

# New Scientist

WEEKLY 15 January 2022

**FIRST PIG TO HUMAN  
HEART TRANSPLANT**  
THE SCIENCE OF OMICRON  
**HOW TO CHANGE  
YOUR PERSONALITY**  
THE PREHISTORIC CAT GAP

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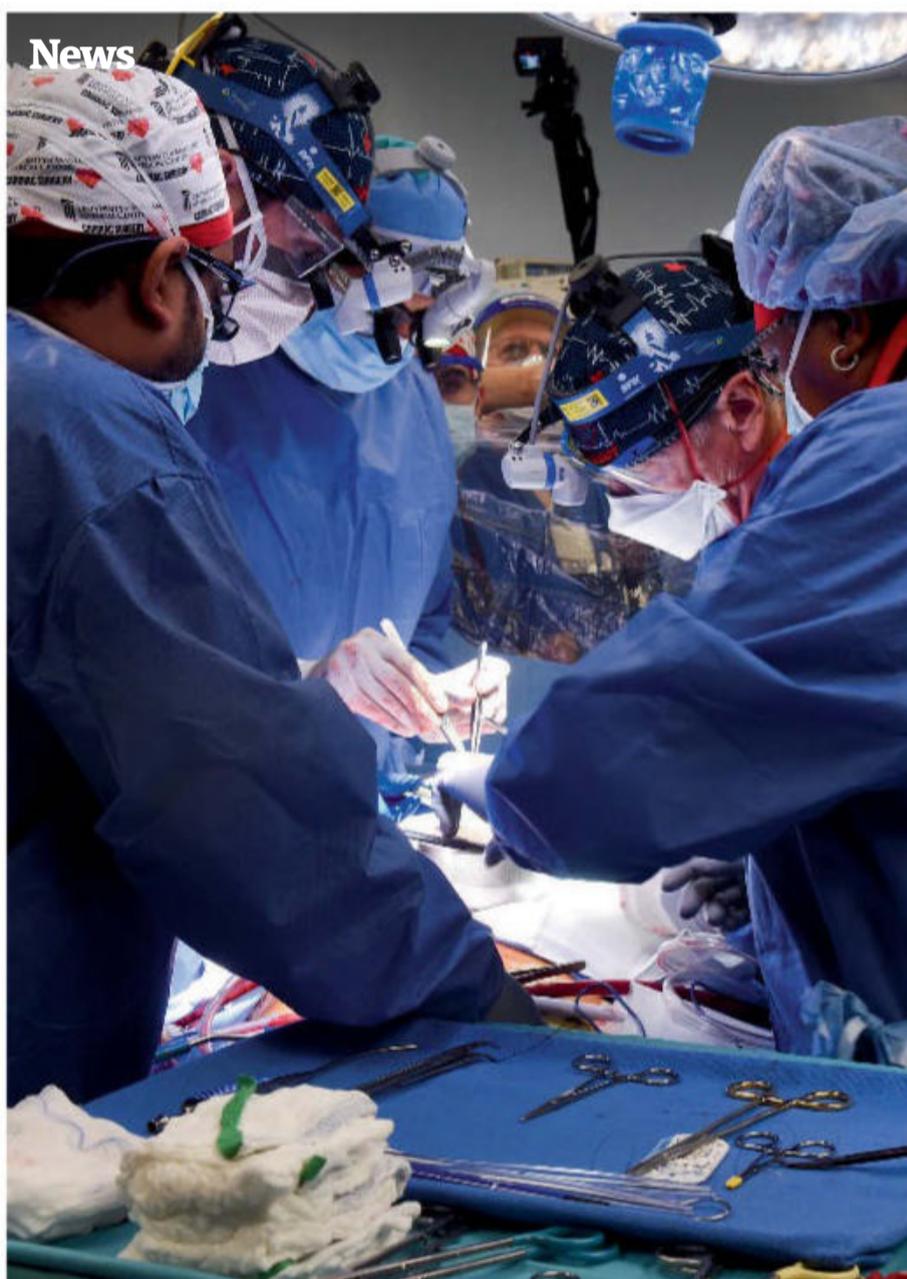
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### Wildlife of Sri Lanka

Join us on an unforgettable 12-day holiday to Sri Lanka, a paradise for wildlife. Your guide will be entomologist and presenter George McGavin, who will take you to the wild corners of this extraordinary island in search of leopards, elephants, whales and plenty of more unusual species too, including pangolins, sloth bears and lorises. The tour departs on 5 March. Find out more and view the full itinerary online.

[newscientist.com/tours](https://www.newscientist.com/tours)

## Online

### Covid-19 daily briefing

Stay on top of all the most crucial developments in the pandemic – from variants to vaccines – with our essential briefing, updated each weekday. There are also links to exclusive interviews and features.

[newscientist.com/coronavirus-latest](https://www.newscientist.com/coronavirus-latest)

## Podcast

### Weekly

In this special episode, *New Scientist* staff give their expert picks of the scientific and cultural events to look forward to this year. Highlights of 2022 include the launch into orbit of SpaceX's Starship, the opening of an upcoming Stonehenge exhibition at the British Museum in London, the TV adaptation of Kate Akinson's novel *Life After Life* and an innovative new breast cancer clinical trial.

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## Podcast



ANDRÉ PATTENDEN/ENGLISH HERITAGE

**Set in stone** An exhibition tells the human story behind Stonehenge

## Discovery tour



ONDREJ PROSICKY/LAMY

**Bear hunt** Rare sloth bears can be tracked down in Sri Lanka

## Events

### Understanding the AI revolution

Beth Singler studies the stories we tell ourselves about artificial intelligence, while Shakir Mohamed works at cutting-edge AI firm DeepMind. Join them for an evening talk on how AI will change our lives. This event takes place in person, from 7pm on 24 February at London's Conway Hall.

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## Newsletter

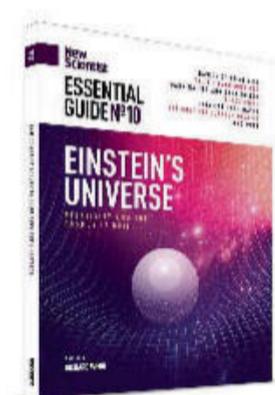
### Health Check

Get reporter Clare Wilson's unmissable newsletter on health and fitness delivered free to your inbox each week. In the latest edition, she looks at how many of us have given up the booze this January, and why the positive effects on people's health are extremely difficult to tease out.

[newscientist.com/health-check](https://www.newscientist.com/health-check)

## Newsletter

**“As many as 1 in 7 adults in the UK will be attempting a ‘dry January’ this year”**



## Essential guide

How did the universe begin? What is it made of? Do black holes exist? Albert Einstein's space and time-warping theories of relativity have revolutionised our view of the cosmos over the past century. Find out how in the 10th *New Scientist Essential Guide*, available now.

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# THE UK'S NUCLEAR WASTE AND THE GEOLOGICAL SOLUTION

Thursday 23 February 2022 6pm GMT, 1pm EST and on-demand

The UK Government has decided that higher activity nuclear waste should be disposed of in a deep underground facility where scientists believe it can remain safe for the long term. Numerous countries have come to the same conclusion and work has already begun to create safe, secure and permanent disposal facilities elsewhere in the world.

This *New Scientist* debate brings together leading thinkers to explore the science behind the geological disposal of nuclear waste, examine the engineering, economic and social challenges at play and asks how similar projects elsewhere are faring.

Find out more and register your place:  
[newscientist.com/nuclearwaste](https://www.newscientist.com/nuclearwaste)

## Panellists

**Katherine Morris**  
BNFL Research Chair,  
University of Manchester

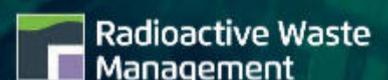
**Vesa Lakaniemi**  
Mayor of Eurajoki, Finland

**Professor Penny Harvey**  
Professor of Social Anthropology,  
University of Manchester

**Professor Cherry Tweed**  
Chief Scientific Advisor,  
Radioactive Waste Management

**Justin Mullins**  
Consultant editor,  
*New Scientist* and debate chair

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# The path of progress

Theories of material reality are less about the destination than the journey

WHY are fundamental physicists so keen to undermine the very theories that are the bedrock of their success? It is a reasonable question to ask confronted with the excitement bubbling around anomalies that seem to be firming up at CERN's LHCb experiment (see page 38).

At stake is a particle that might – the “might” bears emphasising – break open the standard model of particle physics, the framework that successfully explains three of the four forces of nature.

The answer lies in what the standard model doesn't explain: the fourth force, gravity; the dark matter and dark energy that seem to dominate the cosmos; and the fact that our matter-dominated universe exists at all. In indicating – perhaps – the existence of a fifth force that could unite previously disparate aspects

of the standard model, the new particle provides a hint of a way forward.

