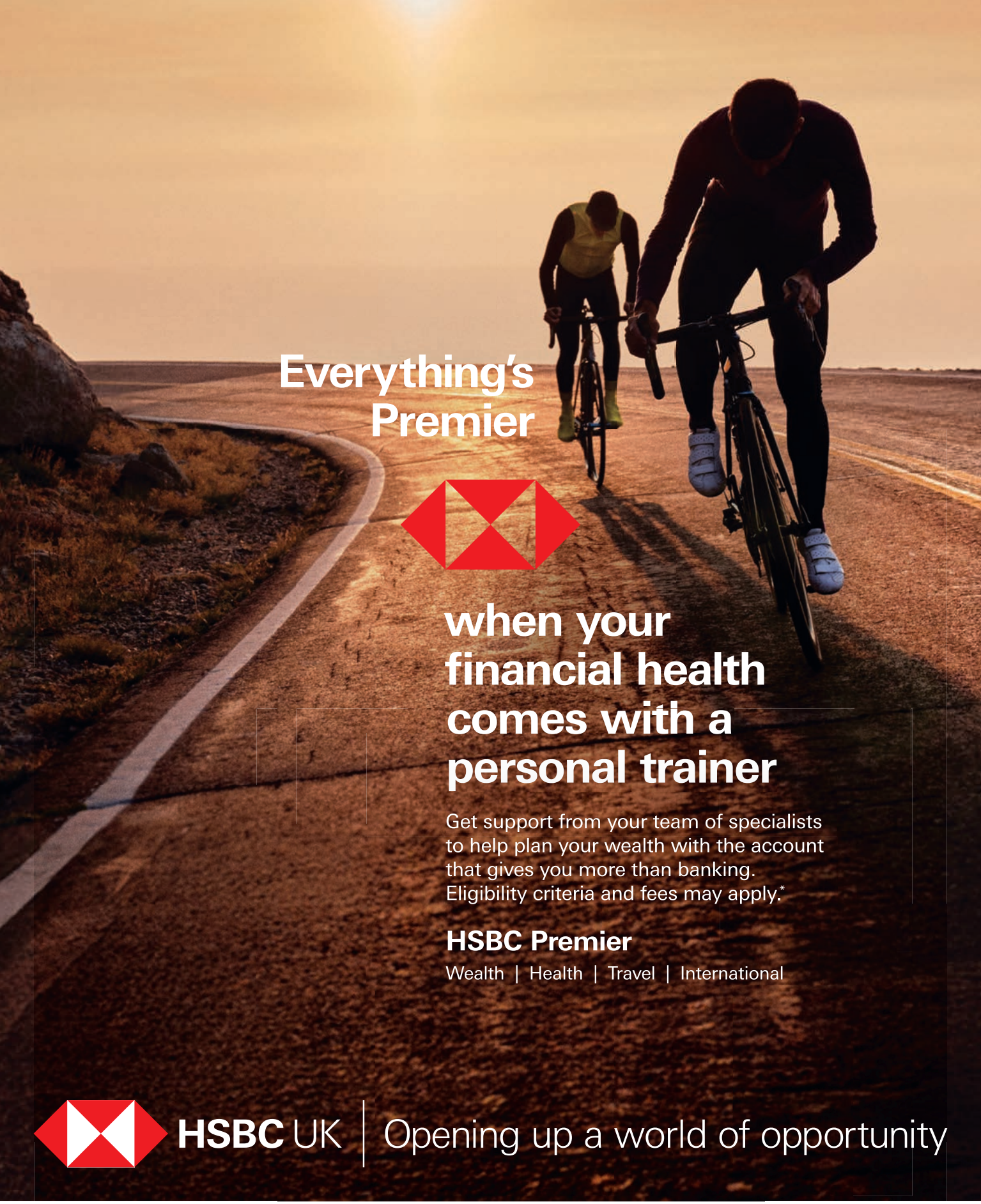

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The curse of knowledge

Commercial health tests promise peace of mind, but do they really deliver?

WOULD you get a full body MRI? Not because your doctor advised, but just to get a comprehensive health check? Recently, these scans, designed to either give you a clean bill of health or alert you to a previously undetected disease, including cancer, are popping up in private clinics. At a time when rates of some cancers are surging in younger people, who can blame those who can afford it if they opt for peace of mind?

And yet, full body MRIs may be more harmful than helpful. A 2019 review of studies, which included over 5000 asymptomatic participants, found that the proportion of people found to have a serious health issue, such as suspicious tumours, was on a par with the number of false positives. While a false positive might not do lasting harm, it can take a serious emotional toll and could lead to unnecessary surgical intervention.

This question of how much to know is at the heart of this week's cover story (see page 38), which examines how much we can know about our individual risk of Alzheimer's disease, particularly when it runs in the family. Tests to look for genes implicated in the condition are available, but Alzheimer's organisations generally advise people against taking them because the presence of specific gene variants isn't deterministic.

"Much of the time your health – and your wallet – could be better off without the tests"

Separately, there has been a rise in at-home tests for anything from liver health to your risk of developing various cancers. These are likely to tempt many of us with their promise of deeper health insights, but while these commercial tests may be helpful to some, it is important to remember that results may be inaccurate, and the findings might cause undue anxiety – because a heightened risk of a disease doesn't mean you will develop it.

The tests themselves might seem quick and easy, but deciding whether to take them should be a slow and considered process, one for which you would be wise to consult a health professional. In some instances, your health – and your wallet – might be better off without them. ▮

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Our brains may "swivel" to focus on different sounds p20

Space

From spelunking to the stars

Pictured here inside a cave in the Italian Apennines, Marco Sieber is part of an international team of astronauts who spent four days living and working underground to simulate the cramped, isolated conditions of spaceflight as part of a European Space Agency training programme. The group had to navigate uneven terrain, including vertical drops of 20 metres, and run experiments to monitor the cave environment.

ANDREW FOX/ALAMY

Climate change

Has Antarctic crossed tipping point?

We are beginning to understand the loss of sea ice in Antarctica – and it could represent a permanent shift with potentially catastrophic consequences, discovers **Madeleine Cuff**

ANTARCTICA may have passed a climate tipping point of no return, scientists are warning, with mounting evidence that a sudden slump in sea ice formation since 2016 is linked to human-induced ocean warming.

For decades, Antarctic sea ice levels remained relatively stable despite rising global temperatures. However, that shifted suddenly in 2016, when the extent of sea ice began to sharply fall.

In February 2023, Antarctic sea ice set a new record minimum, the third record-breaking summer for low sea ice in just seven years. September 2023 also saw a record low maximum for this sea ice.

Climate models have long predicted that sea ice loss would accelerate in the Antarctic, but the speed and magnitude of the decline since 2016 have taken climate scientists by surprise and researchers have been scrambling to explain the shift. Last week, scientists met at the Royal Society in London to discuss whether the recent changes represent a climate tipping point.

SHUTTERSTOCK/OLEKSANDR MATSIBURA

Sea ice levels in Antarctica have reached record lows

Warming waters

Natural variability in climate and weather cannot explain the sudden transition, says Marilyn Raphael at the University of California, Los Angeles.

The satellite record for sea ice measurements only began in 1979. Using proxy data from Antarctic weather stations, Raphael and her colleagues extended the time series back to the start of the 20th century.

They concluded that, based on historical data alone, the chance of 2023's sea ice minimum happening was less than 0.1 per cent. "We really are looking at extreme behaviour in terms of sea ice," she said in a presentation at the Royal Society meeting.

The sudden decline in ice formation has the hallmarks of a climate tipping point, says Alexander Haumann at the Alfred Wegener Institute in Germany. He told delegates that the change happened suddenly, affected the entire continent and will cause outsized impacts on the wider climate and ecology of Antarctica.

"What we are seeing now is that the entire Antarctic sea ice is responding as a whole," he told *New Scientist* at the meeting. "And the changes that we are observing are very long term and seem to be retained in the system for a long time."

Haumann says a "superimposed change" on the sea ice system is to blame, and now emerging research suggests that warming ocean waters are behind the sudden decline. The world's oceans have absorbed around 90 per cent of the excess heat trapped in the atmosphere as a result of human activity.

In Antarctica, warmer, deep ocean waters are usually kept separate from mixed surface waters by a layer of cold, fresh water. But new research by Haumann and his colleagues suggests that changes to wind speeds and salinity in the Southern Ocean have significantly weakened this boundary layer since 2015, resulting in greater upwelling of warmer, deep ocean water to the surface, driving ice loss. This deep ocean water has been warming as a result of climate change, studies show.

> **"The sudden decline in ice formation has the hallmarks of a climate tipping point"**

Haumann says natural variability in the climate system may have triggered the changes to ocean salinity and winds, but he warns that this has unleashed the effects of human-caused warming stored in the deep ocean water. In effect, it may mean the impact of warming ocean waters is now being felt in Antarctica, where it is limiting the formation of new sea ice.

The recent circulation changes could only be reversed by a dampening of the upwelling effect or a sudden change in the saltiness of the Southern Ocean, such as through a rapid influx of fresh water from the melting of a huge glacier, says Haumann. But any future system response is highly uncertain, he says.

The consequences of this recent shift could be catastrophic. Antarctica's sea ice helps to stabilise glaciers and ice sheets on the land. Without adequate sea ice formation, their melting rates will accelerate, with the potential to cause extreme global sea level rise. It is estimated that the Antarctic ice sheet contains enough water to raise global sea levels by 58 metres.

Loss of Antarctic sea ice will affect the brightness of Earth's surface, as dark ocean waters absorb more heat from the sun than reflective white ice, resulting in further warming.

Meanwhile, hundreds of gigatonnes of carbon that is stored in the deep waters of the Southern Ocean could also be released into the atmosphere via increased deep water upwelling, research suggests.

Scientists are only just beginning to understand how these kinds of climate feedback effects could play out in the Antarctic, after decades of grappling with inaccurate and low-resolution models. ▮

Genetics

Egg cells made with DNA from human skin fertilised in the lab

Christa Lesté-Lasserre

HUMAN embryos have been developed from eggs given the DNA of adult skin cells. This could provide a way for same-sex couples or women with fertility problems to have children who are biologically related to both their parents.

Scientists already know how to reproduce animals by cloning, through replacing an egg's nucleus with that of a body cell, such as a skin cell. But aside from the legal limitations with human cloning, many couples want babies with a mix of both of their genes, which requires sperm and an egg, says Shoukhrat Mitalipov at Oregon Health and Science University.

Eggs and sperm are haploid, meaning they carry only one set of chromosomes. The challenge, then, is halving the full set of chromosomes present in cells like skin cells after selecting a healthy blend of the original genes.

Girls develop all their eggs while still in the womb, where the progenitors of egg cells – which originally contain 46 chromosomes – go through an elaborate process of duplicating, blending and splitting to halve to 23 chromosomes.

Mitalipov wondered if he could mimic that process by taking advantage of natural chemical processes that favour such division in mature human eggs, before and during fertilisation.

> "This could be a way for gay couples to have children who are biologically related to both parents"

After achieving this in mice, he and his colleagues tested the approach in an early-stage trial in people (*Nature Communications*, doi.org/g95gvx). They removed the nuclei from hundreds of eggs donated by healthy women, which were stopped at a precise phase in their development associated with chromosome division. Next, the nuclei of skin cells called fibroblasts from a healthy female volunteer were placed into these eggs, and the researchers could see the chromosomes lining up on spindles, scaffolds within cells for separating chromosomes.

Then, the team injected sperm from a healthy donor to fertilise some of the eggs. This is a similar approach to that used to make embryos using a third person's mitochondrial DNA.

This injection normally triggers an egg to finalise its chromosome selection and eliminate duplicate DNA in preparation for receiving more from the sperm. But in the skin-derived eggs, this process stalled, with the chromosomes lining up but never finishing separating. So the researchers tried again with a new set of fertilised eggs, this time using electrical pulses that let calcium rush into the egg – simulating a natural signal triggered when a sperm cell contacts the outside of the egg – and incubating the eggs with a drug that switches them out of the inactive state they are usually in prior to fertilisation.

Over a series of tests, the researchers managed to get eggs that halved their chromosome count. By the experiment's end, 9 per cent of the fertilised eggs had become blastocysts – a ball of cells that forms about five or six days post-fertilisation, which is usually what is transferred to the uterus during IVF. The researchers didn't attempt such a transfer or maintain the blastocysts beyond six days.

But the mix of remaining chromosomes appeared prone to genetic problems. "I feel that this approach is currently far too immature to be considered for clinical application," says Mitinori Saitou at Kyoto University in Japan. ▮

Solar system

NASA's asteroid deflection test had a puzzling outcome

AFTER NASA smashed a spacecraft into an asteroid, its orbit slowly but surely changed over the next month, and astronomers can't explain why.

In 2022, the Double Asteroid Redirection Test (DART) flew a nearly-600-kilogram satellite into a small asteroid called Dimorphos, which orbits a larger one called Didymos.

Before the impact, Dimorphos completed an orbit every 11 hours and 55 minutes. Observations soon after revealed that the collision had reduced the orbital period by about 30 minutes, but in the following weeks and months, the orbit shrank even further, by another 30 seconds.

Astronomers said that this might be because the smaller satellite was gradually flinging out some of the rocks churned up by the impact that weren't immediately lost, causing the overall system to lose energy and the orbit to get smaller.

Now, Harrison Agrusa and Camille Chatenet at the Côte d'Azur University in Nice, France, have calculated that the ejection of rocks can't be the explanation, because Dimorphos isn't massive or strong enough to send debris flying out of the system (arXiv, doi.org/p79d).

"A boulder could fly by Dimorphos, and Dimorphos will scatter it onto a wider orbit. That can happen, but that boulder eventually is going to come back and come close to Dimorphos again," says Agrusa.

ASI/NASA

The asteroid Dimorphos (right) orbits the larger asteroid Didymos

He suggests a more likely explanation is that the impact sent it spinning in a complex way, which sloshed rocks and boulders on its surface back and forth. Friction from these boulders sliding around and colliding with each other could produce heat. The loss of energy as heat could account for the reduction in the asteroid's orbit, he says, although the study didn't model this.

While this highlights the difficulty in predicting how the orbits of asteroids change after they are struck, it is less relevant for deflecting asteroids heading towards Earth, says Agrusa. This is because binary asteroid systems like Didymos and Dimorphos are fairly rare, and this effect would be unlikely to occur for a single asteroid changing its orbit around the sun, which is what matters for a potential Earth impact, he says. ▮

Alex Wilkins

Mental health

How do your feelings of happiness vary as you grow older?

Chris Stokel-Walker

THE commonly held belief that happiness follows a U-shaped curve – with peaks at the beginning and end of life – might be incorrect.

The pattern was popularised in a seminal paper by researchers David Blanchflower and Andrew Oswald in 2008, based on data from half a million people. Since then, it has been held as a common belief and has even been the subject of mainstream books.

But Fabian Kratz and Josef Brüderl – both at the Ludwig Maximilian University of Munich in Germany – posit that this belief may be wrong.

Kratz says he was motivated to revisit the claim "because [the U-curve] did not reflect my personal experiences with older people". So the pair looked at self-reported happiness statistics for 70,922 adults who took part in the annual socioeconomic panel survey in Germany between 1984 and 2017. They then modelled how happiness changed within each person's life.

Rather than forming a U-shaped curve, they found that happiness generally declines slowly throughout adulthood until people's late 50s, when it begins to tick upwards until 64, then drops dramatically (*European Sociological Review*, doi.org/p78v).

TOM SALYER/ALAMY

People's levels of happiness change throughout their lives

One of the reasons Kratz believes previous studies have come to what he sees as incorrect conclusions is that they oversimplify the trajectory of happiness, partly by ignoring deaths brought about by suicide or ill health. "You get the impression that after a certain age, happiness would increase only because the unhappy people are already dead," says Kratz.

"There's been a lot of debate in the social sciences about non-replicable findings – results that disappear when new data are collected," says Julia Rohrer at the University of Leipzig in Germany. "But there's another, less appreciated issue: researchers sometimes analyse their data in systematically flawed ways. This can produce results that replicate reliably, yet are still misleading."

Avoiding the troughs

Others say the results prompt a new set of questions. "This paper is great for thinking about what we're really trying to know in research," says Philip Cohen at the University of Maryland, but he points out we should now try to learn why happiness changes throughout life and if the troughs can be avoided. Kratz and Brüderl themselves are keen to avoid speculating on why the changes they observed occur.

Oswald says the paper "has interesting results and all research should be welcomed", but he adds that the pair didn't control for factors such as marriage and income, which may influence happiness.

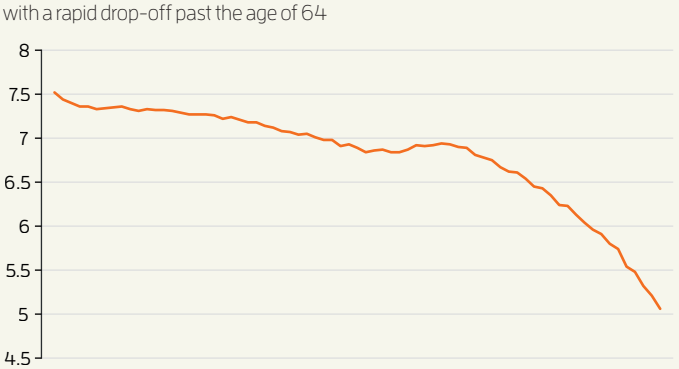
He also points out that the study only looked at one country, so we don't know if the results apply elsewhere. Kratz says this would be an interesting avenue for future research, particularly as the findings could have implications for policy. "Previous scholars argued that we need affirmative action policies to help individuals cope with their midlife crisis," says Kratz. "I do not want to say that this is not urgent, but our results suggest that the most urgent issue is to address happiness decline in old age." ▮

"Our results suggest the most urgent issue is to address happiness decline in old age"

Need a listening ear? UK Samaritans: 116123 (samaritans.org); US Suicide & Crisis Lifeline: 988 (988lifeline.org)

Happiness declines slowly, then all at once

Happiness, as measured on a scale from 0 to 10, declines as we grow older, with a rapid drop-off past the age of 64



SOURCE: EUROPEAN SOCIOLOGICAL REVIEW DOI.ORG/P78V

Ornithology

Birds may share universal warning call

Several species of bird from different continents use and understand each other's anti-cuckoo calls, a discovery that may tell us more about the origins of language, explains **Chris Simms**

MORE than 20 species of bird around the world use a similar "whining" alarm call to warn that birds like cuckoos are around. The call seems to be understood across species, and its specific use hints at how language may have originated.

Cuckoos are one of a range of some 100 species known as brood parasites that lay their eggs in the nests of other birds, attempting to con the hosts into incubating and caring for the hatchlings as if they were the hosts' own offspring.

Will Feeney at the Doñana Biological Station in Spain and his colleagues have now found that 21 bird species, which last shared a common ancestor about 53 million years ago, all use structurally similar "whining" vocalisations when they spot a brood parasite (*Nature Ecology & Evolution*, doi.org/p78m).

The species include superb fairy-wrens (*Malurus cyaneus*) in Australasia, tawny-flanked prinia (*Prinia subflava*) in Africa, Hume's leaf warblers (*Phylloscopus humei*) in Asia and greenish warblers (*Phylloscopus trochiloides*) in Europe.

"All of these different birds from all around the world seem to have converged on using this same vocalisation to denote their respective brood parasites," says Feeney.

The researchers found that the species that produce this alarm call often inhabit areas where there are lots of brood parasites that make use of many different host species, and when the potential hosts hear the whining call, they attempt to scare away the invader with aggressive physical mobbing.

"Brood parasites represent this very unique kind of threat. They are an enormous threat to your offspring but not at all a threat to you," says Feeney. "Our data suggests that [the call] is to bring in birds as quickly as possible, potentially to assist."

"For the superb fairy-wrens, because they're cooperative breeders, it's quite possible that the mobbing call is intended to draw in other individuals to participate in the mobbing," says Rose Thorogood at the University of Helsinki in Finland.

Call heard round the world

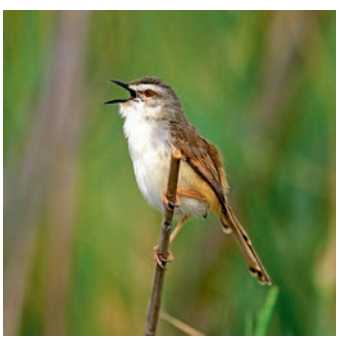
To investigate further, Feeney and his colleagues played recordings of the calls made by brood-parasite hosts from other continents to potential host birds in Australia and China. They discovered that hearing the foreign warning calls elicited just as rapid a mobbing response as hearing the calls produced by their own species.