Good on it, but what do the rest of us get out of it? In short, we don't know – yet. No one was thinking of powered space flight in the 17th century when Isaac Newton unified heavenly and earthly motions with his laws of motion and gravity. When

**“We don't know what the benefits of any possible new unification of physics are – yet”**

James Clerk Maxwell unified electricity and magnetism in the 1860s, televisions, lasers or smartphones weren't on anyone's radar (and nor was radar).

True, any unification that LHCb might or might not have seen is likely to kick in at energies far beyond any

everyday technology we can envisage now (although one implication could be that those energies are lower than we thought).

But immediate technological or material gain isn't the point. To formulate his physics, Newton had to invent calculus, the mathematics that today underlies scientific models of everything from climate change to pandemic spread. In devising his laws for electromagnetism, Maxwell asserted that light always travels at constant speed – paving the way for Albert Einstein's theories of relativity that, besides explaining gravity and the wider cosmos, enabled innovations such as GPS.

Science begets science and, along the way, technology of universal benefit drops out. That progress may be stuttering and is rarely linear – but we should never doubt it is worth going along for the ride. ■

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# Gifts in Wills could be the key to protecting the future of human health

Our experience of COVID-19 shows how suddenly a global health challenge can appear. As someone interested in science, you will understand that while nobody can predict what we will face next, we can be certain that the future will bring many more threats to human health.

As Chair of the Medical Research Foundation – the charitable arm of the Medical Research Council – I have seen the incredible impact that individuals who remember the Foundation in their Wills can have on the future of our health and wellbeing here in the UK. These gifts fund research and researchers which can have far-reaching implications for human health.

**With a gift in your Will you can play a key role in providing the science that will protect the health of future generations.**

Right now, the Foundation is funding research to tackle antimicrobial resistance, and investing in researchers like Dr Myrsini Kaforou – who will make the fight against antimicrobial resistance her life's work.

Without support at the crucial early stages, researchers like Dr Kaforou can be forced to abandon their passion and leave science altogether, with an immeasurable loss to future human health. Gifts in Wills provide the long term funding and security that allows the Foundation to invest in projects like Dr Kaforou's and lay the foundations for quality research in years to come.

**Your Will can fund the rational response to health challenges that medical science provides.**

**“As scientists, our duty is to secure the future of research for the generations that follow.”**

Professor Fiona Watt, President of the Medical Research Foundation and Executive Chair of the Medical Research Council.

While we don't know what the future holds for human health in the UK, we do know that research, and the brilliant scientists driving that



“The funding I received through the Medical Research Foundation will be transformative for my research.” Dr Myrsini Kaforou

research forward, are the key to meeting those challenges for years to come.

But many of these scientists rely on the generosity and foresight of fellow members of the public – people like you, who understand the power of science and are willing to leave a gift to medical research in their Wills. At the Medical Research Foundation, over 90% of our voluntary income comes from individuals who choose to include a gift in their Will – they are crucial in the Foundation's ability to fund research that will enable the next generation of scientists to make real world discoveries in the future.

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**Professor Nick Lemoine MD PhD FMedSci**  
Chair of the Medical Research Foundation

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UNIVERSITY OF MARYLAND SCHOOL OF MEDICINE

## Surgeons prepare the pig's heart for transplant

primate research using Revivacor's pig organs, but has no financial connection to the firm. "We have to be cautious. We have to wait and see," he says.

Bennett was approved to have the risky procedure as he was too sick to go on the waiting list to get a human heart. If he is successfully taken off the bypass machine and continues to stay well, it could open the door to such transplants for a growing pool of people. It could also lead to pig-to-human transplants of kidneys, livers and lungs in future.

There have been fears that virus genes naturally found in pig DNA could cross into humans, but these have faded after successful transplants of pig pancreas cells into people with diabetes. No such problems have arisen with transplants of whole pig organs into primates either. Still, it is likely that Bennett's doctors are closely monitoring him to check for this possibility, says Anthony Warrens at Queen Mary University of London.

"This is a very early experiment and will not translate into clinical practice within a short period of time," he says. "If it works, it could be a small number of years away."

If this procedure succeeds, providing the organs to offer it more widely in future shouldn't be a major obstacle. Pigs have about eight piglets in each litter and can start breeding before they are a year old, although they would need to be farmed in special hygienic conditions.

A spokesperson for NHS Blood and Transplant in the UK said in a statement: "We have been watching this particular field of research for many years. However, there is still some way to go before transplants of this kind become an everyday reality." ■

## Medicine

# First pig heart transplant

The world waits to see the outcome of this groundbreaking surgery and what it could mean for organ donation, reports **Clare Wilson**

FOR the first time, a human has been given a transplant of a pig's heart. David Bennett, 57, had the operation in Baltimore, Maryland, on 7 January using a heart that had been genetically modified to boost the chances of acceptance in a human body.

The donated heart came from a pig developed by US firm Revivacor. In total, the animal had 10 genes modified. Four of those were inactivated, including one that causes an aggressive immune response and one that would otherwise cause the pig's heart to continue growing after transplant into a human body.

To further increase the chances of acceptance, the donor pig had six human genes inserted

into its genome and Bennett is taking immune-suppressing medications. As *New Scientist* went to press, Bennett was coping well with the new heart, but hadn't yet been taken off a heart-lung bypass machine supporting its function. His medical team told *The New York Times* that the animal heart was doing most of the work and that, so far, the heart "looks normal".

"This is a great step forward – you can compare it with the first landing on the moon," says Joachim Denner at the Free University of Berlin.

Transplants from other animals, a procedure known as xenotransplantation, have long been seen as a way to save the lives

of the thousands of people who die each year while waiting for a donated organ. The chief concern is whether our immune systems will accept such transplants, as organ rejection can happen even when human donors and recipients are carefully immunologically matched.

Many research groups have been trying for years to modify animals so their organs provoke less of an immune reaction, and they have had success transplanting them into primates such as baboons.

These first days after Bennett's operation are critical, although immune rejection could take weeks or longer to develop, says Denner, who has been involved in

# Understanding omicron

Studies are beginning to shed light on why omicron behaves so differently to other coronavirus variants, reports **Michael Le Page**

THE global number of confirmed covid-19 cases is currently hitting record levels as omicron spreads. But while this variant – which has around 50 mutations compared with the original SARS-CoV-2 virus – is much more infectious than previous ones, there is growing evidence that it is less likely to cause severe disease in those it infects. Preliminary studies are now providing insights into why this might be the case.

Data from South Africa, the first nation to have an omicron wave, gives an indication of the variant's lower severity. Reported cases there peaked at 117 per cent of the level of the country's delta wave, whereas hospitalisations peaked at 63 per cent and deaths at 24 per cent.

One factor in why omicron seems to be sending a lower proportion of cases to hospital could be that more people are now protected against severe disease, due to previous infections and vaccination. However, animal studies suggest that omicron is also inherently less likely to cause severe symptoms.

For instance, a team led by James Stewart at the University of Liverpool, UK, has found that mice become less ill and recover faster with omicron compared with other variants. "Ours is one of a number of animal studies now," says Stewart. "They do point to very much the same thing."

Work by Joe Grove at the University of Glasgow, UK, and his colleagues suggests that the reason omicron is less severe is that it infects cells in a slightly different way. The process begins when the spike protein of the virus binds to a protein called ACE2 that protrudes from the surface of most human cells.

The second step occurs when the spike protein is cut by another



WALDO SWIEGERS/BLOOMBERG VIA GETTY IMAGES

Inspecting samples at the African Health Research Institute, South Africa

## 17%

Increase in peak infections of omicron in South Africa, compared with earlier delta wave

## 37%

Drop in peak hospitalisations when comparing South Africa's delta and omicron waves

## 76%

Drop in peak deaths when comparing South Africa's delta and omicron waves

protein in our bodies, causing the virus to release its contents inside a cell. With other SARS-CoV-2 variants, this cutting is done by a protein called TMPRSS2 found on the outside of cells, and it enables the viruses to then fuse with our cells.

With omicron, the spike protein doesn't seem to be cut while it is still outside our cells. Instead, the virus appears to first become enveloped by the membrane of a cell and pinched off into a small sac within that cell. Only then is the spike protein cut by proteins called cathepsins. This process is slower.

Put together with results from other teams, the finding suggests that omicron infects cells differently, making it more likely to infect the nose than the lungs. "The emerging picture is that this is probably the mechanism that underlies this switch from a lower respiratory tract infection to an upper respiratory tract infection," says Grove.

Why this has happened isn't known, he says, and there is no guarantee that future variants

will remain less severe. The 2006 SARS virus infected cells in the same way as omicron, yet oddly was far more deadly, says Grove.

"That said, as we all get immunity from vaccines and natural infection, our antibody and, importantly, our T-cell responses are being strengthened," he says. "So the ability of the virus to cause severe disease will be diminished."

However, the impact of a virus depends on how many people it infects as well as on how severe it is, which is why flu kills far more people than Ebola. In countries such as Australia that had previously succeeded in preventing large outbreaks, omicron is already having a much greater effect than other variants.

"This variant is much more infectious and spreading very rapidly," says Stewart. "It's already putting pressures on healthcare systems worldwide."

A big part of why omicron is so infectious is undoubtedly its ability to evade antibodies and infect a far greater proportion of people who have been vaccinated or infected by other variants. But this can't be the whole story.

One possibility is that it is related to the observed higher levels of the virus in saliva, meaning the variant is more likely to spread when people talk, shout, cough or sing.

"I think the higher levels of virus in saliva relative to previous variants must correlate in some way with the increased infectivity," says Diana Hardie at the University of Cape Town in South Africa. "I don't have proof of it, but it makes sense."

Her team has compared the results of PCR tests done using nasal and saliva swabs from the same individuals. The mouth swabs involved people coughing and then swabbing the inside of

# Testing for the new variant

Omicron and changed rules have left people wondering what coronavirus test results really mean. **Clare Wilson** explains

both cheeks, above and below the tongue, on the gums and on the hard palate for at least 30 seconds.

With the delta variant, only 70 per cent of saliva swabs were positive when the nasal swabs were all positive. But with omicron, it was the other way round. Only 86 per cent of nasal swabs were positive when all the saliva swabs were positive.

In other words, saliva swabs may be a more reliable way of detecting omicron infections with PCR tests. Hardie thinks this applies to lateral flow tests – also known as rapid antigen tests – too, and plans to investigate this. There are already anecdotal reports that mouth or throat swabs are better than nasal swabs for detecting omicron.

Another reason why omicron is so infectious might be that a much higher proportion of people are asymptomatic and spread the virus without ever realising they are doing so. Lawrence Corey at the Fred Hutchinson Cancer Research Center in Seattle, Washington, and his colleagues have been analysing data from ongoing studies in South Africa where people have been tested regardless of symptoms.

The results suggest that the rate of asymptomatic infections is around eight times higher with omicron than with other variants, says Corey. The researchers think this could be a major factor in explaining why this variant is spreading so fast.

“It’s plausible,” says Stewart. But all these findings are preliminary and need to be confirmed, he says. “I think it’s very early days. Tread cautiously, I would say, in interpretations of everything.”

It makes sense that there would be more asymptomatic cases with omicron, says Grove. “That data is completely consistent with the idea that this virus is, on a person-by-person basis, less severe.” ■

## How have covid-19 testing rules changed?

Many countries have lessened their restrictions for people with covid-19 since the start of the surge caused by the omicron variant. In the UK, the isolation period for people with an infection has been cut from 10 days to seven, as long as you get a negative result on two lateral flow tests (LFTs), also known as rapid antigen tests. These must be done on days six and seven, and carried out at least 24 hours apart. People should remain cautious around others and avoid those who are vulnerable, though.

## “There’s huge variation in the length of infection and huge variations in viral load”

### Could the isolation period be shortened further?

In the US, the isolation period has been cut to five days for people with no symptoms or whose symptoms are waning, although you should still wear a mask around others for five more days. The UK Health Security Agency (UKHSA) says it has no plans to follow suit, and that the situation differs in the two countries. In the UK, the isolation “clock” begins on the day of a positive test or the first day of symptoms, whichever is first. In the US, it starts on the first day of a positive test and, because these can take several days to access, “day five” is likely to fall later in the course of an infection.

### Why do some people test positive even though they feel well?

Symptoms may not reflect how much virus is present in a person’s throat or nose. You

could have replicating virus but no symptoms and vice versa. “There’s huge variation in the length of infection, and huge variations in viral load,” says Al Edwards at the University of Reading, UK.

The UKHSA estimates that 10 to 30 per cent of people would still test positive on an LFT at day six, and that 5 per cent of people would still be positive at day 10, although the guidance in the UK says you no longer have to isolate on day 11, no matter what your LFT results show.

### Can you test positive for covid-19 without being infectious?

Even if you have had three doses of vaccine, a positive LFT result means you are infectious to other people because virus protein is present in large quantities in your nose or throat. For that, the virus must be multiplying inside your cells.

However, PCR tests can give positive results for weeks after an infection, because they can detect tiny quantities of the virus’s genetic material, which aren’t necessarily infectious.

A positive lateral flow test suggests that the virus is replicating in your cells

## In the UK, do I still need a PCR test if I have a positive LFT result?

People in the UK who test positive by LFT no longer need to take a follow-up PCR test, a temporary change. This is because background levels of covid-19 are so high – with about 1 in 15 people infected in the last week of December – that a positive LFT result is currently less likely to be false.

### Does this mean people can just rely on LFTs now?

No. Anyone in the UK with covid-19 symptoms but a negative LFT result must still take a PCR test to rule out an infection. This is because LFTs have too high a rate of false negatives – saying you are free of covid-19 when you are really infected – to rely on them if you have symptoms. There are several reasons why LFTs are prone to false negatives, including people failing to swab their nose or throat properly and failing to mix the swab well with the testing fluid, says Edwards. “LFTs are only able to detect large amounts of virus.”

### Are false negative LFT results more likely with omicron?

The UKHSA says initial studies suggest that LFTs are as sensitive to omicron as they are to the delta variant, although it is doing further tests. But the US Food and Drug Administration has said LFTs may be less sensitive at detecting omicron.

It is possible that LFTs that only involve swabbing the nose may be more likely to give false negative results for omicron, because this variant may be more likely to reach high levels in saliva before it does in nasal mucus (see “Understanding omicron”, left). ■



GEORGE CLERK/GETTY IMAGES

Oceanography

# Outsider nets prize to predict where a message in a bottle would float to

David Hambling

A SATELLITE engineer with no background in oceanography has won an international competition to predict where a “message in a bottle” will drift in the ocean.

Chris Wasson, who is based in southern California, beat 31 teams to scoop the \$25,000 top prize in the Forecasting Floats in Turbulence Challenge, organised by the US Defense Advanced Research Projects Agency (DARPA).

“I don’t have any real background in oceanography or weather system forecasting, but the problem was stated as more data- and algorithms-oriented,” says Wasson. “So I registered thinking I’d just see how things went.”

Competitors had to forecast the locations over 10 days of 90 devices set adrift in the Atlantic. They were given the previous 20 days of movement data and information on currents, wind and waves.

Wasson won against teams of experienced oceanographers. Second prize went to Deltares, a research institute that is based in the Netherlands, and third

place to the Center for Ocean-Atmospheric Prediction Studies in Tallahassee, Florida.

Wasson modelled the combined effect of wind and surface currents on each float. For the initial 20 days, he compared his predictions with the actual position and fine-tuned his model each time, using a combination of machine learning, which is a form of artificial intelligence,

**A float like those used in DARPA’s ocean drifting challenge**



and mathematical modelling.

When it came to the next 10 days of movement, Wasson predicted the location of one float to within 4 kilometres of where it actually ended up, an achievement only matched by one other team.

He found that ocean currents were the dominant factor, though strong winds could override them. While his model was generally quite accurate, some of the floats took off in directions he didn’t predict, possibly because of inaccurate ocean current data.

While Wasson had a reasonable

idea how his model would perform, he didn’t know how strong the competition was. “Some other teams also put up some very high-scoring days during the competition, so it was a real nail-biter,” he says.

Nikolas Aksamit at the University of Victoria in Canada says that technical specialists from outside the field of oceanography have often contributed to the subject, so Wasson’s win wasn’t a complete surprise.

DARPA hopes the challenge will prove useful for its Ocean of Things (OoT) project, an array of thousands of free-floating sensors that will be deployed this year to detect ships and submarines. The agency will make OoT data publicly available to help future drifter models.

The same drift forecast methods could also be applied to oil slicks, the dispersion of fish larvae and locating shipwreck survivors. Wasson says further advances in this are likely to be made by oceanographers, but says he will keep his eyes open for future DARPA challenges. ■

Paleoanthropology

## Ancient humans may have started hunting 2 million years ago

OUR ancestors were regularly butchering animals for meat 2 million years ago. This has long been suspected, but the idea has now been bolstered by a study of cut marks on animal bones.

The find cements the view that ancient humans were active hunters by this time, contrasting with earlier hominins who ate mostly plants.

The new evidence comes from Kanjera South, an archaeological

site near Lake Victoria in Kenya. Gazelles and wildebeest were common in the area at the time and dozens of their fossil bones have been excavated.

Many of them carry cut marks, suggesting ancient humans hacked meat off them. But it wasn’t clear whether the humans were the first to the carcasses – which would indicate that they hunted them – or whether they merely drove off big carnivores that did the killing.