"This indicates that the function of this vocalisation is to facilitate a communication across species rather than just within," says Feeney.

Thorogood warns "it might not be that they have an ancestral, ancient shared alarm towards brood parasites, but rather it might actually just be that there is a specific acoustic feature that seems to be quite successful at driving away brood parasites".

The team also did a similar playback experiment in territories of yellow warblers (*Setophaga petechia*) in North America, which are used as egg incubators by brown-headed cowbirds (*Molothrus ater*), but don't make the distinctive whining alarm call. When hearing the alarm calls of superb fairy-wrens, the warblers rapidly returned to their nests – much as they do in response to other calls indicating distress – rather than mobbing.

Feeney says this suggests there is an innate component to the alarm calls that many bird species respond to, but birds in areas where brood parasites are common have tailored the call and response to pass on knowledge of the local risk. "They've taken a distress call vocalisation and repurposed it for use in a novel context, which is a high threat to offspring," he says. "That would explain why all these birds from all around the world are using a similar sound."



JÜRGEN & CHRISTINE SOHNS/IMAGEBROKER.COM/ALAMY

Tawny-flanked prinia share an alarm call with many other birds

In 1871, Charles Darwin speculated that the origins of spoken language might be traceable to the imitation and modification of instinctive sounds that humans and other animals produce – for example, a squeak if you are scared or a scream in response to pain. "The birds adapting these innate calls to another purpose could be the first stepping stone towards language," says Feeney.

"All these different birds have converged on this same vocalisation for their brood parasites"

"Calls often have specific meanings, and in some cases, they refer to external objects or events, rather than merely communicating about internal states like fear, or attributes like sex or species," says Rob Magrath at the Australian National University in Canberra.

"This referentiality means that such calls are akin to human words, which often refer to external objects or events," he says. "So, animal communication and human language appear to be on a continuum, rather than 'language' being a uniquely human feature." ▮

DAVID ONGLEY

A superb fairy-wren (left) gets into a shouting match with a cuckoo

Archaeology

Shackleton's ship was doomed before it even set sail

Colin Barras

GRANGER – HISTORICAL PICTURE ARCHIVE/ALAMY

The Endurance became trapped in the Weddell Sea in 1915

IT HAS been 110 years since Endurance, often described as the strongest wooden ship ever built, sank after becoming trapped in sea ice near Antarctica. But a reassessment of the evidence reveals that the vessel was actually far weaker than other polar ships of the time – and also suggests that expedition leader Ernest Shackleton was aware of its shortcomings.

Shackleton had planned to trek across Antarctica from the Weddell Sea to the Ross Sea, visiting the South Pole on the way. But Endurance never made it to Antarctica's icy shore. In 1915, it became stuck in ice in the Weddell Sea and sank – although all crew members survived using the ship's lifeboats.

Jukka Tuhkuri at Aalto University, Finland, was involved in the Endurance22 expedition that discovered the wreck of the ship on the sea floor in 2022. Tuhkuri began to wonder why such a sturdy ship sank. But as he explored the history of polar vessels built at the time, he realised there was a simple explanation: Endurance wasn't particularly strong.

In the late 19th and early 20th centuries, a handful of boats were constructed to cope with sea ice. Some were more oval in shape than a standard ship, with a shallower keel. Both features make it harder for sea ice to get a strong purchase on the sides of a vessel, causing the ice to slide beneath the hull instead. Inside the ships, meanwhile, the lower decks gave the hull greater rigidity, because they crossed from the left to the right side of the vessel along its full length, creating box-like structures within the ship that strengthened it.

> **"This was a strong ship in a poetic sense. In an engineering sense it was not"**

Endurance had none of these features. It was a relatively long ship with a tall keel. Tuhkuri calculated that, as a result of this design, some of the other polar vessels of the time could withstand between 1.7 and 2.7 times greater compressional load than Endurance (*Polar Record*, DOI: 10.1017/S0032247425100090). What's more, the ship's engine was so large that the lower deck could run along only part of the length of the ship, ending at the engine room and creating a weak spot in the hull where there was no reinforcing box-like structure.

When Tuhkuri examined Shackleton's correspondence, he discovered that the explorer knew about these problems. In a letter to his wife shortly before he set sail for Antarctica, Shackleton confided that Nimrod, a ship he had used during an earlier Antarctic expedition, was stronger.

Predictably, Endurance couldn't cope with the crushing pressures of the sea ice. The boat was squeezed and bent, and eventually its keel was torn away to leave a gaping hole below the water line.

But by then, the myth that Endurance was the world's strongest wooden ship had emerged, and Shackleton perpetuated the idea. It is unclear why he did so, but it is a detail that Tuhkuri says adds colour to the story of Shackleton's ill-fated expedition. "Endurance was a strong and heroic ship in a poetic sense," he says. "In an engineering sense, unfortunately, it was not." ▮

Health

Cannabis extract offers alternative back pain treatment

Olivia Goldhill

A DRUG derived from cannabis eases chronic lower back pain without serious side effects or signs of addiction.

There are currently few treatment options for people experiencing chronic pain, with many having to take opioids that come with a high risk of addiction.

The experimental drug VER-01 is an extract from the cannabis plant containing 5 per cent tetrahydrocannabinol (THC), the principal active ingredient.

In a clinical trial, 820 people with chronic lower back pain were randomly assigned to take VER-01 or a placebo for 12 weeks. At the end of this period, people taking the drug had a reduction in their pain scores of 1.9 on average on a scale of 0 to 10, while those taking a placebo had a 1.4-point reduction (*Nature Medicine*, doi.org/g95cdc). There was no indication of a risk of withdrawal or abuse with the medication.

"It's one of the first really high-quality studies for medical cannabis which many people, both researchers and patients, have been waiting for," says Winfried Meissner at Jena University Hospital in Germany, a researcher on the study.

Those who took VER-01 also had significant improvements in sleep quality and most of the side effects were mild. People gradually increased their dosage during the trial, taking up to 13 doses per day.

The treatment was especially effective for back pain caused by nerve damage, known as neuropathic pain. Meissner says people with chronic pain should always be treated first with physical therapy, but painkillers can help those who are unable to move.

Although the reduction in pain wasn't massive, it is rare to see huge reductions in chronic pain, says Marta Di Forti at King's College London. ▮

Genetics

Autism may have different subtypes

DNA analysis suggests autism exists in a variety of forms that are diagnosed at different ages

Michael Marshall

THE age at which children are diagnosed with autism seems to be partly influenced by their genetics, which may also affect how the condition develops.

"This really provides support for the idea that autism is actually potentially multiple conditions," says Natalie Sauerwald at the Flatiron Institute in New York, who wasn't involved in the study.

Autism is a neurodevelopmental condition, characterised by difficulties with social interactions, plus restricted behaviours and interests. The World Health Organization estimates that about one in 127 people are autistic.

Varun Warrier at the University of Cambridge and his colleagues wanted to find out why some autistic people are diagnosed later than others. They compiled data on people who were diagnosed with autism between the ages of 5 and 17. Their carers completed a questionnaire about their social, emotional and behavioural development, to help the team see if these factors were associated with their age at diagnosis.

The sex of a child, as well as their socioeconomic status, have previously been associated with age at diagnosis, but the team's analysis showed that these influences are actually quite weak.

Instead, they found evidence of autistic children developing along different trajectories (*Nature*, doi.org/p78z). One group started experiencing difficulties early in life and these stayed largely constant. The other had fewer difficulties in early childhood, but experienced more in late childhood and early adolescence. This explained "anywhere between 10 to 25 per cent of the variance in age of autism diagnosis", says Warrier.

Further, the researchers found that these differences between the two groups were reflected in the children's DNA, which had previously been collected. Those who were diagnosed later tended to have a different set of common genetic variants than those diagnosed earlier, which explained 11 per cent of the variation in age of autism diagnoses. The team didn't have the necessary data to look for rare variants or those that arise spontaneously, rather than being inherited.

"This really provides support for the idea that autism is potentially multiple conditions"

Despite these two trajectories, there is no sign of a hard separation between them, says Sauerwald. "You have overlap between the groups, probably because they're not perfectly separable," she says.

Warrier emphasises that neither group should be thought of as having milder or more severe autism, which research increasingly suggests takes multiple forms. In July, Sauerwald and her colleagues published a study in which they found evidence of four moderately distinct groups, with differing symptoms, behaviours and underlying genetics.

Understanding possible autism subtypes could help improve diagnostic practices and lead to more tailored support for autistic children and their families. ▮

Space

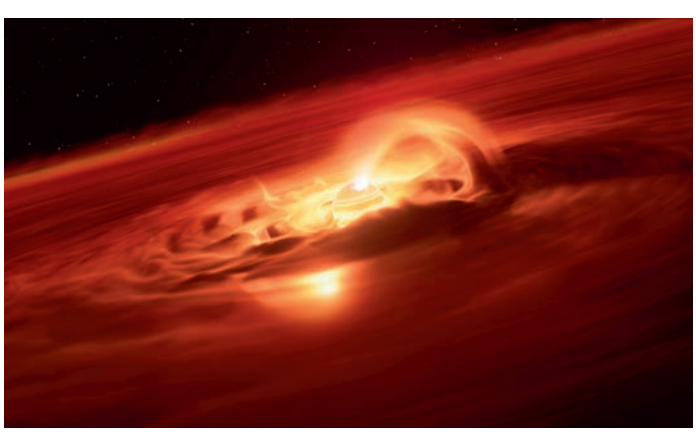
Ravenous rogue planet rampages through space

A ROGUE planet has been caught eating 6 billion tonnes of gas and dust per second. This behaviour blurs the line between planets and stars, suggesting both can form in similar ways.

Rogue planets, free-floating balls of gas unattached to any parent star, appear to be extremely common and may exceed the number of stars we see in the galaxy. But we still don't understand whether they form like planets in orbit around a star and are then banished to wander the galaxy alone, or if they can form by themselves like stars.

Víctor Almendros-Abad at Palermo Astronomical Observatory in Italy and his colleagues have now seen a rogue planet called Cha 1107-7626 going through a phenomenal growth spurt (*The Astrophysical Journal Letters*, doi.org/p78x).

The planet first caught astronomers' attention in 2008 because it had what looked to be a primitive planetary disc forming around it. Almendros-Abad and his team started observing the planet with the European Southern Observatory's Very Large Telescope in Chile in April, and in June they watched as it suddenly began consuming matter at nearly 10 times the rate it had before. It kept this up for the next two months.



ESO/L. CALÇADA/M. KORNMESSER

An artist's illustration of the rogue planet Cha 1107-7626

The planet reached a growth rate previously only seen in stars, like our sun, which have more than 100 times as much mass.

Almendros-Abad and his team think a mechanism similar to that found in stars must be at play, where strong magnetic fields funnel material through a narrow channel from the volume of gas and dust beyond. But it is unclear exactly how, or why, the planet began consuming so much more mass. ▮

Alex Wilkins

Analysis **Artificial intelligence**

Should we worry AI will create deadly bioweapons? Not yet, but one day

AI tools are being used to design proteins and viruses, but rising fears over them enabling bioweapon attacks may be misplaced, finds **Michael Le Page**

ARTIFICIAL intelligence promises to transform biology, allowing us to design better drugs and vaccines. But some fear it could also be used for darker purposes, to create bioweapons that wouldn't be detected by conventional methods until it was too late. So, how worried should we be?

"AI advances are fuelling breakthroughs in biology and medicine," says Eric Horvitz, chief scientific officer at Microsoft. "With new power comes responsibility for vigilance."

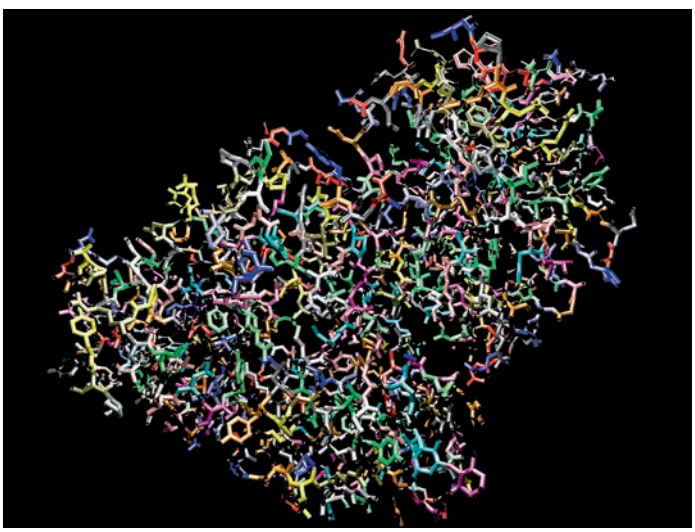
His team has published a study looking at whether AI could design proteins that do the same thing as existing dangerous proteins, but are different enough that they wouldn't be recognised as such (*Science*, doi.org/p78k). The team didn't reveal which proteins they attempted to redesign – parts of the study were withheld – but it probably included toxins such as ricin, famously used in a 1978 assassination, and botulinum, the potent neurotoxin better known as Botox.

"AI advances are fuelling breakthroughs in biology. With new power comes responsibility for vigilance"

To make lots of a protein like botulinum, you need the recipe – the DNA that codes for it. When biologists want a specific piece of DNA, they usually order it from companies that specialise in making any desired piece.

Due to concerns that would-be bioterrorists could order the recipes for making bioweapons this way, some DNA-synthesis companies voluntarily screen orders to check if someone is trying to make something dangerous. Proteins are sequences of amino acids, and the screening checks whether the amino acid sequence matches any "sequences of concern".

DR TIM EVANS/SCIENCE PHOTO LIBRARY; BELOW: AMERICAN PHOTO ARCHIVE/ALAMY



The toxin ricin is one protein that AI tools could be used to design

But with AI, it is in theory possible to design a version of a protein that has a different amino acid sequence but does the same thing. Horvitz and his colleagues attempted this with 72 potentially dangerous proteins and showed that screening methods often miss these alternative versions.

This isn't as alarming as it sounds. Firstly, the team didn't actually make the redesigned proteins, for obvious reasons. But in a separate study earlier this year, they tested redesigned versions of harmless proteins – and basically found they didn't work.

Ricin can also be obtained from natural sources, like castor beans

Secondly, while there have been attempted bioterrorist attacks, albeit very few, there is little reason to think this is because of a failing of the voluntary scanning system. There are already ways to obtain dangerous substances without resorting to AI redesigns – for instance, ricin can be obtained from castor oil plants, found in many gardens. This study is the equivalent of warning that a bank could be robbed by some highly sophisticated *Mission Impossible*-style plan, when in fact the vault door has been left wide open.

So does that mean we stop worrying about AI-designed bioweapons? Not quite. While Horvitz's studies looked only at proteins, it is viruses that pose the big threat – and AI is already being used to redesign entire viruses.

Last month, a team at Stanford University in California revealed the results of their efforts to redesign a virus that infects the bacterium *E. coli*. As with the redesigned proteins, the results were unimpressive – of the 302 AI-designed viruses that were made, just 16 could infect *E. coli*. But this is just the start.

A growing risk

When asked about AI-designed viruses, James Diggans at the DNA-making firm Twist Bioscience, and a member of Horvitz's team, said it is easier to detect DNA-encoding viruses of concern than proteins of concern. "Synthesis screening operates better on more information rather than less. So at the genome scale, it's incredibly informative."

But not all DNA-making companies carry out this screening, and bench-top DNA synthesisers are becoming available. There is talk of designing AI tools that will refuse to create dangerous viruses or try to detect malevolent intent, but people have found many ways to get around safeguards meant, for instance, to stop AIs providing bomb-making instructions.

History suggests the risk from "wild" viruses is much higher than the risk from bioterrorism. Despite what the current US administration claims, the evidence suggests that SARS-CoV-2 emerged when a bat virus jumped to other wild animals, and then to people at a market – no lab involved.

For all these reasons, the risk of an AI-designed virus being unleashed anytime soon is probably near zero. But this risk is going to grow as the required technologies continue to advance – and the covid-19 pandemic showed just how much havoc a new virus can create, even when it isn't especially deadly. Increasingly, there will be reason to worry. ▮

Chemistry

We've solved the mystery of highly reactive oxygen

Karmela Padavic-Callaghan

AFTER several decades, researchers have finally got a grasp on how an odd and destructive type of oxygen is formed in chemical reactions in living cells and certain batteries.

Not all oxygen molecules are created equal. In some, the two most energetic electrons have opposite values of quantum spin, while in others, the spins match. When they match, the molecule is known as "singlet oxygen", which is highly reactive; it can cause toxic changes in proteins and fats within cells and eat away at parts of some batteries. Now, Stefan Freunberger at the Institute of Science and Technology Austria and his colleagues have figured out when this evil twin of the oxygen we breathe arises in chemical reactions.

The researchers carried out a series of experiments that started with a molecule of superoxide – a compound that contains oxygen and participates in chemical reactions used by mitochondria to power cells – and ended with the production of oxygen in either form. While cells have enzymes that help this process, the team tried different "mediator" molecules. This allowed them to record oxygen-making reactions with a broad range of driving forces, or energy differences that force the reaction to happen in the first place. They discovered that it is exactly this driving force that matters – for singlet oxygen to form, the force had to get very high (*Nature*, doi.org/p783).

Because mitochondria have high pH values that keep the driving force low, the new work implies that singlet oxygen isn't produced in high quantities within these cellular powerhouses, which protects the cell from damage.

Kristopher McNeill at ETH Zurich in Switzerland says this analysis could explain why some kinds of batteries corrode from the inside. ▮

Ageing

Evolution could hold the key to women's longevity

Chris Simms

WE NOW have a better idea of why women live longer than men, on average, thanks to the most comprehensive analysis yet of the differences in lifespan between male and female mammals and birds.

The average global life expectancy is about 74 years for women and 68 years for men. There are various ideas why women tend to live longer, including that they are better protected against potentially harmful mutations in the sex-determining chromosomes, but the picture is far from complete.

72%
The proportion of mammal species where females live longer than males

To search for clues from other animals, Johanna Stärk at the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, and her colleagues analysed data on life expectancy in 1176 species – 528 mammals and 648 birds – in zoos and wild populations.

They found that in 72 per cent of the mammal species, females live longer than males, by 12 or 13 per cent on average. But in birds, males tend to outlive females in 68 per cent of the species, surviving about 5 per cent longer on average (*Science Advances*, doi.org/g95j6c).

The researchers say this trend backs up the idea that sex chromosomes account for some of the differences in lifespan.

In mammals, having two copies of the X chromosome makes an individual genetically female, while males have two different sex chromosomes, X and Y. In theory, females are better protected against harmful mutations in sex chromosomes, because the second copy of the X chromosome acts as a backup.

In birds, the sex determination system is the other way around: females have two different sex chromosomes, Z and W, while males have two Z chromosomes. So the different life expectancy trends in mammals and birds back up the idea that the sex with different chromosomes – the heterogametic sex – incurs a longevity cost.

Global life expectancy is higher for women than it is for men

REUTERS/OSWALDO RIVAS

The team also found that mating systems play a role. In polygamous mammals where there is strong competition for mates, males generally die earlier. This is also true of birds with polygamous mating systems. "This may also explain why the male advantage in birds is considerably lower than the female advantage in mammals," says Pau Carazo at the University of Valencia in Spain.

He says that in mammals, both the genetic factor and sexual selection traits work in the same direction in shortening male lifespan, whereas in birds the pressures may balance each other out, because males are often involved in strong sexual selection, but females bear the costs of heterogamy.

Stärk and her colleagues also found that the sex that invests more in raising offspring tends to live longer. In long-lived species like humans or other primates, this is probably evolutionarily advantageous, because it helps females survive until their offspring are sexually mature.

However, there were exceptions, like birds of prey. "The females are larger, and it's often the females that engage much more in protection of the territory, but still females live longer," says Stärk. Why is a mystery, she says.

The lifespan differences between sexes are smaller in zoos, says Carazo, which is probably because life in captivity minimises environmental pressures like fights and disease. ▮

Archaeology

Life-sized camel carvings

Almost 200 prehistoric engravings have been found in Saudi Arabia

James Woodford

ANCIENT inhabitants of the Arabian desert created monumental works of rock art on cliff faces, including life-sized images of camels (right).