During a study of modern carcasses, Jennifer Parkinson at the University of San Diego in California and her colleagues realised that

carnivores tend to eat particular parts of prey. That means if ancient humans scavenged the carcasses after carnivores had eaten, meat would be missing from these areas. In which case, the cut marks left by the ancient human tools would lie on different parts of the bones, where there was still meat.

Parkinson’s team then looked at the bones from Kanjera South and found that the ancient humans were

**“The location of cut marks on ancient bones suggests humans were hunters, not scavengers, by this time”**

cutting the bones in the places that would be expected to have been stripped of meat by carnivores. This suggests there was still meat there, and that the humans were first on the scene (*Quaternary Science Reviews*, doi.org/hcd7).

No ancient human remains have been found at the Kanjera South site, so we don’t know which hominins did the hunting. “We have thousands of stone tools, so we know hominins were there, but they didn’t happen to die there,” says Parkinson. However, the most likely candidate is *Homo habilis*. ■ Michael Marshall



ATEM Mini Pro model shown.

# Introducing ATEM Mini Pro

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## Animals

### World's smallest land snail could fit in a grain of sand

Chris Simms

A NEWLY discovered snail species is the smallest yet found on land. *Angustopila psammion*, discovered in cave sediment in northern Vietnam, has a shell just 0.48 millimetres high and a shell



*Angustopila psammion* is a very tiny snail

volume of only 0.036 cubic millimetres. This makes it so small that you could fit about five individuals inside the average grain of sand.

Unsurprisingly, these snails are hard to spot. To find them, Barna Páll-Gergely, a land snail taxonomist at the Eötvös Loránd Research Network in Budapest, Hungary, and his colleagues gathered soil samples from caves and placed them in a bucket of water. They then removed the floating debris, dried it, sieved it and examined it under a microscope (*Contributions to Zoology*, doi.org/hb66).

The snails probably didn't live in the caves, says Páll-Gergely. "We assume that the sediment had fallen in through crevices in the rock, because it contains bleached, opaque shells of surface-dwelling terrestrial gastropods. The living snails presumably live deep in limestone crevices close to or on root systems."

There are smaller known snails in the sea – the record holder there is *Ammonicera minortalis*, with a diameter of around 0.4 mm. That is probably close to the lower limit, which is determined by the number of neurons a newborn snail must have to be functional, and the shell of the adult snail being large enough to accommodate at least one egg. ■

## Astronomy

### Merging black holes produce an exceedingly speedy runaway

Leah Crane

WHEN a pair of black holes merge, the resulting larger black hole can be sent hurtling away at incredible speeds – and now we have seen it happen.

Vijay Varma at the Max Planck Institute for Gravitational Physics in Potsdam, Germany, and his colleagues found this fast-moving black hole by taking a second look at data from the Laser Interferometer Gravitational-Wave Observatory (LIGO) in the US and its corresponding observatory in Italy, called Virgo. These measure gravitational waves, ripples in space-time caused by the motions of massive objects.

The signal that Varma and his colleagues studied is designated GW200129. It came from two black holes orbiting one another that spiralled inwards and smashed together, resulting in a single, larger black hole. They found that, before the merger, the black holes were spinning, and their spin axes weren't aligned with one another or the axis running

through the point in space around which they orbited.

This hints at where the pair may have formed. "Isolated systems tend to give you aligned spins, according to models," says Leo Stein at the University of Mississippi. "When we see these misaligned spins, that's a hint that this binary may have formed in a more crowded environment," like a dense clump of old stars.

# 1500

Probable speed of the black hole in kilometres per second

That misalignment is also a deciding factor for the fate of the final black hole. When black holes merge, the momentum held by the spin has to go somewhere, and ends up being split between the gravitational waves emitted in the collision and the final black hole.

The merger can be compared to a cannon's firing, says Davide Gerosa at the University of Milano-Bicocca in Italy.

"When the cannonball flies, the cannon recoils in the opposite direction," he says. "When the black holes emit gravitational waves, those carry some linear momentum – the gravitational waves are the cannonball and the black hole that is left behind is the cannon."

Researchers have calculated that this "kick" effect should be able to give black holes speeds of hundreds of kilometres per second, but this is the first observational evidence. Varma and his colleagues calculated that the final object's speed was at least about 700 kilometres per second and probably closer to 1500 kilometres per second, which may be fast enough to propel it out of its home galaxy (arxiv.org/abs/2201.01302).

This evidence that black holes can recoil after mergers is important, because removing a black hole from the crowded environment where it was born means that it won't be around to participate in more mergers. This makes it difficult to explain some of the larger black holes LIGO has spotted, which we would expect to result from a series of mergers.

It also means that the cosmos is full of black holes zooming around at extreme speeds, but that shouldn't worry us. "Space is so extraordinarily vast that there is basically no chance that on Earth we'll encounter anything like this," says Varma. "This one is happening billions of light years away, so even if it was pointed directly at Earth, we wouldn't have to start worrying about it any time soon. But it's pointed away from Earth." ■

An artist's illustration of a black hole



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# More than just a phage

Bacteria-killing viruses are increasingly being used to clean up our food and could soon be put to work in healthcare, reports **Michael Le Page**

LISTERIOSIS kills hundreds of people every year in Europe alone. The bacterium that causes it, *Listeria monocytogenes*, can contaminate all kinds of foods and keeps growing even in fridges. But if you live in the US, Canada, Australia, New Zealand or Israel, you probably have a lower risk of infection because you are eating foods sprayed with a cocktail of viruses that kill listeria bacteria.

Bacteria-killing viruses, called bacteriophages, are increasingly being used to destroy harmful microbes during food processing, to stop food rotting and to treat plant and animal diseases on farms. One big advantage of this

**“One of the biggest issues with antibiotic resistance has been the abuse in the food industry”**

approach is that phages can kill bacteria that have become resistant to antibiotics or disinfectants.

Bacteriophages are already everywhere. There are an estimated  $10^{31}$  phages on Earth, more than every other kind of biological entity combined. Your gut alone is thought to hold  $10^{15}$ .

Given their multitudes, it is no surprise people have wanted to put them to work. Phages have been used to treat human infections since the 1920s, when the Eliava Phage Therapy Center in Tbilisi, Georgia, was set up. It still treats people today, but phage therapy is seldom used elsewhere. It is much easier to prescribe antibiotics than to find a phage capable of killing the specific bacterium infecting a person.

When it comes to food, it is a different matter. Phages are increasingly being used in some countries to kill bacteria that cause food poisoning. The main targets are salmonella, shigella and the

O157:H7 strain of *E. coli*, in addition to *L. monocytogenes*.

These bacteria can lurk on fresh foods such as salads and can also contaminate the surface of foods after cooking. There is no perfect way to get rid of them. For instance, ionising radiation is extremely effective, but it can alter the taste, texture and look of food.

When using phages, the usual approach is to spray a fine mist containing them over food. This can be highly effective at killing unwanted bacteria. Numerous studies show that it can reduce bacterial numbers by orders of magnitude and sometimes even to the point of undetectability.

Other advantages are that phages leave no perceptible traces and have no effects on people, packaging or machinery, unlike some of the chemical alternatives used for disinfecting foods.

They can also be used on organic, halal and kosher foods. Treated foods don't have to be labelled, as all fresh foods already contain phages, so packaging can remain unchanged.

## Phage cocktail

However, the approach has its drawbacks too. The main issue is that each phage targets only one specific bacterial strain, so a mixture of phages is required to kill all the strains that might be present. This means a cocktail that proves potent in the US, say, might not work in other countries. And because bacteria are always evolving, the effectiveness of each phage needs to be constantly monitored and the mixture tweaked as necessary.

This can complicate efforts to obtain regulatory approval, says Alexander Sulakvelidze, head of the Maryland-based phage company Intralytix. Regulators



**Vegetables can be sprayed with phages to kill pathogens**

are used to dealing with single chemicals rather than cocktails requiring constant adaptation, he says. It took Intralytix more than four years to get its first phage product, ListShield, approved by the US Food and Drug Administration in 2006.

In addition, because phage sprays don't usually kill all bacteria, their populations can regrow over time, especially if food isn't stored properly. Other issues include chemicals in or on foods killing the phages, or the spray not coating every surface.

For all these reasons, even phage enthusiasts are cautious about the claims they make.

“It's a key tool that could be added to the toolbox,” says Tobi Nagel at Phages for Global Health, a non-profit organisation that promotes their use in low-income

countries. “I won't go so far as to say phages could be the be-all and end-all solution.”

Persuading companies to adopt the technology can also be hard. “Food processors were somewhat reluctant to apply viruses on their food,” says Sulakvelidze.

But many have been won over. The main motivating factor for them is avoiding food recalls, which can cost firms millions. For instance, in 2009 the Peanut Corporation of America filed for bankruptcy after being found to be the source of a salmonella outbreak that killed nine people.

Today, Intralytix has five approved phage products for killing dangerous bacteria on human and pet foods, and is making a profit, says Sulakvelidze. Several other companies sell similar products.

Nagel hopes to make such products available in low-income countries too. Phages for Global Health is working with researchers



JEFFREY GREENBERG/UNIVERSAL IMAGES GROUP VIA GETTY IMAGES

Extending shelf life would not only benefit producers and consumers, but also help save biodiversity and limit carbon emissions by reducing food waste. Food production is a major cause of emissions and habitat loss.

Lastly, many teams hope to use phages to treat diseases in animals and plants. This could help reduce antibiotic use by farmers.

“One of the biggest issues we’ve had with antibiotic resistance has been the horrible abuse in the food and agricultural industries,” says Ben Temperton at the University of Exeter, UK. “If we can increase the amount of phage use and decrease antibiotics that can only be a good thing.”

But using phages on farms is trickier than applying them to food. When they are given to animals that are moving around and swapping bacteria, resistance can rapidly evolve and spread, says Sulakvelidze.

With plants, resistance is less of an issue, says Blackwell, whose team is developing phage treatments for potato blackleg, a bacterial disease that attacks the stems of the plants.

However, phage resistance isn’t as serious a problem as antibiotic resistance. If phage resistance appears, you simply look for other phages that the bacteria cannot resist – and doing so is much cheaper than finding new antibiotics, says Temperton.

As regulators and companies become more comfortable using phages on food, it could also help with their adoption for treating antibiotic-resistant infections in people, says Temperton. “The familiarisation of using these as an antimicrobial can only really serve the clinical use of phages positively,” he says. “If people see it working in food and it’s kind of normalised that

in Kenya on phage treatments for chickens just before slaughter, to reduce meat contamination with campylobacter.

An additional challenge is storage, she says, as phages need to be kept cold, but a team in Canada has developed a way of turning phages into dry powders that don’t need refrigeration.

Preventing food poisoning isn’t the only thing phages are being developed for. Several teams want

**“We have products targeting the spoilage pathogens of potatoes, mushrooms and salads”**

to make food last longer, by killing the bacteria that make it rot. “We have a pipeline of products targeting the spoilage pathogens of potatoes, mushrooms, salads, anything which is of commercial interest,” says Alison Blackwell, chief executive of UK-based company APS Biocontrol.

way, I definitely think that’s going to be a big, big positive.”

This is already happening in the US, says Sulakvelidze. He says Intralytix decided to focus on food uses because it would have run out of money trying to get human therapies approved back in 1998 when it was founded. US regulators now have the understanding and processes in place to deal with such phage therapies, and Intralytix plans to launch three clinical trials within the next year or two.

**Not just food**

“There’s clearly a renaissance in phages, and phage biocontrol and therapy, which hopefully will lead to some human therapeutic products in the not-too-distant future,” he says.

Intralytix also wants to launch phage “nutraceuticals” that people can buy, for instance to get rid of undesirable components of their microbiome, such as bacteria associated with obesity. The firm is exploring skincare and oral hygiene products too.

But in Europe, the use of phages hasn’t really progressed. APS Biocontrol, for one, has been waiting several years for approval to use phage products on farms, says Blackwell. “The US is really ahead of Europe,” she says.

The one exception is Belgium, where phage therapy can be prescribed. The approach is being pioneered at the Queen Astrid Military Hospital in Brussels.

All in all, it looks as if phage therapy might finally go mainstream. “In the last five years, we’ve seen so much growth it’s unbelievable,” says Nagel. The bad news is that it is happening because we are fast running out of alternatives due to growing antibiotic resistance. “I think it’s desperation,” she says. ■

**10<sup>31</sup>**

Estimated number of phages on Earth

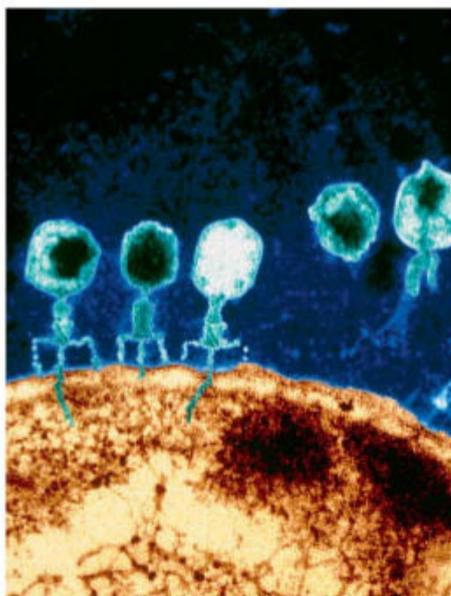
**10<sup>15</sup>**

Number of phages thought to be in your gut

**100m**

Number of light years all the phages on Earth would stretch if stacked end to end

**Bacteriophages (light blue) attack an *E. coli* bacterium (yellow)**



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Interview: Patricia Brennan

# Evolution of the clitoris

A study of dolphin genitalia should end any notion that the clitoris is just a “mini penis”, finds **Jessica Hamzelou**

NEW research in bottlenose dolphins shows that the females have clitorises that evolved for pleasure. Biologist Patricia Brennan tells *New Scientist* how she and her colleagues carried out this study, why it is so vital to study female genitalia and her response to naysayers who question the value of her work.

**Jessica Hamzelou: How did you come to study this subject?**

Patricia Brennan: I have been collaborating with a researcher studying vaginas in dolphins. When we dissected the vaginas, I would look at these clitorises and be just amazed. I was like: “Oh my gosh, these are pretty big, well-developed clitorises.”

We know that dolphins have sex all the time, not just for reproduction. It makes sense that the clitoris would be functional [and give pleasure when stimulated].

**Are dolphins really having sex all the time?**

Bottlenose dolphins live close to the shore, where scientists can go out on their boats and study them. They see them having sex year-round, even when the females are not receptive, so not ready to get pregnant.

Not only do they have sex all the time, they have a lot of homosexual sex. The females will rub each other’s clitorises with their snouts and their flippers really often. It’s not like every once in a blue moon, it’s actually pretty common. Females also masturbate.

If they’re out there seeking all these sexual experiences, it’s likely that it’s feeling good.

Bottlenose dolphins have sex even when reproduction isn’t possible



LISA QUINONES

**Profile**

Patricia Brennan is a biologist who studies sexual behaviour and evolution. She is based at Mount Holyoke College in Massachusetts

**What are you looking for in the dolphin clitorises?**

We were particularly interested in the erectile tissue. We looked at the nerves, too – we were shocked by how big they were. We were also able to see free nerve endings right underneath the skin. These are known to increase sensitivity. We have these in great abundance in our fingertips, and in the human clitoris and the glans penis.

And then we found that the skin itself in the clitoris is about a third of the thickness of the adjacent skin. Once we put all of those things together, we were

pretty certain that this is functioning in pleasure, just like in humans. It’s providing the morphological evidence that we need to say, yes, this is what a functional clitoris looks like (*Current Biology*, doi.org/hcfk).

**Is this controversial?**

There is this hypothesis that, because penises and clitorises share the same developmental pathway, the clitoris is just a mini penis, it doesn’t necessarily have a function. There is debate whether even human female orgasms are functional or just a by-product. It just refuses to die.

We can show that this is actually a fully functional organ that’s serving a purpose. It’s probably evolutionarily a good idea because it makes you seek out sex more often.

**Critics have questioned the importance of your research in the past. What is your response?**

We’re trying to describe natural phenomena. There are people who are uncomfortable with studies of sexual behaviour, in humans or other animals. I’m a scientist. I ask questions where I think there are interesting questions to be asked. ■



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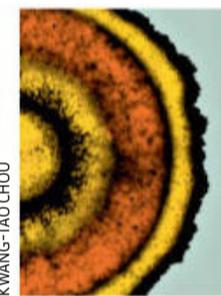
Microbiology

# Bacteria can form complex structures like those of animals

Alex Wilkins

**BACTERIAL** biofilms contain a level of structural organisation that we thought was unique to plants and animals.

Biofilms, slimy clumps of microorganisms, were long considered to be biologically simple, with no more than a primitive level of structural organisation. This contrasts with many multicellular organisms, including animals, in which cells can grow into different forms at different times and places during the body’s development to produce complex structures.



KWANG-TAO CHOU

Tree ring-like structures in a bacterial biofilm

Now, Gürol Süel at the University of California, San Diego, and his colleagues have discovered that bacterial biofilms aren’t as simple as we thought. They explored the response of a *Bacillus subtilis* biofilm to being starved of vital nitrogen. This typically causes bacterial cells to change and become more resilient in an adaptation called sporulation.