Michael Petraglia at Griffith University in Brisbane, Australia, and his colleagues discovered 176 engravings on 62 panels in the Nefud desert in Saudi Arabia in 2023. There are 90 life-sized images of camels, another 15 smaller camel engravings and two camel footprints (*Nature Communications*, doi.org/p72t).

The researchers say the images were possibly carved to warn that the land was occupied or as a signpost for water sources.

The team also found stone points, beads and ochres indicating links with Late Neolithic people in the Levant, as well as tools that would have been used to make the engravings. These objects were able to be dated and ranged in age from 12,800 to 11,400 years old.

SAHOUT ROCK ART AND ARCHAEOLOGY PROJECT

Health

Uncovering the ins and outs of belly buttons

THE belly button, it turns out, is one of the least-studied parts of the human body. But one of its great mysteries may now have been solved – why most people have an "innie", or concave belly button. This may be due to a previously unknown structure that pulls the belly button inwards.

The discovery arose when a team of researchers was trying to determine the best techniques for abdominal and hernia repair surgeries, which often involve incisions to the belly button, also known as the umbilicus or navel.

In particular, the researchers wanted to reduce the incidence of what are known as "umbilical incisional hernias", where muscle weakness caused by previous surgery can lead to a bulge in the belly button when abdominal tissue tries to push through.

Satoru Muro at the Institute of Science Tokyo in Japan says in spite of the fact everyone has one, the anatomy of the umbilicus is almost "completely unreported". The researchers did a detailed microscopic analysis of the region around the belly button on five donated human bodies and then built a 3D model of the structure.

A belly button is the remnant of the fetal umbilical cord, which protrudes through the abdominal wall to connect to the placenta until birth. After birth, in around 90 per cent of people, the umbilicus scar heals into a concave divot. But Muro says the team discovered a "fibrous, tunnel-like structure" immediately beneath the umbilical skin that continues

"While everyone has one, the anatomy of the belly button is almost completely unreported"

"seamlessly" into the deep tissues. These deep tissues, the abdominal fascia, stabilise the abdomen and hold our organs in place.

"The structure is composed of densely-oriented collagen fibres arranged circumferentially like a sleeve, which we have named the 'umbilical sheath'," he says. "This sheath appears to anchor the umbilical depression to the deep fascia in all directions." This helps maintain the characteristic inward shape of belly buttons (*Research Square*, doi.org/p72m).

However, the team wasn't able to study anyone with an "outie", so they say more work will be needed to understand how the umbilical sheath varies in different individuals.

Kat Sanders at the University of Sydney in Australia says further research will be needed, as five subjects isn't a large enough number to generalise about everyone's navels. JW

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Every 3 minutes someone in the UK develops dementia.

It will take a society to beat dementia.

Alzheimer's Society

Neuroscience

Music is instrumental in learning how to read

Chris Simms

JIM WATSON/AFP VIA GETTY IMAGES

LEARNING to play an instrument seems to boost reading skills in young children by enhancing their ability to recognise and manipulate the sounds that make up words.

Music training has long been linked to improved early reading abilities, but how it does this wasn't clear.

To find out more, Maria Garcia-de-Soria at the University of Aberdeen, UK, and her colleagues studied 57 children, aged 5 to 9, with roughly equal numbers of boys and girls. About half had been learning an instrument for at least a month and were practising for a minimum of half an hour a week, while the rest did non-musical extracurricular activities.

They found that children who were learning an instrument outperformed the others on tests of phonological awareness. This is the ability to recognise and manipulate the sounds, or phonemes, that comprise words. They also showed better reading skills (bioRxiv, doi.org/p72r).

The team controlled for factors that can influence literacy, such as socioeconomic status and general cognitive ability.

In another part of the experiment, the researchers used electroencephalography to record the children's brain activity as they listened to a recording of *The Gingerbread Man* fairy tale.

Children who play an instrument may have advanced reading skills

They found that stronger neural activity in language-related centres of the left hemisphere of the brain was correlated with better reading outcomes for all the children. However, the musical group showed higher reading scores even with lower levels of this activity, which may mean they have more adult-like processing of language.

"Adults tend to process music and speech more bilaterally, and sometimes more on the right hemisphere. The musically trained children seem to have a more adult-like tracking of speech," says Garcia-de-Soria.

"The finding that musical training refines the left-hemisphere phonological encoding processes of language is consistent with the broader literature," says Alice Mado Proverbio at the University of Milano-Bicocca in Italy. However, music training can also lead to specialisation in the right hemisphere of the brain, fostering faster reading, she says. ▮

Physics

We may know what causes will-o'-the-wisps

Alex Wilkins

BUBBLES merging in water can spontaneously generate electric sparks powerful enough to ignite methane, which could explain mysterious flashes of light known as will-o'-the-wisps.

In bogs, swamps and marshes, people occasionally see mysterious blue-tinged flashes of light above water, which have commonly been associated with ghosts or spirits. A more likely explanation for these will-o'-the-wisps, or ignis fatuus, is that the flashes come from the combustion of gases, like methane and phosphine, produced by decaying organic matter in the murky water below. But it is unclear what would make the gases ignite.

Now, Richard Zare at Stanford University in California and his colleagues have observed spontaneous electric sparks between bubbles of methane and air in water in the laboratory, which they call microlightning. They say such events could easily have enough energy to ignite methane gas.

"We continue to discover things about water that, once you understand them, they're obvious, but before then, they seem completely bizarre," says Zare. "No one thinks of water related to fire. They think water puts out fire. They're not telling you, 'with water, I can get a spark and set something on fire'. This is new."

Zare and his colleagues had already seen water droplets, the size of a grain of salt, building up charge and spontaneously creating sparks, so they thought a similar effect might occur between methane bubbles in water. They used a nozzle to send microbubbles of methane mixed with air through water and observed where the bubbles would collide using a high-speed camera, as well as a photon counter and spectrometer.

"We continue to discover things about water that, before you understand them, seem bizarre"

As the bubbles rose through the water, they changed shape and accumulated charge. When two bubbles met, the difference in charge between them would cause a spark, producing a flash that Zare and his team recorded with both the camera and photon counter (*PNAS*, doi.org/g95d3t).

They also measured the frequencies of light in the flash, and found these matched the signature of specific compounds that had been chemically excited. This suggests the sparks would be powerful enough to trigger the ignition of a gas like methane.

While it isn't a definitive interpretation of what is causing will-o'-the-wisps, it is a plausible possibility, says Detlef Lohse at the University of Twente in the Netherlands, and likely to spark further investigation. ▮

Flashes of light in water have been associated with ghosts and spirits

CHRONICLE/ALAMY

Neuroscience

Our brain 'swivels' in search of sounds

Human ears no longer pivot towards certain noises, but our brains may do something similar

Caroline Williams

DOGS do it, cats do it, deer do it – in fact, many species of mammals can swivel their ears to direct their hearing. Humans lost this ability about 25 million years ago, but what we lack in ear-waggling skills we may make up for in our brain's ability to choose in which direction to listen most intensely.

Barbara Haendel at the University of Wurzburg in Germany and her colleagues used mobile electroencephalography (EEG) to record the brain's electrical activity while volunteers were on the move.

Until recently, EEG could only be done seated, with the scalp-mounted electrodes wired into a computer. In recent years, though, the development of smaller, lighter and, crucially, wireless EEG set-ups has made it possible to measure brain activity on the move, and to begin to connect behaviour with brain function.

These kinds of studies are revealing that movement has important effects on how the brain works. Haendel's group has previously shown that walking affects the processing of visual information, so we are more likely to notice objects in our peripheral vision, which would normally be suppressed when we're not moving. Now, her team has shown that something similar is true for sound, and the brain constantly adjusts which direction it should listen to the hardest.

In the experiments, 35 volunteers were fitted with mobile EEG sensors and motion sensors, and then asked to walk around a figure-of-eight-shaped path, while listening to a continuous stream of sound played through in-ear headphones.

Compared to when they were standing or walking on the spot, the EEG showed that there was a significant boost to sound-processing in the brain when the volunteers set off along the path. When they took a turn, the brain adapted further, prioritising sounds coming from that direction. As they continued along the path, the brain's internal focus of attention switched sides with each turn, as if panning from one stereo speaker to another, or physically turning an ear towards the sound (*JNeurosci*, doi.org/p72f).

Team member Liyu Cao at Zhejiang University in Hangzhou, China, speculates that this internal form of ear swivelling might be an evolutionary adaptation to staying safe. "This might allow for faster reaction times and safer navigation in dynamic environments," he says.

This research could help improve the design of navigation aids for people who are visually impaired and advance hearing aids so they filter background noise based on someone's direction of walking, says Haendel.

It might also help us understand why exercising outdoors seems to have more benefits for brain health and cognition than when it is done on treadmills or stationary bikes. "Active exploration sharpens perception, supports spatial mapping and integrates multisensory cues into a coherent sense of space," says Maren Schmidt-Kassow at Goethe University in Frankfurt, Germany, who wasn't involved in the study. "Cognition is deeply grounded in action." ▮

Space

A black hole jet has been captured in incredible new detail

IN 1918, astronomer Heber Curtis spotted the first black hole jet – a vast stream of superheated plasma from the supermassive behemoth that sits at the centre of galaxy M87. Now, Maciek Wielgus at the Institute of Astrophysics of Andalusia in Spain and his colleagues have looked at M87's jet with the James Webb Space Telescope (JWST), revealing its well-known bright features in extreme detail.

Wielgus and the team took the data from a study observing M87's stars, which JWST's infrared sensors are particularly sensitive to. This overwhelming starlight meant the jet was hard to make out, so they had to reanalyse the data to remove the polluting light (*Astronomy & Astrophysics*, doi.org/p72g).

JAN RÖDER, MACIEK WIELGUS ET AL. (2025)

A jet blasts from the black hole hidden in galaxy M87, the bright object to the left

The first bright point on the jet, just visible to the right of the star-like intensity of the galaxy in the image here, is thought to be caused by the jet's compression as it goes into a higher pressure region. This is similar to the bright diamond-shaped structures seen in the exhaust from a rocket engine.

While not visible in the image here, the team could also see the end of M87's other, opposite jet, the beam of which is typically much harder to see. Because it is speeding away from us at near the speed of light, this means it will appear much dimmer to us than it really is. But when this beam hits another region of gas at a different pressure, it spills out and becomes visible.

This, together with the end of the visible jet nearer to us, marks the edge of a bubble of material that surrounds M87. Now the other end of the jet has been imaged in such detail, astronomers can start modelling what sort of gas structures might be in this bubble, says Wielgus. ▮

Alex Wilkins

Obituary

How Jane Goodall changed the way we see animals – and the world

The conservationist and primatologist, who chronicled the social lives of chimps, leaves a lasting legacy on how we view the natural world, says **Rowan Hooper**

JANE GOODALL, who has died aged 91, changed the world through the way she saw animals, particularly chimps.

In 1960, when she was 26, she observed a chimp she had named David Greybeard fishing for termites with a twig he had stripped of leaves. "At that time," she later said, "it was thought that humans, and only humans, used and made tools. I had been told from school onwards that the best definition of a human being was man the tool-maker – yet I had just watched a chimp tool-maker in action."

She reported her finding to her mentor, the palaeoanthropologist Louis Leakey, who sent a famous telegram in reply: "Now we must redefine 'tool', redefine 'man', or accept chimpanzees as humans."

In the end, we chose the middle option and looked for some other thing that we could do that other animals couldn't. But Goodall's work was vital to undermining the view of human exceptionalism that had prevailed not just among scientists but in society as a whole.

A major breakthrough

Her work took aim at the assumption of the French philosopher René Descartes that had propped up the exploitation of animals and the destruction of the environment for 400 years. Descartes said animals have no soul and can be considered machines for us to use as we will. Goodall showed that chimps had the intelligence and foresight to design and build tools, but she also ascribed emotions and personalities to them. Some were calm, like David Greybeard, others timid, curious or feisty.

In this, her work echoed that of another world-changing scientist with similarly brilliant

CHRISTOPHE PETIT TESSON/EPA-EFE/SHUTTERSTOCK

observational powers. In his book *The Expressions of the Emotions in Man and Animals*, Charles Darwin attempted to explain the evolution of facial expressions, ascribing them to emotional states: jealousy, rage, love and so on. But he did so in animals as well as humans, and the establishment rejected it.

The book was poorly regarded at the time and neglected for more than 100 years. Goodall's work in the 1960s was also initially dismissed and even scorned. It didn't help that she was a young woman with no degree. Both Darwin and Goodall were driven by unquenchable curiosity and a power of patient, intense observation – and these qualities underlie their success. We now understand that both Darwin and Goodall were right: many animals have emotions and inner lives.

Goodall was chosen by Leakey to study chimpanzees at Gombe in what is now Tanzania. He wanted someone who was unbiased by established scientific thinking, and he believed a woman would make a more patient, empathetic field biologist. It is unlikely a trained biologist would have made the breakthroughs Goodall did.

She was the first scientist to make descriptions of chimp

Goodall championed conservation and was renowned for her pioneering work with chimpanzees

courtship and mating rituals, of their reproductive cycles, and of how mothers introduce their babies to the troop – experienced mothers, Goodall found, calmly allowed the others of the troop to see the baby, whereas first-time mothers hid the baby, provoking hooting and mayhem in the troop.

In the 1970s, the focus of her life began to change, moving from

"Goodall's work was vital to undermining the view of human exceptionalism among scientists"

CBS VIA GETTY IMAGES

observing chimps to championing them. She established the Jane Goodall Institute in 1977, which became a vast non-profit conservation organisation, with offices in 25 countries. In 1986, she organised a conference for field biologists working on chimps at sites across Africa, and it drove home the threat facing the animals and the forests they rely on. She also learned about the problems facing people who live near the chimps' habitats.

In 1991, she started Roots & Shoots, an organisation aimed at teaching young people about conservation. It is active in over 75 countries. Constantly touring and speaking on conservation, she gave around 300 public appearances a year. In 2024, she visited each of the offices of the Jane Goodall Institute to speak to the media about conservation work and the rights of animals.

Goodall died in California, in the middle of a speaking tour. She wrote 32 books, including 15 for children. In her final one, *The Book of Hope*, she wrote: "I realised that if we couldn't help people find a way of making a living without destroying the environment, there was no way we could try to save the chimpanzees."

Goodall spoke of the influence of another of the 20th century's most important figures, the ecologist and conservationist Rachel Carson. At the University of Cambridge in the 1960s, she said, "I read Rachel Carson's *Silent Spring* and was inspired by her courage in battling with pharmaceutical companies, the government and scientists about the danger to the environment of DDT."

Carson knew there was a long fight ahead, but never gave up and will continue to inspire, she said. The same is true of Jane Goodall.

Sponsored by ViiV Healthcare

Unfinished business: ending the HIV epidemic

To end the HIV epidemic, affected communities need innovative medicines, new options and an end to stigma

SINCE the 1980s, researchers have worked tirelessly to develop effective treatments that can suppress the HIV virus to undetectable levels. As a result, by taking a single daily dose of an antiretroviral (ARV) medicine, people with HIV can now expect to live long and healthy lives – as well as prevent transmission to others.

The impact has been dramatic, with annual global AIDS-related deaths having fallen from 2.1 million at the peak in 2004 to 630,000 in 2024. The number of new acquisitions has plummeted too: an estimated 1.3 million people acquired the virus in 2024, marking a 60 per cent decline since the peak in 1995.

"We're at a pivotal moment in the quest to end the HIV epidemic," says Jean van Wyk, chief medical officer at ViiV Healthcare. This quest is to meet the UN's 2030 goals that ViiV has been involved with since the 1980s as the pioneers of the first ARV medicine.

Barriers to care

Despite the tremendous progress in scientific innovation, there is still a long way to go. "As more progress has been made, many people have become complacent about HIV," says van Wyk. Of the 41 million people living with HIV today, nearly a quarter are not receiving life-saving treatment and new transmissions are not falling fast enough. "We're still seeing new diagnoses in a broader range of communities, and we're certainly at risk of missing our goal," he says.

So what will it take to end the epidemic? **The most basic principle is to get tested for HIV.** Early diagnosis can lead to early treatment and have a tremendous impact on the course of disease. Although testing has improved since the setbacks during the global pandemic, about 5.3 million people still did not know that they were living with HIV in 2024, according to UNAIDS.

Advanced therapy

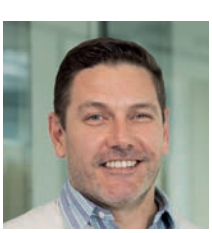
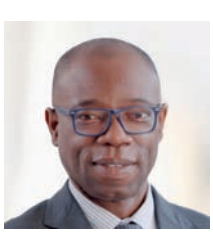
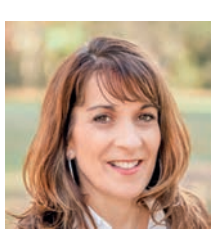
Another goal is to develop innovative treatment options that address the realities of day to day living. For many, especially those at the margins who are dealing with challenges like mental health issues, substance abuse or homelessness, having to take a pill every day can be a barrier to staying on treatment. For them, ARV therapy has advanced from several pills throughout the day with considerable side effects, to one pill a day, or longer-acting options.

Improvements to quality-of-life are also important. Even for those who stick to their treatments, says Babafemi Taiwo, vice president and head of early development at ViiV, "the pills are a constant reminder of the trauma of diagnosis and the burdens of living with HIV, which makes it difficult for people to be truly free from the virus." Linking individuals to quality health care is key to allowing people living with HIV to live long, healthy lives and reduce the likelihood of transmission to sexual partners.

Preventing HIV in the first place is a vital step to ending the HIV epidemic. PrEP (pre-exposure prophylaxis) is medicine that greatly reduces the likelihood of becoming

"We're at a pivotal moment in the quest to end the HIV epidemic"

From left to right:
Jean van Wyk, Chief medical officer
Babafemi Taiwo, Vice president and head of early development
Sherene Min, Vice president and head of global clinical development
Annemiek de Ruiter, Head of global medical sciences


HIV-positive if exposed. With multiple options available, including daily oral pills or long-acting treatment, more people can feel empowered to take control of their health and reduce the chance of acquiring HIV.

Addressing and eliminating stigma will be crucial too. According to the CDC, HIV has been marked by intense stigma, rooted in fear and misconceptions that persist from the epidemic's early days. "Fear of disclosure is a major problem," says Taiwo. "There is fear that somebody might find your pills in your backpack or in your locker."

"It's hard to imagine, but I still see women who I have been looking after for 25 years, and they only feel able to talk about their status with us in the clinic," says Annemiek de Ruiter, head of global medical sciences at ViiV and a consultant physician specialising in HIV care. Many of her patients experience intense fear and stigma, often years after diagnosis. "I've become very aware of people who are still hiding their medication and every day trying to find a moment when nobody's watching to take it."

Given this stigma, many people avoid being tested or taking their HIV medicine for fear of being labelled. It also helps to explain why, for all the scientific progress, eliminating stigma remains one of the major challenges in ending the epidemic.

As the only global company solely focused on preventing, treating and ultimately curing HIV, ViiV is unafraid to disrupt the status quo for HIV treatment and prevention by designing innovations that meet the evolving needs of the HIV community.

That's why ViiV is continuing to develop therapies that can make it easier to stick with treatment, with options for longer dosing intervals and more freedom. De Ruiter says longer-acting medicines could overcome many of the practical and social challenges faced by those living with the virus.

Relentless in the pursuit to end HIV, ViiV's world-class scientists are continuing to define the future of long-acting innovation with the next generation of HIV treatment, including a portfolio built around a class of drugs known as integrase strand transfer inhibitors, or INSTIs.

Longer-acting options

"INSTIs play a central role in modern HIV care and are considered the gold standard," says Sherene Min, vice president and head of global clinical development at ViiV. "Longer-acting therapies in particular, will address many of the challenges around stigma, adherence and quality of life."

Certain medicines developed by ViiV have been used in combination with other ARVs to achieve optimal viral suppression or for HIV prevention. Now, ViiV is developing longer-acting therapies as the next generation of long-acting HIV tools and the cornerstone for HIV care of tomorrow. These treatments must have a high barrier to resistance, staying ahead of the virus, and might be delivered in different formulations to offer a range of treatment and prevention options.

"We've learned that if you give people choice, they're more likely to have success with treatment," says Min. "You need to think about what is going to fit best with people's lives."

That is especially important when it comes to tackling HIV in children, who often struggle with access and adherence to treatments, says Min. ViiV is currently developing innovative formulations designed for them.

All of that has important consequences for the UN's goal of ending the epidemic by 2030. ViiV believes the next generation of INSTIs will be a big part of the solution, so that no person living with HIV is left behind.