But rather than all the cells adapting in the same way, the researchers could demonstrate that stress-mitigating genes produced by the bacteria caused only some cells to adapt, creating concentric rings through the roughly circular biofilm. This tree ring-like pattern is consistent with a “clock and wavefront” mechanism, a more complex structure previously seen only in animals and plants (*Cell*, doi.org/gn2rq7).

“If we just think of [biofilms] as globs of bacterial cells... we’re mistaken,” says Süel. “They’re highly organised.” ■

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Palaeontology

# Australian fossil bonanza

Remains reveal what life was like in the country's ancient rainforests

Chen Ly

**THIS** immaculately preserved mygalomorph spider is one of the many fossils that have emerged from excavations at the McGraths Flat, a 16-million-year-old fossil site in New South Wales, Australia.

"It's unlike anything that we have seen alive today in Australia," says Matthew McCurry at the Australian Museum Research Institute in Sydney, a member of the team that studied the well-preserved spider fossil and other McGraths Flat remains. With a set of sturdy legs attached to its 4-centimetre-long body, "it's an extremely large spider", he says.

Fossils at the site include plants as well as vertebrates and invertebrates, and they show that the site was once a rainforest (*Science Advances*, doi.org/hb96).

"Australia was becoming more arid and most modern ecosystems were developed," says McCurry. "It's Australia's origin story, in a way." ■



MICHAEL FRESE



Health

# Drop in child asthma cases linked to pollution

ABOUT 1 in 12 new child asthma cases worldwide are associated with exposure to a toxic gas released by diesel vehicles, according to a new estimate showing a drop due to cleaner air.

Breathing high levels of nitrogen dioxide (NO<sub>2</sub>) has been previously linked with triggering and exacerbating asthma in childhood. The evidence is now considered strong enough that in 2020, a UK coroner ruled that exposure to the pollutant contributed to the death of 9-year-old Ella Kissi-Debrah.

Susan Anenberg at George Washington University in Washington DC and her colleagues estimate that 1.85 million new

childhood asthma cases were linked with the gas in 2019, making up 8.5 per cent of all new cases that year. That is down from 13 per cent four years earlier, mainly due to higher-income countries cleaning up their air.

"I think this is a good news story for NO<sub>2</sub>. The fraction of new paediatric asthma cases that are attributable to NO<sub>2</sub> has dropped," says Anenberg.

However, the team shows how unevenly the burden today falls on cities and poorer countries. About two-thirds of the linked asthma cases are in urban areas. And while high-income nations saw NO<sub>2</sub>-associated cases fall by 41 per cent – driven largely by

North America – south Asia and sub-Saharan Africa saw them rise.

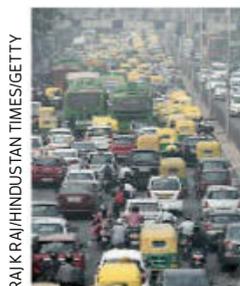
The team used satellite and land-use data to map annual average NO<sub>2</sub> levels globally, before taking data on total childhood asthma cases to estimate how many were associated with NO<sub>2</sub> (*The Lancet Planetary Health*, doi.org/hb6v).

"It is important to note that the actual pollutants in the traffic

emission mix that cause asthma remain elusive, and these results do not suggest that we should focus on only emissions of NO<sub>2</sub> alone," says Jonathan Grigg at Queen Mary University of London.

Although figures on air pollution and child asthma cases are patchy in some parts of the world, Anenberg says the results stand and are a reminder that governments need to translate tough new guidelines from the World Health Organization into legal standards. "The key takeaway for me is the vast majority of people on the face of the planet are breathing air pollution that is unsafe," she says. ■

Adam Vaughan



RAJ KRAJ/HINDUSTAN TIMES/GETTY

Heavy traffic on a street in New Delhi, India

## Archaeology

### Ancient Egyptians used bandages for medicine too

Colin Barras

**AFTER** virtually unwrapping the mummified body of a young girl who died 2000 years ago, archaeologists have found something unique: a bandaged wound.

The ancient Egyptians were no strangers to linen bandages, which they first used to wrap their dead more than 6000 years ago, about a thousand years before the first pharaohs rose to power. But until now, Egyptologists hadn't found bandages used to dress the wounds of living ancient Egyptians.

As part of a study investigating skin infections in ancient Egyptian children, Albert Zink at the Institute for Mummy Studies in Bolzano, Italy, and his colleagues looked at the mummy of a girl who was between 2.5 and 4 years old when she died, and whose remains are now housed in the Egyptian Museum of Berlin, Germany.

It is no longer considered good practice to physically unwrap ancient Egyptian mummies, both for ethical reasons and because doing so destroys the elaborate linen bandaging around the body. Instead, the team used a CT scanner to look inside the mummy.

Doing so revealed a bandage-like structure around her left leg, just above the ankle. After analysing the CT scans, the team concluded that the structure was a dressing that had been placed over a puss-filled wound shortly before the girl died (*International Journal of Paleopathology*, doi.org/hb6x).

"The evidence for the wound dressing is very strong as there are clear signs of an underlying infection," says Zink.

It isn't clear whether the wound contributed to the girl's death or why the embalmers left the dressing in place for the mummification process. The fact that they did, however, means the dressing was also preserved. ■

## Analysis Energy

### Can the UK avoid a fuel bill crisis? The government wants to protect people from rocketing prices, but most options will only delay financial pain, says Adam Vaughan



MARK KERRISON/IN PICTURES VIA GETTY IMAGES

RISING energy bills due to sky-high wholesale gas prices have already squeezed UK household budgets, disrupted industrial plants and triggered the collapse of 28 energy suppliers. Now the issue is on the brink of escalating into a major cost of living crisis.

By 7 February, Ofgem, the energy regulator for England, Scotland and Wales, will announce a new level for a regulated price cap that protects 15 million customers. When it takes effect in April, the average annual dual fuel energy bill could rise to £1925, a huge 50 per cent jump, according to analysts Cornwall Insight.

The consequences of an unmitigated rise that steep will be "an avalanche" of people falling into debt or rationing heating, says Adam Scorer at fuel poverty charity National Energy Action.

The size of the overnight increase is likely to ripple well beyond vulnerable customers to affect the wider economy into next year, says Emma Pinchbeck of trade body Energy UK.

The UK government is talking to the energy industry about short-term ways to mitigate the increase. Energy minister Kwasi Kwarteng met industry figures on

5 January, but the government has been silent on its plans. There is little debate that it has to act – the question is how.

MPs from both major political parties have argued for cutting the 5 per cent VAT on energy bills. There are two downsides beyond a lower tax take. The first is that it is a blunt instrument, helping the rich as well as the poor. The bigger issue, says Scorer, is that it is only a modest saving, estimated at about £90 a year.

## 50%

**Rise in average UK energy bill expected under new price cap**

By contrast, the government providing direct financial support to some households could reduce the average annual bill by £500.

Some MPs have called for environmental levies, which support wind farms and other green measures, to be suspended, but the government will want to avoid being seen as anti-green. Instead, the levy could be shifted off energy bills and onto general taxation. That would save about £160 a year for the 15 million customers covered by the price

### Fuel poverty campaigners in London in November 2021

cap. This option is attractive because paying for the measures through energy bills is regressive. "That one definitely has potential," says Craig Lowrey at Cornwall Insight.

But Pinchbeck says while options such as a VAT cut or shifting levies would be welcomed by the energy industry, an intervention is needed on the wholesale cost of energy. That's because £1030 of a future £1925 bill will be wholesale prices.

However, interfering with wholesale prices could have unintended consequences, such as deterring investors and companies that are ploughing billions of pounds into power stations to help the UK reach net-zero emissions, says Lowrey.

Whatever options stick, most only push financial pain down the road. "These are sums of money that have to be recovered somewhere, somehow," says Lowrey. He says there is probably no single "silver bullet" option, but there may be a "silver buckshot" of several measures implemented.

What are the longer-term options to ensure the country isn't back in this position when the cap is revisited in August, and for years to come? Producing more gas in the UK won't make a difference because it is a global commodity, but considering more gas storage is worth exploring, says Pinchbeck.