"The tremendous strides we've made provide so much hope," says van Wyk. "We're getting to the point where we can talk about ending the HIV epidemic, which is an incredible feat of science. But we have to keep pushing because there is more to do."

To find out more visit:
viivhealthcare.com/ending-hiv/

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A slice of sense on UPFs

Not all ultra-processed foods are bad for us – regulation and eating advice must reflect this, say **Julia Belluz** and **Kevin Hall**

ELAINE KNOX

THEY have been called "poison", "addictive" and "junk", but however you describe ultra-processed foods (UPFs), it is clear they are the nutritional bogeyman du jour. That fear is reasonable, given their consumption has been linked to a dizzying array of health effects, from obesity and type 2 diabetes, to anxiety and depression.

Their dominance has changed food systems so rapidly that much of what we eat today would be unrecognisable to even our recent ancestors. We certainly haven't adapted to them, evolutionarily.

It is no wonder that they are the main target of strategies to address diet-related chronic disease in the UK and US. Even so, we think all-out UPF panic needs to give way to a more nuanced conversation. It is a mistake to paint flavoured yogurt and wholegrain bread with the same scaremongering brush as cakes and sugary cereal. Just because a food is ultra-processed doesn't mean it is unhealthy. Our approach to them should reflect what the science says so far.

When people consume more UPFs, saturated fat, sodium and sugar intake rise, and they get less fibre, protein and beneficial micronutrients – the opposite of healthful eating. But when it comes to how UPFs cause weight gain, Kevin's recent research found they tend to be overconsumed when energy dense (more calories per bite) or hyperpalatable (featuring pairs of nutrients that don't typically co-occur naturally – such as high salt and fat, carb and salt or sugar and fat).

On the flip side, when people eat meals with lots of UPFs that aren't energy dense and hyperpalatable, Kevin's work revealed that they don't gain weight. They can even lose weight when not necessarily setting out to do so on such diets.

These findings have enormous implications, not only for our personal choices, but for nutrition policy and regulation. Rather than targeting all UPFs, we should focus on those that fail to meet the nutritional standards of healthy food. The US Food and Drug Administration (FDA) is moving in this direction, having recently issued a definition of what constitutes a "healthy" food. It is similar to the UK's nutritional profiling system and accounts for ingredients from food categories people need to eat more of, such as vegetables, fruits and whole grains, while also limiting sugar, sodium and saturated fat. By targeting UPFs that also have a high calorie density or contain hyperpalatable nutrient combinations, we can zero in on the products that seem to be the greatest culprits in promoting obesity and other diet-related conditions.

To tackle those specific foods, we must apply a battery of public health policies similar to those that cut tobacco consumption: marketing restrictions, mandatory labelling and aggressive taxes. We also need to introduce policies that make healthy food more convenient, affordable and widely available, as well as incentivise companies to make their UPFs healthier – think frozen, wholegrain-crust pizza topped with vegetables.

Some UPFs are already considered healthy by the FDA's standard (again, think wholegrain bread or yogurt). None of these would be the subject of such policies or regulations. Many of us also rely on the likes of UPF pasta sauces, hummus, frozen dinners, canned beans, bouillons and breads, which can be an easy and affordable part of a healthy diet. That is why being specific about which UPFs are most likely to cause harm is important.

UPFs aren't going anywhere for now, and the story of their science is still being written. So, let's move beyond panic towards a healthy co-existence by understanding how some of them cause harm and acting accordingly.

Julia Belluz and Kevin Hall are the co-authors of *Food Intelligence: The science of how food both nourishes and harms us*

No planet B

Pie in the sky

Pie in the sky A conspiracy theory that bad actors use contrails from aircraft to poison us distracts from the very real effects of aviation on the climate, says **Graham Lawton**

Graham Lawton is a staff writer at *New Scientist* and author of *Mustn't Grumble: The surprising science of everyday ailments*. You can follow him @grahamlawton

Graham's week

What I'm reading
What We Can Know *by Ian McEwan.*

What I'm watching
The Hack *on ITV.*

What I'm working on
I've just had surgery for a hernia, so I'm working on not rupturing my stitches.

This column appears monthly. Up next week: Annalee Newitz

MANY years ago, I went to report on a climate science meeting at University College London. I have no memory of what the meeting was about, but I do remember a lot else about that day. When I arrived, there were protesters outside – not unusual for a meeting about climate change, which in those days tended to attract both activists and deniers.

On this occasion, the protesters were peaceful; I ignored them and went in. About halfway through the morning, they got into the lecture theatre and started heckling the speaker. Then they invaded the stage, shouting slogans and waving placards.

They were a breed of protester I hadn't encountered before – not climate change activists or deniers, but adherents to a conspiracy theory called chemtrails. This, in a nutshell, alleges that the condensation trails, or contrails, left by high-flying aircraft contain chemical or biological agents, deliberately released by bad actors to control the weather, poison the populace or facilitate some other evil purpose.

They aren't. Contrails are long, thin ribbons of ice crystals generated when water vapour in engine exhaust freezes in the frigid air at the cruising altitude of commercial aircraft. They usually dissipate quickly, but under certain atmospheric conditions they can persist for hours, forming contrail cirrus clouds. These are what conspiracists call chemtrails.

Like all good conspiracy theories, the concept contains a seed of truth. Contrails may look eerily beautiful on a summer's evening, but they are quietly harming the environment.

Everybody knows flying is bad for the climate: burning aviation fuel accounts for about 2.5 per cent of humanity's total greenhouse gas emissions. But contrails and contrail cirrus clouds – classed as "aviation non-CO_2 climate effects" – are probably as bad, if not worse.

That's down to simple physics. Like greenhouse gases, the ice crystals in cirrus clouds trap infrared radiation travelling away from Earth into the atmosphere, creating a warming effect. They also reflect incoming sunlight, which has the opposite effect. But on balance, they cause warming.

The truth is that we just don't know the full impact of contrails. Last year, in recognition of this gap in our knowledge, NASA asked the US National Academies of Sciences, Engineering, and Medicine to come up with a research strategy to better understand and deal with the climate impacts of contrails.

> **"Contrails may look eerily beautiful on a summer's evening, but they are quietly harming the environment"**

Published last month, its report revealed that contrails contribute to warming to an extent that may exceed the impact of aviation fuel (though there is a lot of uncertainty in the figures). Happily, it found ways to mitigate its effects, such as changing fuel composition and engine design or rerouting flights to avoid areas where contrails consolidate into cirrus clouds.

The report makes no mention of chemtrails, which is understandable. I suspect the expert panel was tempted to slap down this baseless conspiracy theory but decided not to give it the oxygen of publicity. Either way, the report probably won't make a jot of difference, at least under the current US administration. Donald Trump and his team are anti-science, conspiracy-minded climate deniers. Dealing with contrails is hardly going to be on their to-do list. For one thing, it will require restrictions on the aviation and fossil fuel industries, so don't hold your breath.

Indeed, I suspect the aviation and fossil fuel industries are quietly happy for the chemtrail fanatics to continue their quixotic ravings, as they provide a welcome distraction from a real issue – the climate impact of contrails.

If anything, the report will be shelved and a new one ordered – on chemtrails. Trump's health and human services secretary, Robert F. Kennedy Jr, has reportedly been flirting with the conspiracy as part of his unscientific "make America healthy again" programme. And the concept is definitely still out there, despite – because of? – the total lack of evidence.

Earlier this year, I exchanged pleasantries with a neighbour on a sunny afternoon. Nice day, I said. It would be, he replied, if it weren't for those, and pointed at the sky. It was criss-crossed with contrails. He is also a climate change denier.

That's the maddening thing about the chemtrail conspiracy – it is utterly counterproductive. Despite their scientific illiteracy, I do believe chemtrail conspiracists have something going for them: they are rightly wary of corporate and government power and care about the environment and human well-being. All their efforts achieve, however, is to suck energy from legitimate protest and misdirect it at a pie in the sky.

The meeting at UCL was abandoned in the face of implacable protests. If the perpetrators thought they scored a victory, they were wrong. Climate change is an existential threat – chemtrails don't exist. ▮

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What we lose

Wildlife Photographer of the Year
Natural History Museum, London

"IT HAD a strange look, like an alien, but it wasn't angry. It sat still on the branch all the time," said Kim Hui Yu, who photographed the flat-faced longhorn beetle in the main image on a family trip to Gunung Jerai on Malaysia's west coast.

A lightbulb in a mosquito net attracted invertebrates overnight. In the morning she chose the most colourful to photograph. "I want people to know that all creatures, even small ones, count. So don't destroy the forest."

The photo, entitled *Alien*, is one of eight in a biodiversity display at the Natural History Museum's 2025 Wildlife Photographer of the Year exhibition, opening in London on 17 October. The images are past entries to the competition.

The display also includes a table-sized map of biodiversity levels, as measured by the Biodiversity Intactness Index created by the museum's researchers.

Hannah McCartney, who runs the competition, says the images can have a powerful impact – the aim is to get visitors to care enough that they later take action. A prime example is *Innocence Betrayed* by Hilary O'Leary (near left, bottom), featuring a 4-month-old black rhino calf nuzzling an anti-poaching scout. It had been found lost in the bush.

Jaime Culebras's *The Happy Couple* (near left, top) zooms in on mating harlequin toads in the Sierra Nevada de Santa Marta National Natural Park, Colombia. Most species of harlequin toads are endangered. Laurent Ballesta's *Pyramid of Life* (near left, middle) shows the range of organisms below East Antarctica's sea ice, including giant ribbon worms and sea stars.

Michael Le Page

On Earth's foundations

A personal odyssey through aeons of our planet's geology offers a passionate mix of science and spirituality, finds **Dhruti Shah**

Book
The Whispers of Rock
Anjana Khatwa
The Bridge Street Press (UK); Basic Books (US, out 4 November)

JAMES OSMOND/ALAMY

IT IS easy to take rocks for granted. How often do we think about the materials that make up the pavements we walk on, or the origins of the pebbles we pick up while sitting at the beach?

And how often do we realise the importance of geology when it comes to nature writing and the hard-hitting conversations now happening about our warming world? Any action concerning climate change and the future of our planet needs to incorporate how we interact with the components that make up our world.

How fortunate, then, that we can gain such an understanding from earth scientist Anjana Khatwa and her new book, *The Whispers of Rock: Stories from the Earth*. Billed as an "exhilarating journey through deep time", it is a love letter written with such passion that you can't help but be moved. Khatwa has devoted much of her life to spreading the gospel of geology, and here she offers clinical, scientific substance to back up her extraordinary depth of feeling.

Throughout the book, she is methodical in her explanations of subjects such as how mountains, craters and slate are formed, while also weaving in fascinating details. We learn that the Taj Mahal in India, an iconic symbol of love, was constructed with ivory-white Makrana marble, the origins of which date back to when several primitive land masses collided nearly 2 billion years ago. A recipe incorporating those tectonic movements, cyanobacteria, photosynthesis and calcium carbonate led to the rock used in this extraordinary monument, a much more complex process than might be realised at first glance.

Once she has established their scientific foundation, Khatwa brings the stories of rocks and minerals to life – and does so far more sensually than any school geology lesson I can remember. In Petra, Jordan, she pushes the reader to take heed of the negative space where rock has been cut back to form buildings, and the beauty that can emerge in unexpected places. Among sandstone and quartz, the rocks whisper "these patterns you see are the traces of rivers of old", she writes. These are Khatwa's friends, and soon these "story keepers of time" become ours too.

"A recipe incorporating tectonic collisions, photosynthesis and more led to the marble used in the Taj Mahal"

Khatwa's love of rocks emerged as a child, when she walked over solidified lava flows in south-east Kenya. In her book, she takes us with her around the world and across aeons, all the way to her home of 20 years in Dorset, UK, where the Jurassic Coast World Heritage Site and its 185 million years of geological history are her neighbours.

On this journey, we come to learn how rocks have shaped her and our world alike. We visit Stonehenge's massive sarsen stones on Salisbury plain in the UK, uncover the science and mythology of the pounamu greenstones in New Zealand and follow the racial and political history of the Black Belt, a region of dark, fertile soil in the US South that was dominated by cotton plantations, following the forced removal of Indigenous communities.

But what makes this book really stand out is Khatwa's personal touch. She offers us vulnerability, sharing her own experiences of motherhood and faith, while not shying away from the fact that the environmental sector in which she works is one of the least diverse fields in the UK.

The rocks of the Jurassic Coast in the UK span 185 million years

She describes how she found herself "moulded into a different person by the whiteness of the environments I worked in", with her cultural and spiritual identity taking second place to her scientific self. This book is a must-read for anyone trying to balance that duality, as well as those who wish to understand it. We cheer Khatwa on as she holds on tight to her rocks and navigates spaces of belonging and unbelonging.

The Whispers of Rock is so packed with information that every chapter requires you to step away and process it. Khatwa is also deliberately provocative, admitting from the beginning of the book that its alliance of science and spirituality may cause discomfort and consternation in some readers because it just isn't what people are used to. But this potentially divisive approach is a catalyst for a truly thought-provoking odyssey. ▮

Dhruti Shah is a freelance journalist based in London

Burning questions

Hannah Ritchie answers key climate queries in her optimistic, data-led guide to reaching net zero, says **Madeleine Cuff**

Book

Clearing the Air
Hannah Ritchie
Chatto & Windus (UK);
MIT Press (US, out 3 March 2026)

A FEW weeks ago, I was having dinner with some friends and the conversation meandered – as it will when there is a climate journalist, a campaigner and two civil servants seated at the table – onto the topic of renewable energy.

As you may have already guessed, I was dining with some pretty clued-up individuals, well-versed in the dangers of climate change and the urgent need to switch to cleaner forms of power. But still, the question was posed to me: surely we will still need some gas in our power grids for back-up fuel? A country like the UK can't rely on just wind, solar and batteries during the dull and dark winter months, can it?

It is moments like these when data scientist Hannah Ritchie's new book, *Clearing the Air: A hopeful guide to solving climate change in 50 questions and answers*, excels. Thanks to my well-thumbed copy, I was able to take my friends on a whistle-stop tour of some of the storage options that could help power the grid when the wind doesn't blow and the sun doesn't shine. Pumped hydropower, geothermal energy and hydrogen could all play a role, I told them.

Ritchie's previous book, *Not the End of the World*, was a crash course in how to solve the planet's environmental challenges. *Clearing the Air* strikes the same optimistic tone, but is more of a "how to" guide, providing data-led answers to any questions you may have about the road to net zero.

The queries are organised by topic, ranging from fossil fuels and renewable energy to electric cars and home heating. Reading it, you can't help but feel this is Ritchie's response to the ongoing deluge of ill-informed – and often outright misleading – media reports and political pronouncements on the net-zero transition, the kind that tell people electric cars will run out of juice on the motorway, heat pumps don't work in cold weather and the world doesn't have enough spare land for solar power.

Geothermal power could be a key part of the UK's energy mix in the future

JIM WEST/ALAMY

***Clearing the Air* pushes back on this disinformation using the power of scientific research and quality data. For example, one of the questions Ritchie answers is about whether wind farms kill birds – a favourite attack line of US president Donald Trump. The answer is yes, wind turbines do kill some birds, but that number is dwarfed by the annual kill rate of cats, buildings, cars and pesticides.**

Nevertheless, wind turbines do pose a real threat to some bats, migrating birds and birds of prey. But Ritchie is quick to point out that there are measures we can take to reduce the risk, such as tweaking the location of wind farms, painting turbines black and powering down blades during periods of low wind. This is the kind of nuance that you won't get from a newspaper headline or a political quip, but it is essential for understanding the benefits and risks of our shift to clean energy.

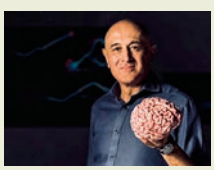
Each question-and-answer sequence follows the same format, which makes this an easy read to dip in and out of, but it veers towards the formulaic if read in one sitting. *Clearing the Air* works best as a kind of reference guide, to keep within close reach when a climate-sceptic uncle turns up for Christmas dinner, say.

Throughout, Ritchie's now-trademark optimism shines through. She makes it clear that for nearly every aspect of the net-zero transition, we have viable options for decarbonisation, without shying away from the challenges or straying into wishful thinking. The effect is powerful: you come away feeling informed and hopeful, with the confidence that it will be possible for humanity to navigate a path out of the climate crisis. In a world of fake news and political spin, this book is a breath of fresh air.

New Scientist *recommends*

Bethan Ackerley
Subeditor
London

I really enjoyed **Horizon: Secrets of the brain** on BBC iPlayer. Presented by physicist Jim Al-Khalili (pictured), the two-part documentary is about the brain's origin and the forces that shaped



this uniquely complex organ in humans.

The story begins with bilaterians, creatures that lived half a billion years ago, and the pressures that led them to evolve neurons, enabling them to move through and respond to their environment.

Fast forward to the 20th century, when scientists in Naples, Italy, used neurons from large squid species to learn how electrical impulses travel around our bodies.

My personal highlight is *Morganucodon*, a tiny, rat-like creature alive about 200 million years ago. Using its fossilised bones and teeth, we learn that early mammals were becoming warm-blooded and discover how the development of *Morganucodon*'s neocortex laid the path for humanity's smarts.

What a shame that the show ended so soon.

BBC/FURNACE/ANDY JACKSON

The film column

The outer fringes

Blue Planet Red promotes the baseless idea that Mars was once inhabited by an advanced civilisation. But in documenting a generation of otherwise sensible researchers, it is inadvertently poignant, says **Simon Ings**

Simon Ings is a novelist and science writer. Follow him on X @simonings

BRIAN CORY DOBBS PRODUCTIONS

This image seems to show a wrench on Mars, but it is just an ordinary rock

BLUE PLANET RED purports to be a documentary about Mars. The world presented by director Brian Cory Dobbs isn't the one you and I might recognise, but it certainly has some appeal: it was home to an advanced civilisation of pyramid builders, who either couldn't save their world from destruction or laid it to waste in an orgiastic nuclear conflict.

Dobbs delivers his arguments for advanced Martian life straight to camera, with many a raised eyebrow and artful pause. I quite liked him. But I wasn't in the least surprised, after watching his film, to learn that his showreel partly consists of woo-woo (by which I mean questionable videos about mobile phones, electromagnetic fields and cancer).

Intentionally or not, though, *Blue Planet Red* is a historical document: the last hurrah of a generation of researchers and enthusiasts who came to maturity under the shadow of a 2-kilometre mesa, a type of geological feature, in the Martian region of Cydonia. Here, in 1976, where the southern highlands of Mars and its northern plains meet, NASA's Viking orbiters snapped blurry images of what looked like a gigantic human visage: the so-called Face on Mars.

Let's not spend too much time here debunking what has already been debunked, so often and so convincingly, elsewhere. Improve the image resolution and the face disappears. Rocks that look like tools and bones are just that: rocks. And the presence of xenon-129 in the Martian atmosphere implies ancient nuclear conflict only if you ignore the well-understood process by which a now-extinct isotope, iodine-129, would have decayed to xenon-129 in Mars's rapidly cooling lithosphere.

> **"The Viking orbiters' ambiguous data was the perfect growth medium for fantastical ideas"**

Yet there is something poignant in capturing the *idées fixes* of this generation of researchers. Those who feature in the film include Richard Brice Hoover, who headed astrobiology research at NASA's Marshall Space Flight Center in Alabama until his retirement in 2011 and helped demonstrate the existence of extremophile life on Earth. He is convinced he has found microfossils in Martian meteorites. Despite his enthusiasm, Hoover never gets around to explaining in this film why each fossil is lying on the top of the rock sample, instead of being embedded within it.

Fellow contributor John Brandenburg is a pretty well-regarded plasma scientist, if you can get him off the subject of Martian nuclear war. And then there is Mark Carlotto, who has spent 40 years seeing civilisational remains on Mars where everyone else sees rocks. Drag him down to Earth and he is a capable archaeologist.

After the final Apollo moon landing in 1972, the initial excitement of the space race began to wane. The images the Viking orbiters sent back promised the next great discovery. Their blurry amalgams of groundbreaking-yet-ambiguous data were the perfect growth medium for fantastical ideas, especially in the US, where the Vietnam war and the Watergate scandal encouraged scepticism and paranoia.