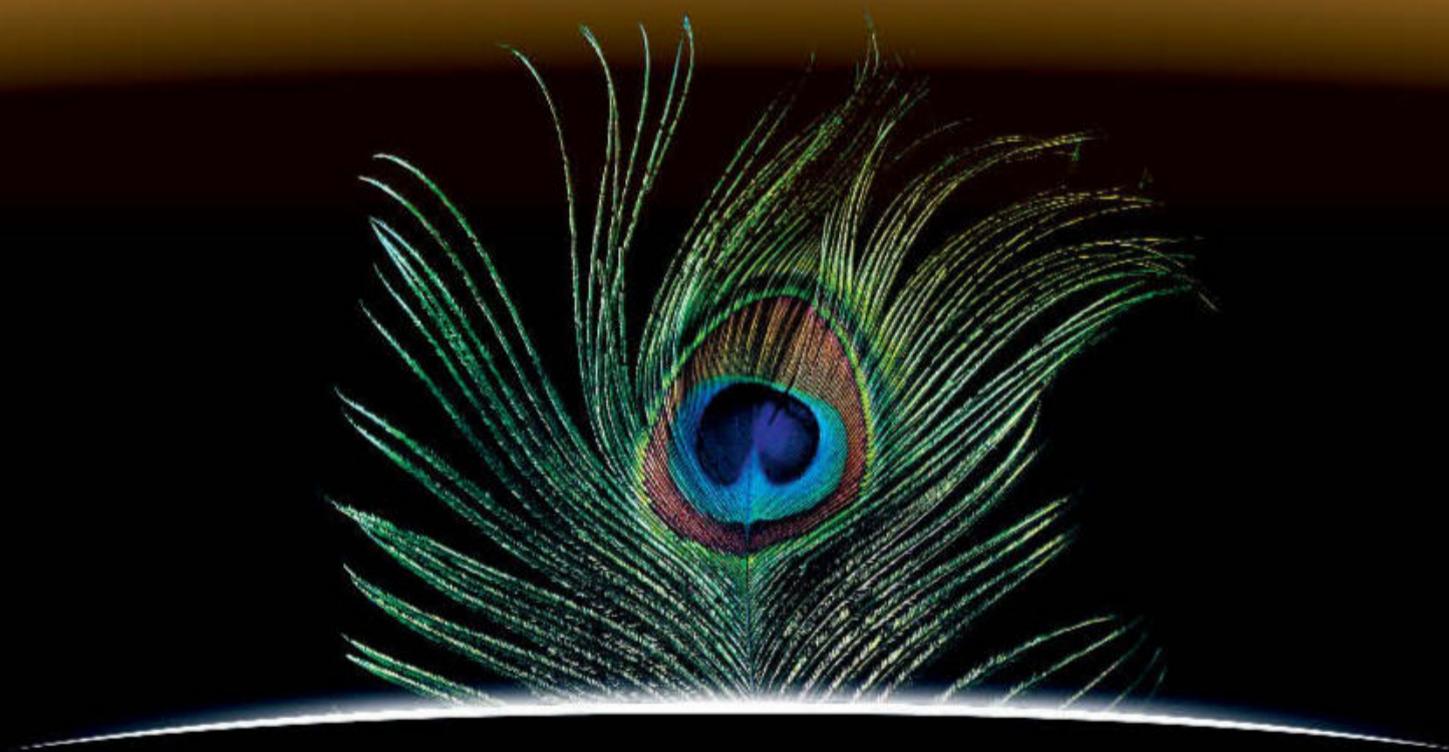
"The long-term solutions are obvious," she says. "More energy efficiency, reducing methane gas in homes [switching away from gas boilers] and diversifying our power sector so we are less reliant on geopolitics and the gas market and more reliant on lovely offshore wind and nuclear and hydrogen." ■

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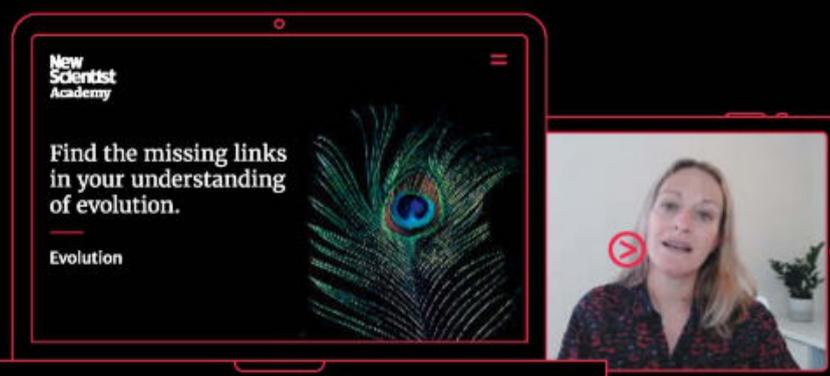
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Welcome to our Signal Boost project – a page for charitable organisations to get their message out to a global audience, free of charge. Today, a message from **The Conservation Volunteers**



## Green spaces are needed more than ever

During the lockdowns and social distancing of the covid-19 pandemic, our local green spaces played a vital part in adjusting to a “new normal”. For some, taking daily walks and exercise in our parks and recreational grounds, or introducing the woodland near our homes to our children, has been enough to reignite a passion for protecting the natural world.

As our Vice President David Attenborough says: “No one will protect what they do not first care about; and no one will care about what they have never experienced”.

That’s why we’ve made it our mission to connect people and green spaces to deliver lasting outcomes for both. For over 60 years, The Conservation Volunteers’ staff, Community Network Groups and volunteers have cared for local green spaces so that they are safe and accessible for all to enjoy.

During the pandemic, that has meant, when it was safe to do so, our volunteers and Community Network Groups being out improving or constructing ponds, planting trees, laying paths, managing woodland, planting wildflowers, building homes for nature, removing invasive species and much more. Our volunteer heroes cared for the environment – a thank you to nature for being there for us when we needed it the most.

### **FEWER HANDS MAKE HEAVY WORK**

Our volunteering sessions were suspended multiple times throughout the pandemic. We were only able to navigate this crisis sustainably thanks to the support of our donors, funders and partners. We know there will be challenges ahead, but we remain positive.

With so many people and communities depending upon green spaces for free access to nature, exercise and recreation – and let’s not forget the climate and ecological emergency, of course – we need to support our volunteers to continue their work. We want to support the momentum so that more people access their local green space and experience the mental and physical health and wellbeing benefits that the outdoors bring.

YOU can join in and feel good. See our website for volunteering opportunities and how to join or set up a Community Network Group.

### **Want to help?**

**If you can donate, you will help our volunteers to care for nature and keep our green spaces open for the benefit of everyone. Visit [tcv.org.uk](https://www.tcv.org.uk).**

Medicine

# Broken hearts in mice repaired using mRNA coronavirus vaccine technology

Michael Le Page

IMMUNE cells in the bodies of mice have been temporarily reprogrammed to repair damaged hearts by removing scar tissue, thanks to the technology used in the mRNA coronavirus vaccines.

“After you give the treatment, the scar goes away,” says Haig Aghajanian at the University of Pennsylvania.

Genetically engineered immune cells called CAR T-cells are already used to treat cancer, but this method is very expensive. The mRNA approach, which involves only temporarily modifying these cells, could dramatically decrease costs.

“We’re hoping this is the next step in CAR-T-type technology that will allow more access,” says Aghajanian.

T-cells are immune cells that use receptors on their surface to recognise cells infected with viruses, which they then destroy.

T-cells can be reprogrammed to target any desired cell type by giving them the right receptor.

Conventional CAR T-cells are made by taking T-cells from a person’s body, genetically engineering them to add a gene for a “chimeric antigen receptor” (hence the name) and then returning them to the body.

Such treatments can be effective against cancers of the blood such as leukaemia, but the first CAR-T treatment to get approved, called Kymriah, cost \$475,000.

Aghajanian’s team is instead turning T-cells into CAR T-cells without removing them from the body, by delivering genes in the form of mRNAs. The mRNAs are packaged inside the same fatty balls, called lipid nanoparticles, used in the Pfizer/BioNTech and Moderna coronavirus vaccines.

In this case, however, the lipid nanoparticles have antibodies

attached to them that bind to T-cells. The team was already working on this before the pandemic, but Aghajanian says the mass roll-out of vaccines should make it easier to get other uses of lipid nanoparticles approved by regulators.

**“T-cells can be reprogrammed to target any cell type by giving them the right receptor”**

Other teams have tried to create CAR T-cells inside the body by using viruses to permanently add DNA genes to the genomes of T-cells. This is potentially risky if something goes wrong.

mRNAs, by contrast, are temporary copies of genes used as templates by protein-making factories. They aren’t integrated into the genome and only persist for days. This means an mRNA

doesn’t permanently alter T-cells. “It does its thing for a few days and then it is gone,” says Aghajanian.

His team has used this approach to target the cells that lay down collagen, which our bodies constantly produce and then remove with other cells. After an injury, the cells that lay down collagen overproliferate, leading to a scar. “If you can get rid of these cells, it goes back into balance and the scar quickly recedes,” says Aghajanian.

To test the method, his team damaged the hearts of mice to create scarring, or fibrosis, that impairs the contraction and relaxation of the heart. Two weeks after an infusion of mRNA nanoparticles, the amount of scar tissue in the hearts of the mice was nearly half of that in untreated animals, and their heart function improved significantly (*Science*, doi.org/gn2gzm). ■

Botany

## Newly identified tree species named after Leonardo DiCaprio

A TROPICAL, evergreen tree from Cameroon, the first plant species to be named as new to science in 2022, has officially been labelled *Uvariopsis dicaprio* in honour of the actor Leonardo DiCaprio.