Dobbs's flashy retelling of tall Martian tales thinks it is about events 3.7 billion years ago, when a wet, warm planet turned into a dust bowl. For me, it is much more about what happened to a band of enthusiasts, glued to monitors and magazines in the 1970s. Let's lay our scorn aside for a moment and look this generation in the eye. Fond hopes won't trip up fine minds quite like this again. ▮

Film

Blue Planet Red

Directed by Brian Cory Dobbs

Streaming on Amazon Prime Video

Simon also recommends...

Book

Mapping Mars

Oliver Morton

This exploration of Martian terrain describes how the human eye, aided by optical technology, brought our neighbour into focus.

Book

The Mars Project (1953)

Wernher von Braun

The US-German (and Nazi) rocket scientist drew inspiration from Antarctic expeditions in this first, foundational technical specification for a human mission to Mars.

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Not sure what to see at New Scientist Live?

Here's what members of the *New Scientist* editorial team are most looking forward to

Martin Davies

Head of event production

New Scientist Live is just around the corner and the excitement in our office is palpable. I'm counting down the days until we open the doors to Excel London and thousands of science enthusiasts come streaming in.

This year, the show will run on **Saturday 18 and Sunday 19 October**, with a schools' day on Monday 20 October, featuring some of the best-loved names in science and entertainment. Plus, if you can't join us at Excel London, all the talks over the weekend will be live streamed.

You can catch legendary naturalist **Chris Packham** revealing the six species that shaped his life, laugh along with bestselling author and comedian **Adam Kay** as he shares candid insights from the NHS frontline, and explore how women can hack their health with **Dr Zoe Williams**.

If you can't make it in person, we are offering online access so you can enjoy the show wherever you are in the world. You can even buy an online upgrade if you're at the show so you can go online after the event to catch up on anything you missed at the time.

Our four main stages will cover the biggest questions in science. You can explore the secrets of the cosmos on the **Universe Stage**, the mysteries of being human on the **Mind and Body Stage**, the wonders of nature on the **Our Planet Stage** and the science of tomorrow on the **Future Stage**.

On top of this, there is the **Engage Stage**, which is our informal arena for interactive presentations. You can test viral videos in **Science of TikTok**, watch a live recording of our podcast 'The world, the universe and us', or discover what **magicians' mind-control tricks** reveal about your everyday decisions.

As always, our packed show-floor has amazing exhibits where you can get hands-on with the latest science and innovations, ensuring you'll find something to delight and amaze.

Whether you're a veteran of past shows or are joining us for the first time, everyone is welcome at the world's greatest festival of ideas and discovery. I can't wait to see you there.

Alexandra Thompson

Assistant news editor

As someone who always seems to have a cold – and who frequently gets dubious recommendations on how to combat them from well-meaning friends – I'm eagerly awaiting Daniel Davis's talk about how to boost our immune health on Sunday. He'll be covering the role stress, exercise and nutrition play in our susceptibility to infections – and busting a few myths along the way.

Like Davis, I'll be appearing on the Mind and Body stage, but on Saturday and strictly in a hosting capacity. While health is my favourite topic, neuroscience has been vying for the top spot lately, so I'll be watching in the wings as Daniel Yon explains how our brain uses past experiences to shape our reality – surely one not to be missed!

Alex Wilkins

Reporter

You might be suspicious when I tell you I'm most excited for a talk by a colleague, Saturday's discussion about meteorite hunters and their quest to discover our solar system's history by *New Scientist* features editor Joshua Howgego. But story snippets that I've heard around the office sound thrilling – trips to the Antarctic digging for space rocks, or hanging out with a Norwegian jazz guitarist who moonlights as a cosmic dust collector.

You'll also find me in the audience for Amy Gandy's talk on the extraordinary materials that can contain the ultra-hot plasma required for nuclear fusion on Sunday. I write a lot about fusion, and it feels like I hear of a new fusion company every week. But, so the joke goes, fusion is always 30 years away. I hope Gandy convinces me otherwise!

Obomate Briggs
Video producer

I am really looking forward to Mandeep Dhami's talk, Minds on trial: The psychological flaws in our justice system. Ever since watching the heartbreaking *The Central Park Five* some years ago, I often find myself thinking about wrongful convictions and how human bias can so easily tip the scales of justice. With recent news highlighting inconsistencies in sentencing and ongoing debates about criminal justice reform, this topic feels more relevant than ever.

It will be fascinating to gain insight into the minds of both judges and jurors, and to see why even the most fundamental legal standards can be interpreted in surprising ways, influenced by subtle psychological factors that we rarely notice. I hope this talk will help us think more critically about fairness in the justice system.

Michael Le Page
Reporter

Did an advanced civilisation with "spiritual" technology thrive during the last ice age before being wiped out by comets 12,000 years ago? I'm sure archaeologist Flint Dibble will have a thing or two to say about such claims. I've read a little about Dibble's battles against pseudoarchaeology and want to know more, so am delighted to be hosting the stage he's speaking on: Our Planet Stage on Saturday.

Then, on Sunday on the Engage Stage, Jo Marchant and Michael Wright will be talking about the oldest known computer, the Antikythera mechanism found in an ancient Greek shipwreck, and demonstrating how a reconstructed version works. I used to work with Jo before she left *New Scientist* to write books about things like the Antikythera, which is why I know her presentation is worth catching.

Bethan Ackerley
Subeditor

So many of the talks at this year's New Scientist Live are must-sees, but the highlight of Saturday for me (and for many sci-fi fans, no doubt) will be Naomi Alderman, author of *The Power and The Future*. In conversation with *New Scientist* culture editor Alison Flood, she will shed light on her creative process and dig into the feminist themes of her books.

On Sunday, I will be heading to see neurobiologist Gina Rippon, who will delve into the emerging science of autism in women and girls. Like so many aspects of neurodivergence, we have long assumed that autism is a male phenomenon, leading to widespread misdiagnosis. I can't wait to learn more about this research paradigm and how it might help the autistic women and girls in my own family.

Michael Dalton
Assistant magazine editor

This is my first New Scientist Live and I can't wait to experience everything the show has to offer, but my inner child is particularly excited by Andy Miah's talk, How gaming changed the world, on Saturday. Gaming is at the heart of many technological innovations and I expect even seasoned gamers will learn a lot, as Andy describes the industry's achievements so far and what the future has in store. It should at least give me some more reasons to justify spending time on the PlayStation.

Earlier that day I'll also be checking out Science is lit with Big Manny, a biomedical scientist and TikTok star who's making science fun and accessible for people of all ages.

Find out more at newscientist.com/nsl2025

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Editor's pick

Some tips and warnings on living to 100

20 September, p 36

From Geoff Sharman, Winchester, Hampshire, UK

I won't be adopting Bryan Johnson's methods for achieving longevity, partly because, at the age of 83, I already have a shot at living to 100, but, more importantly, also because life isn't a rehearsal or a research project. Life is for living. I have had a long career, travelled widely, conducted published research, served as a councillor, raised funds for charities close to my heart, enjoyed gardening, sailing, photography and other hobbies, and, with my wife, raised a family.

I found these much better uses for the 6 hours a day he devotes to his health routine, and hope to continue them for a while longer.

From James Willis, Alton, Hampshire, UK

Your special issue reminds me of the words of 20th-century *Lancet* editor Theodore Fox: "Life itself is not the most important thing in life. Some cling to it as a miser to his money and to as little purpose. Some risk it for a song, a hope, a cause, for wind in their hair."

From Trevor Prew, Sheffield, UK

While it may appear attractive to readers in the prime of their lives, the reality of living to 100 doesn't appeal to me. Healthy living may be extending lifespan, but not quality of life. My 89-year-old mother is now trapped in a body that has no strength, and my father's memory is failing, so he can't remember what he has just read or seen. This mirrors the experience of other older people, who have told me they "just want to die" or can't even remember who their family is any more.

From Brian Bennett, Lathom, Lancashire, UK

Blueberries are mentioned in many articles on ageing due to the possible beneficial effects of their anthocyanin content. However, I do wonder whether other types of fruit, such as blackcurrants and damsons, should also be considered. These are often cooked, which seems to release the anthocyanins from their skin into solution, whereas blueberries are more often eaten raw, possibly causing the anthocyanins to go straight through the system.

From Chris Severn, Sydney, Australia

One more tip for living long is to "go to the doctor". Beyond 50 or so, a regular health check is a good idea. An annual medical with blood tests helps spot illnesses early and builds up a set of data that makes future problems more obvious. Periodic checks on anything that is higher risk for you personally will help catch potential killers early. Lastly, seeking timely advice when "something doesn't feel right" may also save your life. It is true that this strategy relies on having good public or affordable health services, but in such cases, it could easily add a decade to your life.

Carbon storage is a bit of a distraction

13 September, p 10

From Paul Broady, Christchurch, New Zealand

Are we really going to store thousands of gigatonnes of carbon dioxide in geological formations? There are real doubts about whether the required technology will become sufficiently developed and whether the energy needed for it would be available. At present, only a few million tonnes per year are being pumped underground and much of this is used to push out more oil. We can't wait for a scale-up that might not arrive. Deep cuts in emissions should be the urgent priority.

A pessimistic view on climate targets

Letters, 16 August

From Vincent Flood, Evanston, Illinois, US

Some views on global warming targets reveal a continuing fantasy: the belief that any such target is achievable without climate engineering. Nobody, their governments included, is going to tell people in low-income countries that they can't have air conditioning or cars (or toasters, microwave ovens, etc.). Global warming is unstoppable, and the adverse consequences will accumulate horrifically as the heat grows, unless somebody starts to fix the problem. Next issue: remedial action by individual nations could well lead to conflict or maybe make the distribution of global warming problems worse.

Geoengineering is going to be very challenging

20 September, p 20

From Jim McHardy, Clydebank, West Dunbartonshire, UK

Drilling through polar ice to pump out liquid water from beneath won't work for several reasons that weren't mentioned. At the depths and temperatures of the buried water, it is close to the equilibrium between being ice or water. A slight change could drive it either way. Water, whether in an artesian well or pumped up, may freeze in a borehole as it rises and the pressure reduces. Also, ice flows under pressure, so the borehole would have to be steel lined and would eventually shear and seal up, possibly before completion.

Another geoengineering idea, a huge orbiting parasol, would be a sight to behold from the ground, but would need to be tilted side on as it passed over countries that weren't in favour of darkness at midday for all sorts of reasons. Huge louvres on a space venetian blind might be better.

WIMP detection is more like cycling than snooker

20 September, p 48

From David Holdsworth, Settle, North Yorkshire, UK

Chamkaur Ghag says that dark matter is probably made of weakly interacting massive particles, or WIMPs. The article talks of a dark matter WIMP hitting a xenon nucleus, which sounds like a microscopic game of snooker. However, at the quantum level, it means that a WIMP interacted with a xenon nucleus via exchange of a W or Z boson. It is more like the Madison sling technique in track cycling than snooker. The subatomic particles are just as much waves as particles, and can pass through each other undisturbed, just like the photons that carry our mobile phone traffic without messing with each other.

On the search for life beyond Earth

20 September, p 23

From Eric Kvaalen, Les Essarts-le-Roi, France

When astronomers say that, sooner or later, we will come across an exoplanet with a nitrogen/oxygen-rich atmosphere, or that, by 2060, we are likely to have discovered planets where it is hard to explain the data without there being life, they are assuming, with no good reason, that life can easily arise if the conditions are right.

The chance that all the hugely complex machinery of even the simplest cells will arise on a planet, even with the right conditions, is, in my view, very small.

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Dementia decoded

How much can lifestyle choices really help you when Alzheimer's disease runs in your family, asks **Daniel Cossins**

A FEW years ago, my dad was diagnosed with Alzheimer's disease, just like his older brother and his mum before him. Slowly, his personality began to ebb away. Now, at the age of 75, his cognitive decline is accelerating: he no longer recognises his granddaughters, for instance, and he lives in a near-constant state of confusion, which means he is losing his independence, too.

As I process this loss and try to support my parents, I have become increasingly curious about what my family history means for me. I am 43, an age at which the misfolded proteins thought to underlie Alzheimer's can begin to build up in the brain. I found myself wanting to better understand my own risk – and what, if anything, I can do about it. Would taking a DNA test to reveal my hereditary risk of Alzheimer's be a good idea? And how could I make sense of the increasingly prominent idea that we can all "prevent" Alzheimer's by addressing key lifestyle factors like diet and exercise? Given the prevalence of the disease in my family, I was sceptical about this.

What I learned was by turns confusing and frustrating – in the sense that Alzheimer's is such a complex disease that almost everything we learn requires careful unpicking – but also surprisingly empowering. As Rudolph Tanzi, a neurologist at Massachusetts General Hospital, puts it: "Genetics is the hand that you're dealt and you may get a lousy hand, but how you play it really does matter."

As difficult as it is, my family's situation is far from unusual. Some 55 million people worldwide are living with dementia, of which Alzheimer's is the most common form; this figure is expected to rise to 78 million by 2030. Meanwhile, despite significant progress, we haven't nailed down the causes of Alzheimer's beyond the frustratingly broad statement that it has to do with age-related changes in the brain as well as genetic, health and lifestyle factors.

Tangled web

The leading idea is the amyloid hypothesis, which suggests that the clumping of a misfolded protein called amyloid-beta between brain cells triggers the abnormal formation of another protein called tau inside them in what are called tangles. This, in turn, leads to neuroinflammation, disruption of neural connections – or synapses – and cell death. "Amyloids are the match and tangles are the brush fires," says Tanzi. "You won't get Alzheimer's from that alone, because that has to trigger neuroinflammation – and that's the wildfire that kills enough neurons and synapses to get the disease."

There are reasons, however, to think that the amyloid hypothesis isn't the whole picture. For a long time, the new treatments it inspired – antibodies engineered to remove misfolded proteins from the brain – failed to reduce symptoms. But in the past few years, some of these drugs, such as Lecanemab, have been approved by the US Food and Drug Administration, having shown modest effectiveness at slowing cognitive decline in people with early-stage Alzheimer's.

Many experts still consider the benefits too small to compensate for the risk of swelling and bleeding in the brain that this treatment carries. But as the first "disease-modifying" therapy, these drugs are still a positive step – and they suggest that more effective options are coming. Indeed, earlier this year pharmaceutical company Roche announced positive early results from a small trial of a drug called Trontinemab, which appears to remove amyloid deposits with a lower risk of brain bleeds.

All of this comes too late for my dad, of course. For me, though, it is motivation to investigate my own risk: if the ideal scenario is "early prediction, early detection, early intervention", as Tanzi says, then I want to know if and when I might need to act.

When it comes to early prediction, the first port of call is my genetic inheritance. We know that genes play a significant role in ›

MATT CHINWORTH

Alzheimer's risk, primarily through the gene that codes for the apolipoprotein E (APOE) protein, which helps transport fats and cholesterol in the body and brain.

Everyone has two copies of the *APOE* gene, one inherited from each parent, and there are three variants. *APOE3*, the most common, isn't thought to affect Alzheimer's risk. *APOE2*, which is relatively rare, may provide some protection against the disease. *APOE4*, meanwhile, is clearly associated with a heightened risk. Studies suggest that having one copy of this increases the likelihood of developing Alzheimer's by three to four times compared with someone with none, while two copies can increase risk as much as 15-fold.

Given my family history, I suspect I will be among the 25 per cent of people worldwide with at least one copy of the *APOE4* variant – and possibly even among the 2 per cent with two.

These days, it is easy enough to find out, thanks to direct-to-consumer genetic tests. The best-known option is the "health and ancestry kit" sold by the company 23andMe, which can include reports on the *APOE* gene. But a quick search for what is available in the UK reveals several other products advertised solely as *APOE* tests. Initially, I was gung-ho. When the kit arrived, however, I found myself hesitating.

All of the Alzheimer's organisations in the UK and the US recommend against such a test. Their primary reasoning is that *APOE* isn't deterministic because there are many other risk factors involved. "The situation where you have two copies of *APOE4* does increase your risk quite substantially, but it doesn't mean that you will inevitably get Alzheimer's disease," says Charles Marshall who studies dementia at Queen Mary University of London.

Besides, dementia is so common that most people have a family history, says Marshall. "So, unless someone in the family had very young onset dementia, it doesn't make a huge difference in terms of an individual's risk to have had a parent who had it later in life."

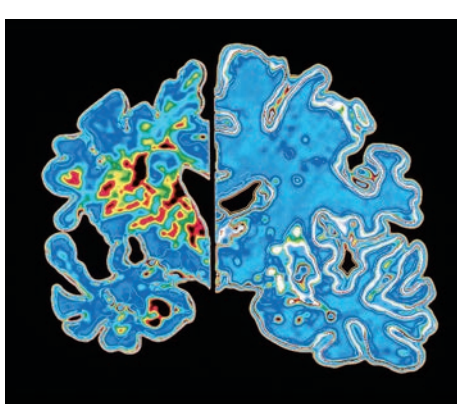
The widespread caution over *APOE* tests also has to do with the potential psychological distress they can cause, says Ashvini Keshavan at University College London's Dementia Research Centre. "The utility [of genetic testing] is so minimal and the downsides so high, in terms of anxiety generation, that people shouldn't be doing it," she says.

As someone with a tendency to ruminate, this gave me pause. Ultimately, however, I decided to go for it. Rightly or wrongly, I had it in my head that I was likely to have at least one copy of *APOE4* and possibly two, so that anything else would feel like a bonus.

As I awaited my results, my thoughts turned to detection – and the misfolded proteins thought to be the cause of Alzheimer's, which can begin to build up in the brain 20 years before even mild cognitive impairment. "If you do carry APOE4, you might want to know whether you have amyloid beginning in your brain and [tau] tangles being induced, because that's how it works," says Tanzi. The idea is that you would then have a window of opportunity to intervene at an early stage of the disease's pathology.

In the past few years, researchers have demonstrated that blood biomarker tests can detect amyloid-beta and tau in the brain more easily than the methods currently used to diagnose early-stage Alzheimer's. One of the most promising blood tests detects the presence of a particular protein called p-tau217, a tell-tale sign of disease pathology, well in advance of symptoms. A 2024 study evaluating a p-tau217 test showed that it was just as accurate as analysis of cerebrospinal fluid, and more so than PET scans.

CAROLINE BARBER/MILLENNIUM IMAGES



ALFRED PASIEKA/SCIENCE PHOTO LIBRARY

Top: Lifestyle factors like socialising can delay the onset of Alzheimer's

Above: The brain of a person with Alzheimer's (left) is shrunken compared with its usual state (right) due to the death of nerve cells

Alzheimer's vaccines

For now, the focus is on how best to roll out these blood tests in clinical settings. But they could eventually be used to screen everyone over 50, say, in much the same way people are currently screened for high cholesterol. "That's the goal," says Tanzi. "We're not going to end Alzheimer's by waiting until the brain has deteriorated enough that you have symptoms."

But there is still nowhere near enough evidence that blood tests can reliably predict your risk of getting Alzheimer's, or when, says Keshavan. "These blood tests do show changes in people who are asymptomatic, but their presence doesn't necessarily mean you're going to develop symptoms within your lifetime." Some people live for decades with amyloid and tau in their brain without developing Alzheimer's – something the researchers refer to as "resilience".

Unsurprisingly, these blood biomarker tests are already available on the open market. Again, though, Tanzi urges caution: "If you think finding out you carry APOE4 causes stress, imagine discovering that amyloid is accumulating in your brain."

Keshavan is even more steadfast. She worries that we will end up in a situation similar to what doctors face with at-home APOE tests today, where "people come with their results and we're having to pick up the

ORLANDO GILL/MILLENNIUM IMAGES

pieces, in terms of dealing with the anxiety and stress", she says. "That is why we are singing it from the rooftops: people should not do this!"

I heed the advice. It is probably too early for me anyway. That said, I wouldn't rule out getting a blood biomarker test in a few years' time, especially if new amyloid-busting treatments are available by then.

On that front, perhaps the most exciting prospect are vaccines against amyloid-beta and tau. The idea is simple: with the help of vaccine additives called adjuvants, you turbocharge the body's natural immune response to clear out the misfolded proteins. Several are already in clinical trials, with a view to using them to not only slow or halt disease progression, but even to help prevent it. The reality, however, is that there is no guarantee that any of these Alzheimer's vaccines will ever be approved for medical use – never mind in time to help me or others in a similar position.

Which brings us to the big question of what, if anything, we can do in the meantime. If you have been following the news, you could be forgiven for thinking we already have the answer. There is a steady stream of headlines confidently declaring that we can all "prevent" dementia by making healthier lifestyle choices. I was instinctively sceptical, though, possibly

Dementia is so common that almost everyone will have a family member affected by it

because the coverage tends to gloss over the details of these studies and how robust their findings are and what they mean for people like me with a family history of the disease.

The most recent flurry of stories was inspired by a *Lancet* Commission report from 2024, in which 27 experts assessed the best available evidence and concluded that 45 per cent of dementia cases could be avoided by addressing 14 key lifestyle factors. They included lower levels of education, hearing and vision impairment, high blood pressure, high cholesterol, obesity, diabetes, smoking, excessive alcohol consumption, air pollution, social isolation, depression, traumatic brain injury and physical inactivity.

The take-home message is that "there's a lot we can do to prevent dementia or delay its onset", says Gill Livingston, a neurologist at University College London and lead author of the report. "Some people will still develop dementia, but [if they address these lifestyle factors], in general, people will develop it later and have it for less long. And that's really important, because if you delay it for 10 or 15 years, you may never get it in your lifetime."

However, critics of the *Lancet* report pointed out that the analysis relied largely on observational studies, which can establish correlations, but not causality. "We don't really have evidence that dementia cases are prevented by addressing any of these risk factors," wrote Marshall at the time.

Livingston, for her part, says that some things just aren't amenable to randomised controlled trials (RCTs), which are considered the gold standard of research, for both practical and ethical reasons. She also points out that the observational studies the *Lancet* considered tended to be large, of high quality and show effects of a similar magnitude in the same direction. "People always say that correlation does not equal causation, but, equally, it often does," says Livingston. "There are no RCTs of smoking and lung cancer, for example, because that would be unethical. But none of us have a problem believing they're related based on the weight of the evidence."

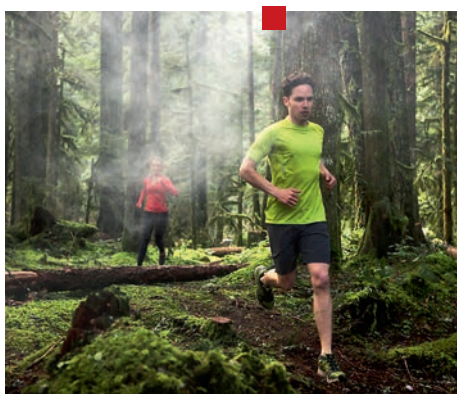
It is also fair to say that the *Lancet* report did include a few RCTs – on the role of blood pressure and diabetes, for example. And they aren't the only ones. Perhaps the most compelling is the Finnish Geriatric Intervention Study to Prevent Cognitive Impairment and Disability (FINGER), the first large-scale RCT to demonstrate that lifestyle interventions can prevent cognitive decline among older adults at risk of dementia.

The first FINGER study, published in 2015, involved more than 1200 participants, aged 60 to 77, with an increased risk of dementia but no obvious memory problems. Half of them were put through a programme of lifestyle interventions involving diet, physical activity, cognitive training and blood pressure monitoring, whereas the control group received only regular health advice. After two years, cognitive performance improved in both groups, but the total average improvement of the intervention group was 25 per cent greater.

"On top of that, we saw that the control group had 30 per cent higher risk for cognitive decline," says Miia Kivipelto at the Karolinska Institute in Stockholm, Sweden, who leads the FINGER programme. The team was also able to demonstrate a ›

"Genetics is the hand that you're dealt, how you play it really does matter"

DIMITRINA LAVCHIEVA/ALAMY



JORDAN SIEMENS/GETTY IMAGES

Being more active, both mentally and physically, can help reduce the risks of Alzheimer's

reduction in the estimated risk of dementia.

The success of the FINGER trials provided a model for multiple follow-up studies in which the interventions have been adapted and refined for different populations in more than 60 countries, with further positive results.

All of this seems encouraging, and many of the researchers I spoke to praised the rigorous nature of the FINGER studies. But we have to keep in mind that these trials haven't yet demonstrated a reduction in cases of dementia, says Marshall. "What we see is that your scores on cognitive tests get better over time, which is not what happens normally," he says. "And if you are in the intervention arm, they get better by a little bit more than the people in the control arm. So, it's not clear how that translates into dementia prevention in the real world."

Building resilience

What we can say, however, is that these lifestyle interventions do seem to affect how resilient your brain is to dementia, and possibly Alzheimer's pathology more specifically, if and when either do arise. "The likelihood is that they delay when you get symptoms in the face of Alzheimer's pathology, which in practice means that some people will then die of something else before they get symptoms," says Marshall.

Which does sound a lot like prevention, to be fair. "I think there's really quite clear evidence that the brain resilience makes a difference," says Livingston. And according to Tanzi, it is never too early to adopt the habits that help to build this resilience, regardless of your APOE status. "The message should go out that in 98 per cent of cases of family history or genetic predisposition, lifestyle does make a difference," he says.

As for which of the various lifestyle factors are the most important, every researcher I spoke to had a slightly different take. The FINGER studies suggest that two key pillars should be priorities: eating a Mediterranean-style diet – high in vegetables, fruits, nuts and whole grains and low in red meat – and being active, physically, mentally and socially. But Livingston emphasises blood pressure and cholesterol levels, on the basis that many lines of evidence suggest that good vascular health seems to reduce your risk of dementia.

It can also depend on your age and life situation. Like me, many people in their 40s are juggling work, childcare and elderly parents, so stress is another important factor, says Kivipelto. "Rather than cognitive stimulation, someone in your position might want to focus on sleep and stress reduction, perhaps by increasing your exercise, as well as checking for hypertension."

When my genetic test results come in, I discover that I have just one copy of the *APOE4* gene variant. To recap, that means I am three to four times more likely to develop Alzheimer's than someone with no copies of that variant. The news doesn't induce much anxiety, though, because at this stage, I have learned enough to know that my *APOE* status doesn't seal my fate – and to have some confidence, tentative as much of the evidence may be, that I might be able to delay the onset of cognitive decline.

If anything, the *APOE* results make me feel more motivated to make good on long-held intentions to undertake a more health-focused lifestyle – especially given that Kivipelto and her colleagues were recently able to demonstrate that APOE4 carriers get greater benefits from the FINGER interventions than non-carriers.

I am aware that essentially amounts to generic health advice – eat better, exercise and so on. But it does feel empowering. As daft as it might sound, every time I pick the mackerel salad for lunch, set off for a run in the woods or even arrange to meet up with friends, I remind myself that I am building my brain's long-term resilience to neurodegeneration.

Besides, until better drugs come along, that is all anyone can do. "At the individual level, no one can say they're preventing Alzheimer's because there are no guarantees," says Tanzi. "But keeping your brain healthy and boosting its resilience is obviously worth doing, and it is likely to mean that you live for longer without dementia." ▮

"In 98 per cent of cases of family history, lifestyle does make a difference"

Daniel Cossins is a freelance journalist

Teetering on the edge

One of Earth's most vital carbon sinks may be collapsing far sooner than anyone expected. Can we save it, asks **James Dinneen**

CLIMATE change deniers love to point out that plants flourish when carbon dioxide levels rise. As we burn fossil fuels, their thinking goes, the Earth will become greener and even more supportive of life than it is now, soaking up more carbon – so what is all the fuss about?

As is often the case with misleading arguments, there is an element of truth here. For many decades, land ecosystems such as forests and grasslands have been growing rapidly and, overall, absorbing huge quantities of CO_2 from Earth's atmosphere.

Yet the discovery in the 1960s that land is a net absorber of carbon, or a sink, came as a huge surprise to ecologists, who expected

IMAGE PROFESSIONALS GMBH/ALAMY

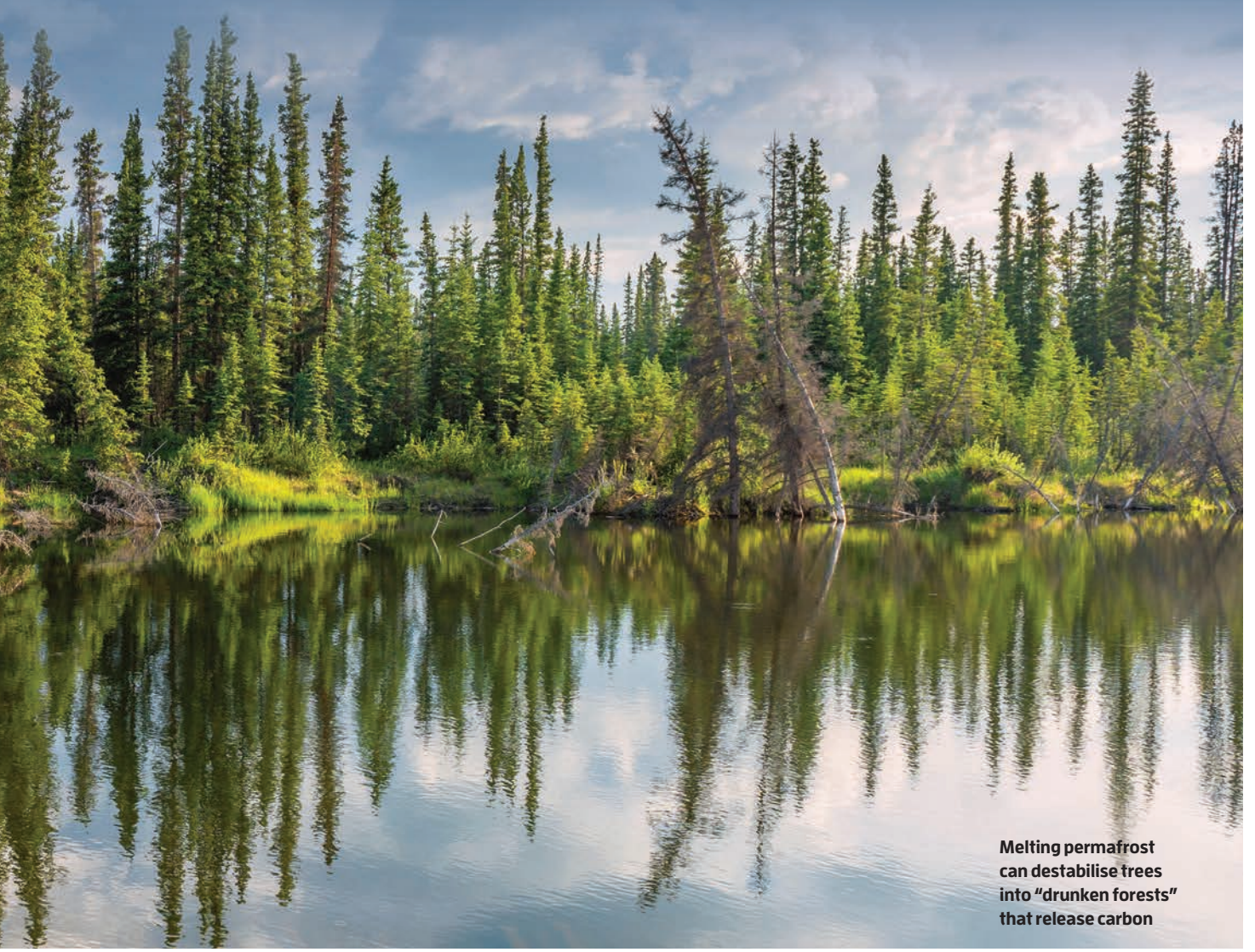
the CO_2 taken out of the atmosphere each year to be balanced by decomposition or burning. "There shouldn't be sinks. Everything that grows, dies," says Scott Denning, an atmospheric scientist at Colorado State University.

This unexpected gift has historically removed between a quarter and a third of the CO_2 emissions humans generate each year – somewhat putting the brakes on climate change until we get our act together. But the missing link in climate denialist reasoning is that this carbon sink can't continue forever. Ecological shocks due to climate change combined with Earth's physical limits will cause it to saturate some time this century.

Worryingly, there are signs that we are already reaching that point. In 2023 and 2024, the land carbon sink seems to have all but disappeared. Researchers are now scrutinising how diverse environments contribute to this delicately shifting balance, from Arctic tundra to tropical rainforests. They hope to understand if this really is the end of Earth's land carbon sink – and what can be done to sustain it.

You can think of this sink as a big swimming pool. The water in the pool represents the roughly 4 trillion tonnes of carbon stored in all of the plants, animals and microbes above and below ground, as well as decaying organic matter in soil. Carbon from the atmosphere trickles into the pool as plants grow and take up CO_2 via photosynthesis. Carbon also leaks out of the pool as organisms decompose or burn. So long as more carbon trickles into the pool than trickles out, this cycle acts as a sink that removes CO_2 from the atmosphere.

This is common knowledge in climate circles now, but it was unexpected and controversial when it was first identified. That was, in part, thanks to climate scientist Charles David Keeling's precise accounting of CO_2 in the atmosphere measured at a station on Hawaii's Mauna Loa volcano. The now-famous Keeling Curve that resulted allowed researchers to figure out that, while atmospheric concentrations of CO_2 ›



Melting permafrost can destabilise trees into "drunken forests" that release carbon

ANNA KUCHEROVA/ALAMY

ERNESTO BENAVIDES/AFP VIA GETTY IMAGES

Above: Wildfires release large amounts of stored carbon

Left: Deforestation is pushing the Amazon into becoming a carbon source

"Without the land sink, one study estimated that the planet would be 0.3°C hotter"

inexorably rose year on year, they weren't rising as quickly as they would if all of the CO_2 we emit by burning fossil fuels remained in the air. So where was the CO_2 going?

At this time, it was already known that CO_2 naturally dissolves in the surface waters of Earth's oceans. So, initially, researchers assumed this was the sink for all the "missing" CO_2. "The first carbon scientists were oceanographers," says David Schimel at NASA's Jet Propulsion Laboratory in California. But simple models soon showed that even vast oceans couldn't do all this heavy lifting, implying that a land carbon sink was helping.

Land ecologists, however, found this hard to accept, as rising rates of deforestation, urban sprawl and agricultural intensification should be making it harder for these ecosystems to take up carbon. This was the 1970s, the era of Joni Mitchell singing about paving paradise, says Denning. "They were certain that the land was a big source of CO_2."

The existence of a land sink also ran counter to the notion that ecosystems tend towards equilibrium – that all growth is balanced by death. The thinking was that "green stuff grows, green stuff dies, green stuff rots, the CO_2 doesn't change", says Denning. "It [was] hard to imagine how you can sustain plant growth faster than death and decomposition over decades."

Yet that is precisely what the numbers showed was happening. Researchers used ships and aeroplanes to refine their measurements of CO_2 in the atmosphere along with isotopic measurements of carbon and oxygen that could trace carbon flows between sinks and sources. They combined this data with the make-up of bubbles of old atmosphere trapped in Antarctic ice cores and developed better Earth system models. By the 1980s, all lines of evidence pointed towards a persistent carbon sink on land sucking up about a quarter of the CO_2 we pumped into the atmosphere every year. (A similar amount to the ocean carbon sink.) Without this land sink, a 2013 study estimated the planet would be 0.3°C hotter.

The underlying causes of the sink remains an area of debate, but there are four major factors that are broadly agreed on. The first is rising levels of CO_2 that enhance photosynthesis in plants. This fertilisation effect is then boosted by nutrient pollution, such as run-off rich in fertilisers from farms. "People are inadvertently fertilising the bejeesus out of the biosphere," says Denning. Another factor is forests growing back after they were cut or burned for agriculture in previous decades. For instance, forests regrowing on former farmland have maintained a strong sink in the Appalachia region of the US. Finally, rapidly rising temperatures in the Arctic have extended the growing season and led to parts of the region turning green faster than expected.

Ultimately, though, the uncompromising algebra of ecology limits how much these factors can strengthen the sink. Carbon dioxide, for example, will only boost growth if plants have an abundance of everything else they need. While plants in greenhouses rapidly grow when CO_2 is pumped in, outdoor experiments that expose trees in real ecosystems to elevated levels of CO_2 see a more modest response. This is because they face other stresses, such as insufficient water or running out of nitrogen and phosphorus in the soil. Nutrient pollution might make up for some of this, but it is concentrated around sites of industrial agriculture, where ecosystems quickly end up with more than they can use. Regrowing forests are a strong sink at first, but less so as they reach maturity, and not at all if they are cut down, or if they burn.

Indeed, the land carbon sink fluctuates for

reasons that aren't always clear. Between 2007 and 2016, the sink grew stronger to the point that it removed around a third of our CO_2 emissions each year. That growth wasn't well understood, says Peter Reich, an ecologist at the University of Michigan, leaving experts divided on the future prospects for the land carbon sink.

An end in sight

When you include the effects of climate change in calculations, though, it becomes clear that the sink can't last forever. In almost all Earth system models, the sink-enhancing effects of CO_2 compete with climate-driven stressors that get worse over time and erode the sink. But it is challenging to project when the sink will disappear with any precision. "I would not dare to put a date on this," says Ana Bastos, a climatologist at the University of Leipzig in Germany.

The challenge lies in the sprawling complexity of how climate change saps the planet's ability to take up CO_2. On the one hand, excessive heat combined with drought can stress ecosystems and spark wildfires; on the other, when excessive heat is combined with extreme rainfall it also causes stress, as well as faster rates of decomposition, as microbes thrive. Various knock-on effects can then weaken the sink further in less direct ways. Wildfires not only instantly release large amounts of stored carbon, for instance, but the smoke they create can also stunt growth by blocking sunlight, while climate-related insect outbreaks can increase the risk of a wildfire igniting in the first place.

In temperate forests, meanwhile, loss of snow cover can slow growth by exposing roots to the elements. And in the Arctic, greening is countered by melting permafrost releasing more CO_2 and methane as microbes defrost and get busy. This melting can even impact carbon storage by destabilising trees so that they tilt sideways in "drunken forests".

There are innumerable effects tipping the balance from carbon sink to carbon source. Consider how in coastal forests flooding exacerbated by rising sea levels poisons trees with salt. Or that the loss of seed-dispersing animals such as primates holds back the regrowth of ecosystems.

Despite this, carbon sinks have, until recently, remained remarkably resilient to climate change. In unpublished research, Pierre Friedlingstein at the University of Exeter, UK, has calculated that climate-related impacts have caused the combined strength of the ocean and land carbon sink to grow by about 15 per cent less since 1960 compared with a scenario without climate change. Similarly, in a paper published in August, Schimel and his colleagues found that sink-enhancing effects increased carbon storage on land by about 38 billion tonnes between 2001 and 2021, while climate stressors reduced it by just over 8 billion tonnes. "But the analysis ends just as we're getting into this period, where things get a little more complicated," he says.

J.G. PAREN/SCIENCE PHOTO LIBRARY

Bubbles of air in ice cores can be used to determine past CO_2 levels

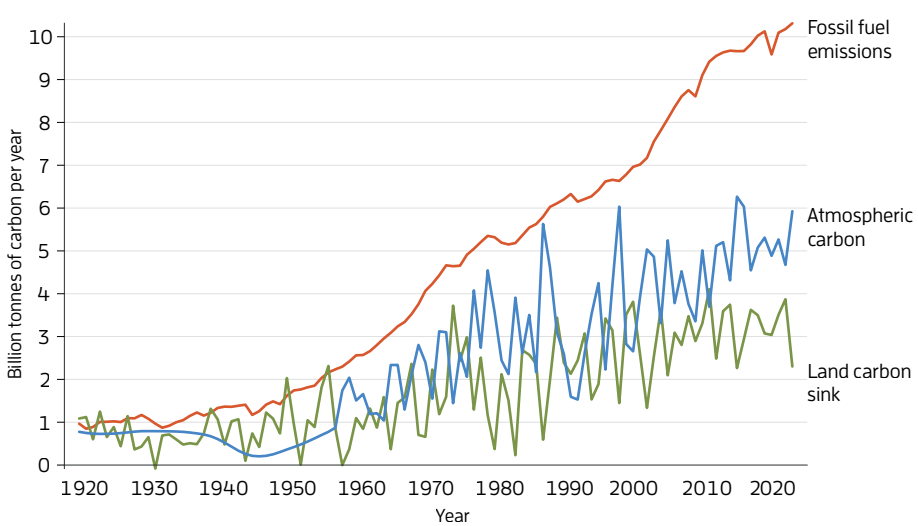
In both 2023 and 2024 – the hottest two years on record – early results suggest climate-driven extremes nearly wiped out the land carbon sink. In 2023, the sink was at least 50 per cent smaller than average over the past decade. This was driven by major wildfires and slow vegetation growth in the northern hemisphere during the first half of the year, followed by extreme heat, drought and fires in the Amazon in the second half of the year.

The sink appears to have been even weaker in 2024, falling to its lowest point in over a decade – but these figures are preliminary. One analysis suggests that, unlike 2023, this was less due to heat and drought than it was to heat and wet conditions accelerating decomposition. In any case, the result was the largest single-year increase in CO_2 levels in the atmosphere on record – even as our fossil fuel emissions stayed flat. "Very short-term extreme events can have this massive impact on the land sink," says Bastos.

Yet researchers are cautious about interpreting the land sink's steep decline over just two extreme years as a trend, particularly as 2023 and 2024 were, in part, so hot because of a strong El Niño climate pattern. Richard Birdsey at the Woodwell Climate Research Center in Massachusetts points out that the ›

Global carbon budget

In the 1960s, researchers realised that the amount of carbon dioxide in the atmosphere (blue) wasn't rising as quickly as they expected based on the amount of fossil fuels being burned (orange). This is largely because land ecosystems, along with the ocean, soak up large amounts of carbon. The land carbon sink (green) fluctuates from year-to-year, but, overall, has gradually increased since the mid-20th century. There are troubling signs that this trend is now stalling due to climate change.



Source: Friedlingstein et al (2024)

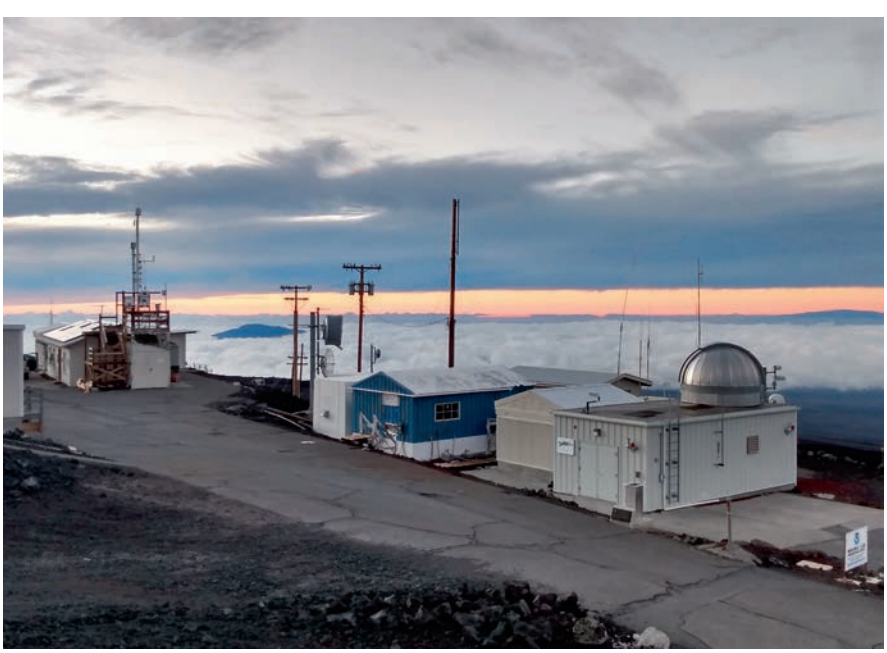
"For the first time in millennia, the Arctic tundra shifted from a long-term carbon sink to a long-term source"

sink also plummeted a decade ago during an El Niño then, before strengthening again. "These numbers have so much uncertainty, I'd want to see a few more years of data," says Reich. Still, he adds that the changes are alarming and could perhaps be a death knell for the land sink. "It's certainly possible," he says. "I worry that it is."

Saving the sink

When you look closely at components of the land carbon sink there are portents of a longer-term decline. For instance, Melissa Rose at the World Resources Institute and her colleagues found the global forest carbon sink has steadily declined since 2001, mainly due to deforestation. In 2023 and 2024, wildfires further reduced the forest sink to its lowest point in at least two decades, fuelling feedback cycles that accelerate climate change. "We're seeing this happening right before our eyes and faster than we thought it would," says Rose.

Similarly, in December 2024, researchers announced that for the first time in millennia, the vast Arctic tundra shifted from a long-term carbon sink to a long-term source due to fires and melting permafrost. The Amazon rainforest, meanwhile, has been teetering on the edge of becoming a continuous carbon source for over a decade. The ocean carbon sink has also significantly dipped since 2021 due to unprecedented marine heatwaves, although the changes are less dramatic than those on land.



NOAA

Atmospheric carbon dioxide measurements at Mauna Loa helped identify the land carbon sink

If the land carbon sink does vanish in the not-so-distant future, the consequences for climate action would be profound. Most countries depend on the continued strength of their sinks to meet emissions pledges under the Paris Agreement that aims to keep long-term global warming to a 1.5°C threshold. So, losing the sinks earlier than expected would mean emissions have to decline more rapidly elsewhere. In Europe, for instance, a sudden decline in the forest carbon sink over the past few years – a perfect storm of overharvesting in the aftermath of Russia's invasion of Ukraine, drought, heat and insect outbreaks – has put the bloc far off track to meet its 2030 emissions targets.

The good news is that there are a slew of effective ways to save the sink, or slow down its demise – even in the face of accelerating climate change. Constantin Zohner, a climate ecologist at ETH Zurich in Switzerland, says the most important steps are to protect, restore and manage ecosystems, in that order. If existing forests were left to grow undisturbed, modelling suggests a maximum potential uptake of 228 billion tonnes of carbon as they reach full maturity over decades – equivalent to about a third of our cumulative carbon emissions to date. Another 87 billion tonnes could be captured by restoring forests in places where they once grew, excluding urban centres and areas now used for agriculture.

Beyond this, better management of ecosystems could enhance the land carbon sink by several billion tonnes each year, according to an estimate by Yichun Xie at Eastern Michigan University and his colleagues. This involves avoiding monster wildfires by conducting prescribed burns, rolling out climate-friendly farming practices like cover cropping and rotational grazing, and more sustainable harvesting of trees. "There is a lot of opportunity, but somehow it has to become part of our economic and policy system," says Reich.

The coming years may prove decisive for these immense fluxes of carbon across Earth. If we want to hold onto the unexpected gift of a land carbon sink then we must stop "removing the allies that we have", says Zohner – and try to keep growth ahead of death just a little bit longer. ▮

James Dinneen is a science and environmental journalist

BECKI GILL

"Everyone's immune system is entirely unique"

Myths about our body's defences abound, but immunologist **Daniel Davis** is on a mission to bust them. He tells Helen Thomson why we should treat simple fixes with caution – and what we can really do to improve our immunity

YOU have probably heard that loading up on vitamin C will ward off a cold, or perhaps TikTok has influenced you to take turmeric or some other supplement to supercharge your immune system. The problem is, these bold claims and quick fixes are nonsense. There are so many myths about immunity, says Daniel Davis, an immunologist at Imperial College London.

In his new book *Self Defence: A myth-busting guide to immune health*, he sets out to challenge these misconceptions. Davis shows how, with each technological advance, such as using super-resolution microscopy to demonstrate how immune cells interact with their targets, the immune system's mind-boggling complexity becomes more apparent.

But far from leaving us adrift, he tells *New Scientist*, this complexity is empowering – helping us appreciate the importance of the immune system in mental health, making us aware of lifestyle factors that might harm our immunity, and improving our ability to distinguish fact from fad.

> "The thing that has the most clearly proven impact on our immune health is long-term stress"

Helen Thomson: Let's start with the phrase "immune health" and claims that we can boost it. That isn't actually the right way to think about it, is it?

Daniel Davis: Yes, there's any number of products that suggest they can "boost" your immunity. But that doesn't feel quite right, because although you need your immune system to be strong against infectious agents, if you just increase its power in a general way, it might attack the body's own healthy cells and cause autoimmune disease or allergies. It has to act in a regulated way to be able to respond appropriately.

So, is it a case of wanting to make our immune system "smarter"?

Any of those soundbite ways of talking about immune health are not nuanced enough. For one, everyone's immune system is entirely unique – at the level of your genes, it's the most unique thing about you. So when we talk about immune health, what we can only really talk about are the things that have been proven to, on average, help people, but whether or not that thing will help you as an individual is extremely hard to know.

One of the biggest discoveries is that the immune system doesn't work in a silo, it is influenced by diet, exercise, our microbiome. Is it possible to say what lifestyle factor has the most significant impact on immune health?

The thing that has the most clearly proven impact on our immune health is long-term stress. For the other things you mentioned, there's a lot of evidence, but it's still quite hard to prove causation. But with stress, we have a molecular understanding of what actually happens.

Which is?

When your body senses threat, it has this fight-or-flight response – a signal goes from your hypothalamus to your pituitary gland to your adrenal gland, producing stress hormones – adrenaline [epinephrine] and cortisol – which help your body get ready for action. This state quietens down the activity of your immune system. That's fine in the short term, doing a parachute jump, for instance. When you land, there are changes in the number of immune cells in your blood for about an hour. Then it goes back to normal. But if you're in a state of chronic, long-term stress, then cortisol levels stay higher, and this weakens your immune system over a longer period, becoming a problem.

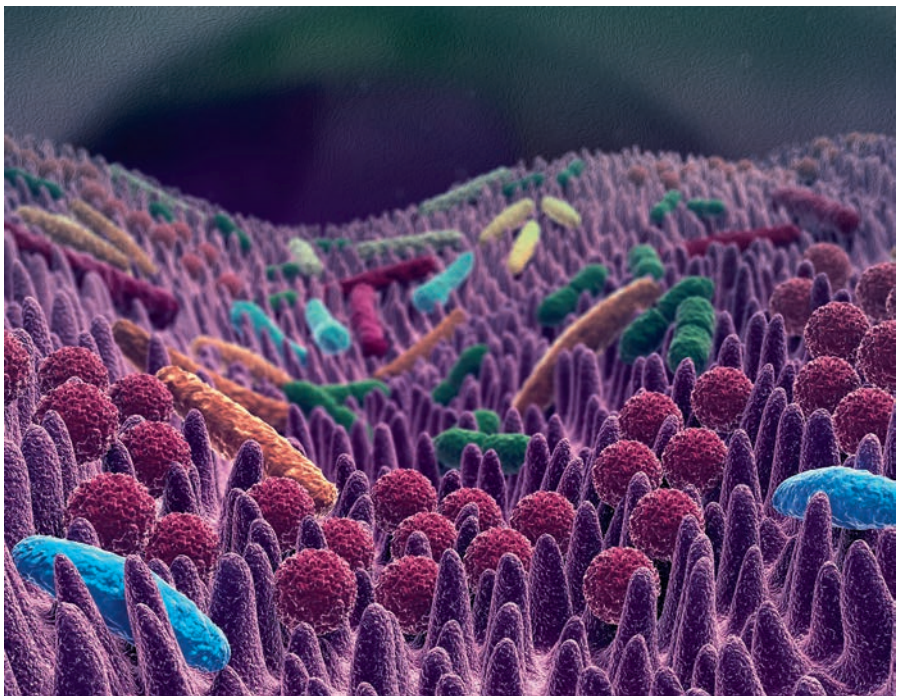
The reason we have so much confidence in how that plays out is if I look at how good your immune cells are at killing virus-infected cells or cancer cells in a lab dish, and then I add cortisol, those cells will be less good at killing the infected cells or cancer cells. By adding this to the correlations we see – how people who are suffering long-term stress respond less well to vaccines, for instance, or how they are more susceptible to infections – it means I can confidently say that long-term stress does impact the immune system.

If I experience stress and make lifestyle changes, is there any way to measure my immunity to see if it is helping?

It's still extremely hard to prove that doing something to reduce your long-term stress helps you. It makes sense that it would, but it's hard to show. In hospitals, they measure the number of white blood cells as a proxy [for immune health]. But there are any number of different types of immune cells in the body, and to some extent, every single cell in your body is part of your immune

MARCO LISSONI/ALAMY

Orange juice isn't the immune-booster many believe it to be



SIMONE ALEXOWSKI/SCIENCE PHOTO LIBRARY

Your gut microbiome can help support your immune system

system. So, picking out a simplistic measurement is hard to do.

I hear experts, often well-known scientists, on TikTok or podcasts claiming certain things will help their immunity. Should we believe them?
The example I use is orange juice. I grew up thinking if I have a cold, I'm going to drink some orange juice. I never questioned it. But it turns out it's not true. It goes back to Linus Pauling, who won two Nobel prizes. He was extremely famous, always on the radio, everyone's listening to him. In 1970, he wrote a book called *Vitamin C and the Common Cold* – it was an instant bestseller. New factories had to be built to keep up with the demand for vitamin C. But it was based on cherry-picked data and anecdotal evidence, and then very strongly advocated in the media.

The truth is that high supplementation of vitamin C has zero effect on whether you catch a cold. It is true that in people who highly supplement with vitamin C, their cold duration is decreased by about 8 per cent, but even that's hard to interpret because people who are taking these high doses are probably doing other things in their lives [that might be the real reason for the shorter duration]. But it's an ingrained myth in our culture, which comes back to one incredibly important scientist having an evangelical approach to telling us something.

Which brings us to today. We need to be careful about any one individual's brilliant success or insight into anything. We need experts, but we also need to be sceptical of any one voice – the scientific consensus is what we should be going with.

Recently, there has been increasing interest in the links between our immune system, inflammation and mental health. That all sounds fascinating.
The connection between the immune system and our mental health is a really exciting frontier. The initial trigger was that a group of people who took medicines that are anti-inflammatory for rheumatoid arthritis reported feeling mentally better even before their physical symptoms had improved. It is a type of medicine which blocks the action of a cytokine – cytokines being protein molecules that immune cells produce and secrete to communicate with other immune cells.

Another line of evidence is that people with some mental health conditions have higher levels of inflammatory markers in their blood. A study of children aged 9 who had higher-than-average levels of IL-6 [a cytokine] found that when they were 18, they were more likely to suffer depression.

Perhaps the most powerful line of evidence comes from experiments in animals – if you inject an animal with [IL-6], then the animal will stay more in a dark area of the cage, not explore, not interact, mimicking mental health conditions.

But we don't yet have a good way of acting on that information. Taking a common anti-inflammatory drug like aspirin or ibuprofen for depression doesn't work. Several small trials have shown this. Whether blocking a cytokine, exactly as done for patients with rheumatoid arthritis, helps people with mental health issues, even when they don't have rheumatoid arthritis, is not clear yet. Where this has been tested, the results so far have either been negative or unclear.

Future research must devise tests to identify people who might benefit: could it be that people with specific mental health conditions and higher-than-average levels of various cytokines in their blood, and perhaps some other telltale mark yet to be discovered, might feasibly be helped with anti-cytokine medicines? We don't know. But the knowledge itself might be empowering – knowing that if you suffer from a mental health condition, it could relate to something like your immune system. It's a really important frontier.

People must ask you all the time for the one thing they can do to improve their immunity. What do you tell them?
There are some answers, but they're not black and white. Long-term stress is a problem. Getting enough sleep is important. But how much and when, for you individually, I don't know. We know the microbiome is important, but can I give you something that will definitely make your microbiome better? No, I can't. These answers might be unsatisfactory, but the ultimate power is knowing that all this is really hard. There's always more to the story, nuances. If there's anything that you get from studying the immune system, it's just the wonder of how complex it is. ▮

Helen Thomson is a science writer specialising in life sciences, health and biotech

The back pages

Mathematics of life

Play nicely

How did cooperation emerge in a cut-throat world? There are clues in the prisoner's dilemma experiment, says **Peter Rowlett**

Peter Rowlett is a mathematics lecturer, podcaster and author based at Sheffield Hallam University in the UK. Follow him @peterrowlett

IT IS a dog-eat-dog world. Everyone for themselves, no matter the cost. If so, how would a behaviour like cooperation ever emerge?

From evolutionary biology to international diplomacy, we can model many situations using so-called game theory. These games have actions or strategies available to each participant, plus payoffs, which are positive or negative values that each player gains or loses from each outcome. Some games are "zero-sum", where one player's gain is equal to another's loss. Some aren't.

One famous game (not a zero-sum one) is especially revealing here. The prisoner's dilemma, in its main form, imagines two "criminals" who have been caught and kept in separate cells with no way to communicate.

There isn't enough evidence to convict either of the main charge, but enough to convict both of a lesser charge. The two are offered a deal simultaneously: testify that the other committed the greater crime and go free while the other gets three years in jail. But there is a catch: if they both betray each other, they each spend two years in prison. If both stay silent, each gets a year on the minor charge.

Each player's payoffs can be shown as the number of years they serve in prison. If both stay silent, the payoff for each is -1. If player A betrays player B, A gets 0 and B gets -3. Betray each other, and A and B get -2 each. How can a player maximise the payoff?

Sometimes, each player has a strategy that is the best response to whatever the other player does. This is called a Nash equilibrium – both do what is best for themselves and both get their best outcome.

SHUTTERSTOCK/ANN KOSOLAPOVA

The dilemma is how the actions interact if they don't know what the other will do. Imagine you plan on silence. If your opponent feels the same, you get a better payoff by betraying. If the opponent plans to betray, you get a better outcome by also betraying. Either way, your best action is to betray. This is true for both players, so each betrays, with a combined payoff of -4.

If both players trust each other and stay silent, the combined payoff is -2. The fact that dog-eat-dog leads to a worse outcome than cooperation, hints at how the latter might emerge.

In a famous 1980s experiment, 62 computer programs played 200 rounds of the prisoner's dilemma. Crucially, they could make moves based on an opponent's actions in earlier rounds. Selfish strategies tended to fare worse compared with altruistic ones. Successful strategies didn't betray first, but would do so when an opponent had betrayed in an earlier game. They were also forgiving, returning to staying silent when an opponent ceased to betray.

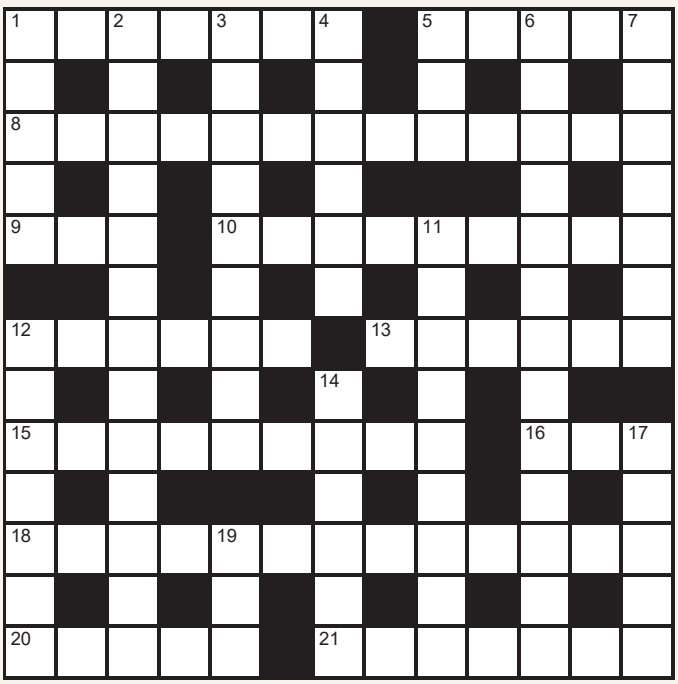
So even though "pure" game theory leads to a bad outcome, a bit of kindness can overcome this. Be nice, but don't let anyone take advantage of you. You have game theory to back you up. ▮

Mathematics of life appears monthly

Next week
Debunking gardening myths

These articles are posted each week at newscientist.com/maker

Cryptic crossword #172 *Set by Trurl*



Scribble zone

Answers and the next quick crossword next week

ACROSS

1 Resting place beside ruined tomb for one programmed to pester (7)
5 Spice before current addition, perhaps (5)
8 "UR SPECIAL TO ME" written out in gold, possibly (8,5)
9 Greek character that may show pressure (3)
10 Nuclear vessel, after switching parts, is very small! (9)
12 Go off expected score, returning eagle or similar (6)
13 Prow of ship not straight – result of being too long at sea (6)
15 Senate's dubious about DA's evidence from hearing, say (5,4)
16 Refuse to share motorcycle (3)
18 At Tasia's house, bizarrely, and there are elephants and orangutans here (5-4,4)
20 Sine wave, reduced by 3, reveals something connective (5)
21 One month before sibling is free of bugs! (7)

DOWN

1 Clean liquid for very young dog (3,2)
2 Antarctic dweller got through a paperback every 24 hours, reportedly (6,7)
3 Flowing mint robes for butterfly (9)
4 They may go up when a job is done well (6)
5 Equation is not all, we're told! (3)
6 Zuck's firm, and his promos, overhauled in major change (13)
7 Withdrawn about defeat, and given to bellyaching (7)
11 Jerk and nearly nail digit in pen-and-paper game (3-3-3)
12 Fights back, seeing sisters in distress (7)
14 Desert, concealed in this (ah, a railcar!) (6)
17 Gauss seen with girl through windowpane (5)
19 Who set out to get another question? (3)

Our games are now solvable online
newscientist.com/games

Quick quiz #323
set by Tom Leslie

1 Which optical phenomenon gives soap bubbles their colourful appearance?

2 What kind of cheese shares its name with a type of subatomic particle?

3 What is the collective noun for a group of ladybirds?

4 Roughly how many times larger is Africa compared with Europe?

5 Which physicist holds the most nominations for a Nobel prize without ever winning?

Answers on page 55

BrainTwister
set by Sam Hartburn
#94 Shape up

A square has a side length of x. There is one value of x for which the perimeter and the area of the square are the same (ignoring units). What is it?

For what side length do the perimeter and area of an equilateral triangle have the same value?

For what side length do the perimeter and area of a regular hexagon have the same value?

Answers next week

Twinkle twinkle

If you could approach closely enough (which, of course, you couldn't), what would the surface of a neutron star look like?

Herman D'Hondt
Sydney, Australia
Neutron stars are formed when giant stars run out of fuel. Their internal pressure is no longer sufficient to fight gravity, and the resulting collapse and supernova explosion leaves a tiny core, with the same density as an atomic nucleus.

Typically they have a mass of about 1.5 times that of the sun, compressed into a 10 kilometre diameter ball. As they still have the angular momentum of the star, they rotate extremely rapidly; the fastest known does so 716 times per second. Over millions of years, their magnetism slows them down.

The slowest known neutron star rotates once every 54 minutes. At that speed or slower, you would be looking at the most perfect sphere in the universe. A faster rotating star will be an ellipsoid – a squashed sphere, somewhat like Earth.

The smoothest sphere ever created on Earth was made by the team of the Avogadro project.

"To approach a neutron star, you'll need a very good heat and radiation shield, and some strong thrusters on your spaceship"

It was expected to be used for a new definition of the kilogram, but another method was selected. The sphere is made from a single crystal of silicon-28 with a diameter of 93.6 millimetres, accurate to 50 nanometres or 0.0000066 per cent. A neutron star would be roughly 1000 times smoother than this.

Looking at a neutron star, it will probably appear as a very shiny ball. While neutrons themselves don't reflect light, the star is probably covered in a thin layer of protons, which may look like a shiny metal coating.

Hilary Shaw
Newport, Shropshire, UK
In short, very smooth and very bright. A newly formed neutron star has a surface temperature in the millions of Kelvin, making it appear bluish-white, although most of its radiation is in the form of X-rays. Because of the intense gravity, the highest "mountains" that could exist on the surface would be less than 1 millimetre high, but they would take more energy than you could expend in a lifetime to climb. With a typical diameter of 20 km, this makes them one of the smoothest objects in the universe (after black holes).

Interestingly, their specific heat capacity is low, so an isolated neutron star might cool rather quickly, and within 1 million years of formation it could look white, then yellow-white. However, this is unlikely because it would also be converting its rotational energy to heat, and it could accrete enough interstellar hydrogen onto its surface to further collapse into a black hole.

So if you want to approach one, get a very good heat and radiation shield, and ensure you have strong thrusters on your spaceship to counter the intense gravity. Even that won't save you, as the viciously strong magnetic field will turn the atoms of your spaceship, and you, into cigar shapes (aligned vertically to the star), and you and the spacecraft will become monatomic dust.

KALI9/GETTY IMAGES

This week's new questions

So annoying **Why do people tut and roll their eyes when they are annoyed? *Alexandra Thompson**, London, UK*

Crack the case **What is the best way to pack a suitcase to get the most clothes into it? Is it with as few folds as possible? Or is it to roll the clothes up tightly? Is there any mathematical basis behind the answer? *Derek Long**, Cambridge, UK*

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Why do people tut and roll their eyes when they are annoyed?

Go fetch!

Why do dogs bring back a stick if you throw it? If I were a dog, I would say to my owner: you threw it, you fetch it

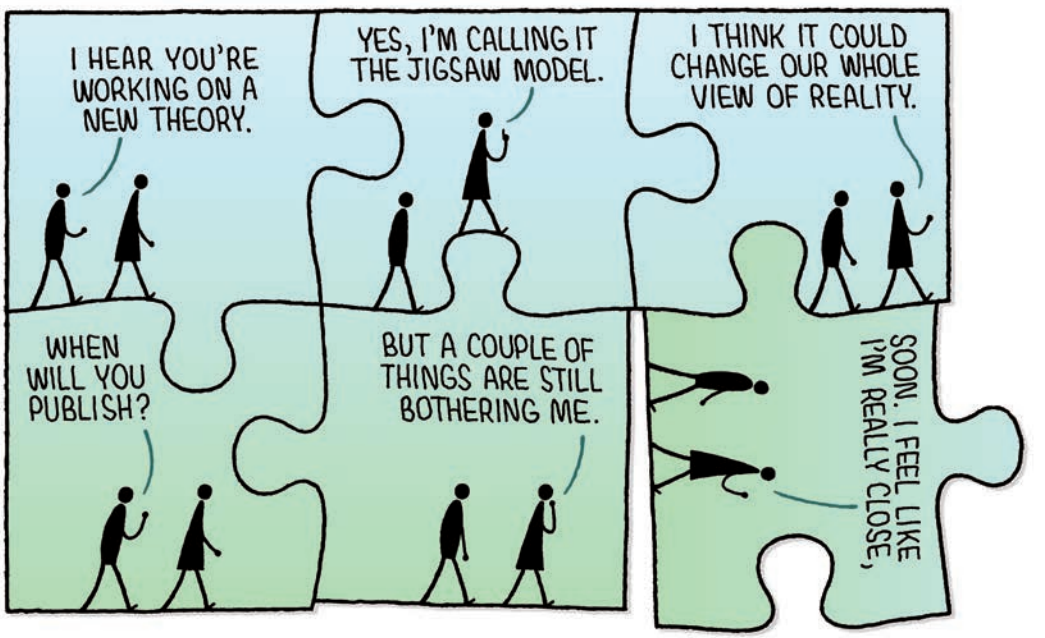
Jonathan Wallace
Newcastle upon Tyne, UK
The questioner indicates that he would refuse to fetch the stick were he in the dog's position, on the basis that it is an unnecessary task that has been created by the thrower. However, if he looks around, he will see many of his fellow humans enjoying such ostensibly pointless activities as pedalling up mountains, running through the countryside and many similar things besides.

These are all forms of play, and we do them because we enjoy them and they make us feel good. Play is an important part of the behavioural repertoire of humans, dogs and indeed most mammal species. As well as making us feel good, it serves an important function, especially in juvenile animals, in helping them to learn and practice survival skills such as hunting – or fleeing – and competing with rivals for mates and territory.

From the point of view of a dog fetching a stick, it isn't performing a chore on behalf of its master, but rather the master is serving it by repeatedly throwing the stick so it can have the fun of chasing it down. Anyone who has owned a dog that enjoyed fetching sticks or balls will know that the owner generally tires of the game well before the dog does.

Jennifer Bambauer
Prescott Valley, Arizona, US
Chasing things is fun for dogs. They have a chase instinct that comes from their wild ancestors, who evolved it in order to hunt more efficiently. Fast-moving objects trigger an urge to chase. When you throw a stick and

Tom Gauld
for New Scientist



the dog runs after it and brings it back to you, it is because they want you to throw it again so it can be chased once more.

Baby talk

Why do we speak to babies and pets in cute, silly voices, as opposed to our normal speaking voice? (continued)

Dr Jill MacKay
University of Edinburgh, UK
"Motherese" is the cutesy language we use around preverbal infants. It serves important roles in language development and emotional coregulation. But why do we use it with animals?

Domestication favours juvenile characteristics in animals, a phenomenon called neotenisation. The instinctive and cultural processes that teach us to speak motherese can spill over to these cute animals with their baby-like large eyes and faces. Many pets, such as dogs, are calmed by their owner talking to them, showing that emotional coregulation with motherese may be present for dogs.

"From the point of view of a dog fetching a stick, it isn't doing a chore for its master, but rather its master is serving it"

But surely they aren't learning language from this kind of talk? In the past few years, there has been a spate of pets online using augmented and assisted communication devices or talking buttons. Could motherese promote language development in pets too? Check back in a few years!

Professor Usha Goswami
University of Cambridge, UK
Although the cute voices people use when speaking to babies and pets sound similar, acoustic analyses show they are quite different. We speak to our pets in a cute voice ("doggerel") to convey our emotions. We speak to our babies in what is technically known as infant-directed speech (IDS) to teach them language.

It is actually difficult not to use IDS when an infant is making eye contact with you, and this seems to have a biological purpose. This sing-song form of speech enhances key rhythmic patterns that the brain uses to build a language processing system. Fluctuations in speech energy, perceived as variability in loudness, create the natural rhythmic patterning that we call speech prosody, which is the hidden structural glue that binds individual speech sounds into recognisable words.

The brain encodes this patterning using rhythmic "brainwaves" that occur naturally at different speeds. IDS enhances key aspects of this structural glue in a similar way in all languages, providing consistent acoustic landmarks for the learning brain.

The acoustic structure of IDS matches English nursery rhymes, which are often perfect metrical poems. IDS unconsciously presents the acoustic statistics required for the brain to learn language in an optimal format. ▮

Answers

Quick quiz #323 *Answer*

1 Iridescence
2 Quark
3 A loveliness
4 Three times larger
5 Arnold Sommerfeld

Quick crossword #193 *Answers*

ACROSS 1 Bismuth, **5** Melanin, **8** Tulip, **9** Barnacles, **11** Modernisation, **13** Nissan, **16** Kilobyte, **18** Top quark, **19** Oedema, **24** Point-and-shoot, **26** Bilharzia, **27** Odour, **28** Exotica, **29** Pharynx

DOWN 1 Bitumen, **2** Solidus, **3** Upper, **4** Hybrid, **5** Muriatic, **6** Nylon, **7** Nasal, **10** Adipose, **12** Stem, **14** Iron, **15** Alumina, **17** Protozoa, **20** Ecology, **21** Anthrax, **22** On-ramp, **23** Fibre, **24** Polio, **25** Stoma

#93 Counting Gaps *Solution*

For the cards 01122, we can use the arrangement 12102, or this reversed, which is 20121.

For 01122334455, the ordering is 31513420524, or this reversed, which is 42502431513.

For 1 to 3, 1 to 4 and 1 to 7, where each number is used twice, solutions are 231213, 23421314 and 1712642537463 5, or one of 25 other solutions in the case of 1 to 7.

Feeling prickly

Feedback doesn't want to overstate this, but we think we have found a problem that will rewrite a huge swathe of music and literature and force us to reconsider one of our most cherished metaphors.

It started when we wrote about educators using Taylor Swift music videos to introduce their students to botany (27 September). Reader Gerald Legg wrote in to highlight a couple of issues. First, one of the topics we said the students were learning was "competition for lightning". Obviously, that should have been "lighting". In our defence, we checked the original academic paper, and it's wrong in there too.

However, it was Gerald's second point that sent Feedback into a spiral. As a passing joke, we had said that "botany is a rose garden filled with thorns" (if you don't get the reference, we can only assume there is a blank space where your Taylor Swift knowledge should be).

Gerald says: "Sorry, but botany is not a rose garden filled with thorns, unless you've got shrubs like blackthorn. Roses do not have thorns but prickles which are superficial epidermal outgrowth whereas thorns are modified stems."

Feedback ran to a selection of search engines and consulted expert sources like the New York Botanical Garden website. We finally satisfied ourselves that, yes, roses don't have thorns. Those sharp things are prickles.

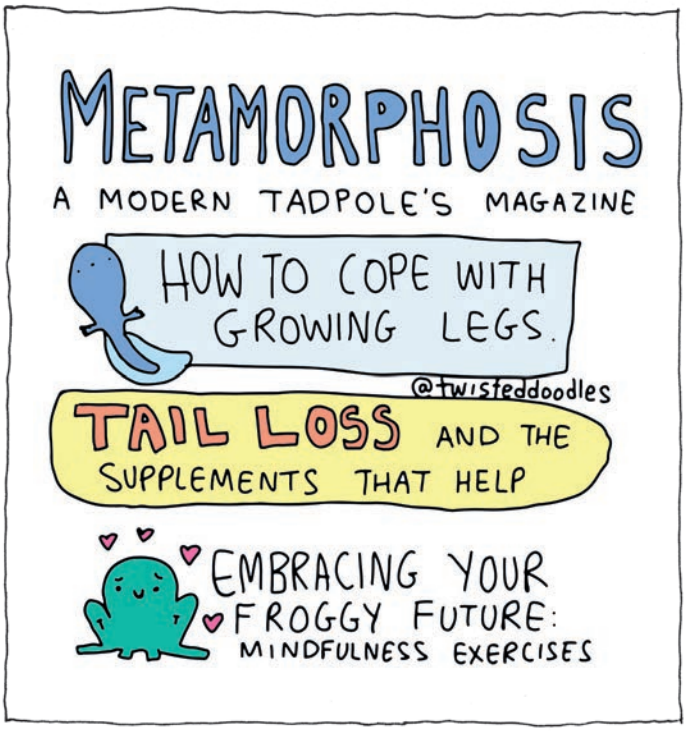
The thing is, it isn't just one joke in Feedback, or one Swift lyric, that is invalidated by this distinction. For starters, we must rewrite William Shakespeare – twice. Sonnet 54 warns readers that "The canker blooms have full as deep a dye / As the perfumèd tincture of the roses / Hang on such thorns", which is just wrong. And then there's Sonnet 35, which ought to begin: "No more be grieved at that which thou hast done / Roses have prickles, and silver fountains mud."

Likewise, Henry Van Dyke should really have called his poem *Prickle and Rose*, and begun it as follows: "Far richer than a prickleless rose / Whose branch with beauty never glows."

Feedback is starting to think that botanical literalism might not work for poetry and song. Still, there are upsides. We get to keep Johann von Goethe's *Heidenröslein*, because Goethe only says that "Little rose defended herself and pricked", without specifying the appendage doing the pricking.

And pleasingly, the droopy power ballad *Every Rose Has its Thorn* by hair metal purveyors Poison can be safely disposed of. Every cloud has a silver lining.

Twisteddoodles *for New Scientist*



Got a story for Feedback?
Send it to feedback@newscientist.com
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Consideration of items sent in the post will be delayed

Sperm tracking

Earlier this year, Feedback devoted a lot of column inches to the Scunthorpe problem: the fact that innocuous words and phrases often contain letter strings that may be offensive when viewed in isolation, which makes it difficult to build automated tools to moderate internet conversations (26 April).

We thought this well might have run dry, but educator and researcher Bernd Würsig is here to tell us otherwise. In the early 2000s, Würsig was leading a team of researchers studying sperm whales in the Gulf of Mexico – and attentive readers have probably guessed where this is going.

One of the researchers was sending daily written reports via satellite phone, but only about half of them got through. It finally dawned on the scientists that many reports used the word "sperm", so the university server was deleting them.

They got around it by sending reports with lines like: "We photographed and followed a matriarchy of whales."

Just one letter

Our ongoing search for the most inspired and/or unedifying scientific acronyms continues.

Christina Cheers starts things off by highlighting an institute that is now called the Australian Centre for Disease Preparedness. It's one of those biosafety labs, she explains, that studies "highly contagious animal diseases".

Over its 40-year history, the centre has seen a few name changes – its current moniker was bestowed in April 2020. Before then, it was called the Australian Animal Health Laboratory. However, according to Christina, it once had a third name.

During its early development, the centre was called the Australian National Animal Health Laboratory, "until the sniggers from many scientists alerted the bureaucrats to the pronunciation [of its acronym] and 'National' was deleted".

Curiously, Feedback could find no mention of this little acronymic misdemeanour on the centre's website. Digging around, however, we found an article in the *Australian Veterinary Journal* from 1974, describing the proposed lab and its benefits. Not only does the article repeatedly call it the Australian National Animal Health Laboratory, including in the title, it even uses the resulting unfortunate acronym.

But for a truly tangled acronym, try Niall Leighton's offering – a European research project that examines "how online narratives, including conspiracy theories and misinformation, spread and evolve, with a focus on individuals aged 45-65". (Failure to read *New Scientist*, that's how.)

The project is called Social Media Narratives: Addressing Extremism in Middle-Age. This ought to be condensed to SMNAEM(A), but somehow has been abbreviated to SMIDGE. Niall says ("but I'm guessing") that it works like this: Social Media narratives: Addressing extremism in mIDdle-aGE.

If anyone can top that, they are a GENuinely Intelligent yet hUmble perSon.

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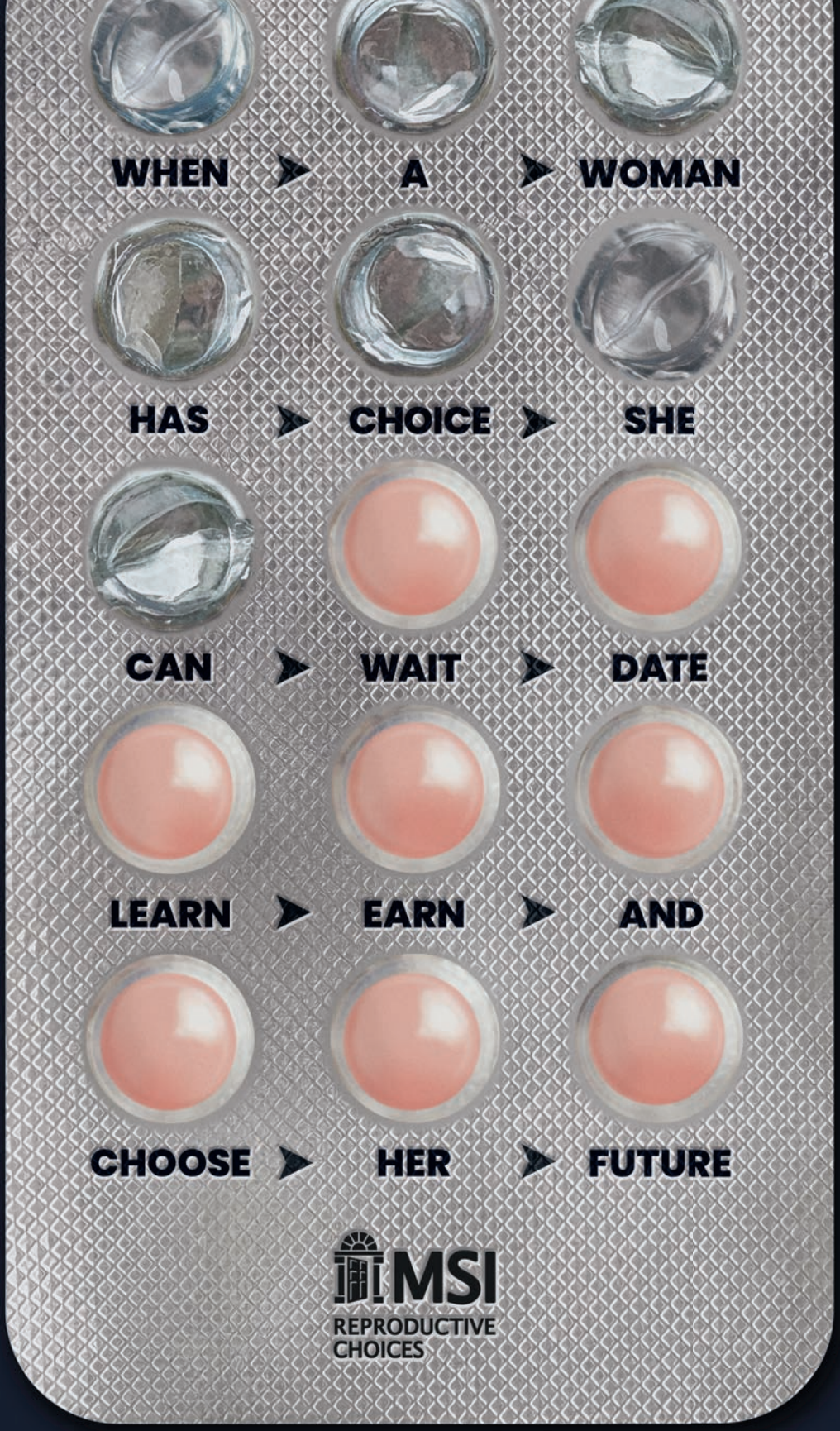

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