Martin Cheek at the UK’s Royal Botanic Gardens, Kew, and his colleagues – including researchers at the National Herbarium of Cameroon and the University of Yaoundé I, Cameroon – analysed photos and specimens of the tree, which is found in Cameroon’s tropical Ebo forest.

They determined that it was previously unknown to science, and also appears to be unknown among



LORNA MACKINNON

local communities. The team named the species after actor and environmental activist DiCaprio to commemorate his efforts to protect Ebo forest from logging.

Standing at around 4 metres tall, *U. dicaprio* can be identified by the distinctive and glossy yellow-

green flowers that grow on its trunk. It is closely related to the ylang-ylang tree (*Cananga odorata*) which is native to India, South-East Asia, the Philippines, Indonesia and Australia (*PeerJ*, doi.org/hb7n).

“This is a plant which, for a botanist, just jumps out at you,”

*Uvariopsis dicaprio*, a distinctive new tree species from Cameroon

says Cheek. “It’s so spectacular.”

Currently, fewer than 50 individual specimens have been spotted, all in a single, unprotected area of Ebo forest. As a result, *U. dicaprio* is critically endangered.

The tree adds to the list of strange and spectacular plants that have been revealed in the past 12 months. During that time, many other plant species have been newly named. For instance, in August 2021, Mark Chase, also at Royal Botanic Gardens, Kew, and his colleagues officially labelled seven new Australian species of wild tobacco (*Nicotiana*), including one that traps and kills small insects. ■

Chen Ly



SHUTTERSTOCK/ONDREI PROSICKY

Microbiology

## Hedgehogs had a form of MRSA over 200 years ago

A STRAIN of the antibiotic-resistant bacterium MRSA seems to have evolved in hedgehogs long before we had antibiotics.

*Staphylococcus aureus* usually lives harmlessly on our skin or up our noses. But methicillin-resistant *S. aureus* (MRSA) is a type of this bacterium that can't be killed with antibiotics like methicillin and can cause hard-to-treat infections.

Over the past decade or so, researchers have begun to find a type of MRSA known as mecC-MRSA in wildlife, including boar, storks, snakes and hedgehogs.

While relatively rare in most of these species, it seems prevalent in hedgehogs. To find out why, Ewan Harrison at the University of Cambridge and his colleagues studied swabs from 276 European hedgehogs (*Erinaceus europaeus*).

Animals in Greece, Romania, France, Italy and Spain didn't seem to have any mecC-MRSA on their skin. But others did: 66 per cent of hedgehogs from England and Wales had this strain, for example. These animals also had a fungus called *Trichophyton erinacei* living on their skin. This is known to produce chemicals that can kill bacteria.

The team found that *T. erinacei* made an antibiotic called KPN that could kill mecC-MRSA only when the bacterium's genes for antibiotic resistance were removed. This suggests that the antibiotic resistance genes are key for the bacterium to survive alongside the fungus on the hedgehog's skin.

The team estimates that mecC-MRSA arose in hedgehogs around 1800 (*Nature*, doi.org/gnz7wx). **Jessica Hamzelou**

Geology

## Some volcanic zones cooler than expected

PLUMES of molten rock feeding Earth's volcanic hotspots aren't as warm as we thought, suggesting that we need a new explanation for the sources of volcanic activity in places like Hawaii.

The hotspots aren't connected to volcanic regions at the edges of tectonic plates, but are thought to be fed by plumes deep in the mantle, which expand and rise because of high temperatures.

But Carolina Lithgow-Bertelloni at the University of California, Los Angeles, and her team have found that a number of these hotspots are being fed by relatively cold material, which suggests that other dynamics may be at work.

"We're not saying these aren't hotspots; we're saying yes they are, but there are different mechanisms that help them rise," says Lithgow-Bertelloni.

Calculating the temperature

beneath volcanic hotspots is hard. The upper mantle can be from 250 to 600 kilometres deep, ruling out direct access. Instead, Lithgow-Bertelloni and her team measured the speed of seismic waves under volcanic hotspots and inferred temperatures based on a model of the rock make-up.

They then compared these temperatures with the relatively cold volcanic regions beneath ridges, at tectonic boundaries. According to classical theory, the plumes need to be between 100°C and 300°C hotter than ridges to rise. But more than half of the hotspots the researchers studied were less than 100°C hotter than ridges. Almost a sixth of the hotspots were essentially cold, meaning they were no more than 36°C hotter than ridges.

The study found that the ratio of helium isotopes differed between cold and hot hotspots, suggesting that they may come from different parts of the mantle (*Science*, doi.org/hb63). **Alex Wilkins**

Marine biology

## Mystery of oxygen made by sea microbe

A NEW way of creating oxygen has been found in a microorganism in the darkest depths of the ocean.

Most oxygen on Earth is made by photosynthesis, which requires light. But Don Canfield at the University of Southern Denmark and his team have identified a non-photosynthesising microbe that still generates oxygen.

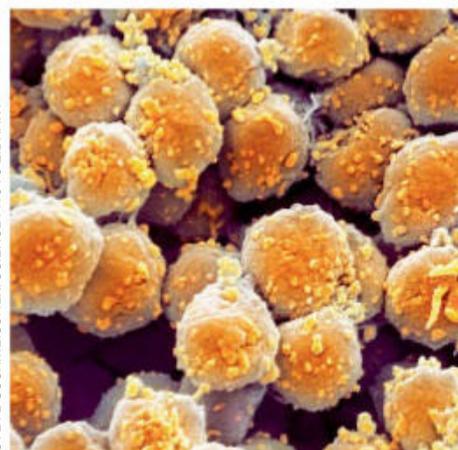
The researchers made the find in their lab after studying various

microbes that can live in the dark, low-oxygen deep ocean. One was *Nitrosopumilus maritimus*, an archaeon that oxidises ammonia to produce nitrogen. Producing nitrogen requires oxygen, and the microbe often lives in oxygen-rich areas of the ocean. It can, however, also survive in dark regions where there is little oxygen – something that has long puzzled scientists.

The researchers produced cultures of the archaea in airtight containers kept in the dark. They then artificially reduced oxygen levels in the containers to mimic the deepest regions of the ocean.

The team found that after the archaea consumed all the oxygen left in the culture, levels started to rise again (*Science*, doi.org/hb6w). It isn't clear how the microbes generate oxygen. There are three known natural ways of producing the gas in the dark without photosynthesis, but the team says the microbes are using a mechanism never seen before.

**Jason Arunn Murugesu**



STEVE GSCHWEISSNER/SCIENCE PHOTO LIBRARY

## Really brief



### Fairy wrens breed out of season

For the second year in a row, Australia's purple-crowned fairy wrens (*Malurus coronatus*) have been spotted breeding outside the wet season – between December and April – in which they normally reproduce. The change in behaviour may allow the species to recover faster after droughts.

### TV remote powers up via Wi-Fi waves

Samsung has created a television remote that draws power from the energy emitted by wireless routers. The new version of the company's Eco Remote, unveiled at the 2022 CES technology trade show in Las Vegas, has a tiny antenna that can capture Wi-Fi signals from a distance of 40 metres.

### Losing weight isn't the key to a long life

The best predictors of a long life include balance, according to a study of older women in the US. The research also found that women who had lost 5 per cent of their body weight in the previous five years were more likely to die in the next five years (*Journal of the American Geriatrics Society*, doi.org/hb64).

## Botany

### Fungus uses RNA to control plant partner

A ROOT fungus that helps eucalyptus trees get nutrients and water maintains this symbiosis in a surprising way – by releasing tiny bits of RNA into the roots to change gene activity in the tree.

Many trees have a symbiotic relationship with ectomycorrhizal fungi that wrap around small roots. This stops the root growing, but the fungal filaments extend far into the soil, gathering nutrients the fungus trades for plant sugars.

It is known that such fungi “talk” to plants by releasing proteins. Now, Jonathan Plett at Western Sydney University, Australia, and his team have shown that one fungus (*Pisolithus microcarpus*) also releases a microRNA when it colonises the roots of the flooded gum tree (*Eucalyptus grandis*).

MicroRNAs are small bits of RNA that reduce production of certain proteins. Cells normally use microRNAs to control their own gene activity, but some pathogens also release microRNAs to turn off genes involved in cellular defence in potential target organisms.

*P. microcarpus* does something similar. After realising it releases a microRNA called Pmic\_miR-8, Plett and his team blocked this substance in the roots of seedlings. Previously colonised roots resumed growth, showing that Pmic\_miR-8 is essential to the symbiotic relationship (*PNAS*, DOI: 10.1073/pnas.2103527119).

It is likely that many other ectomycorrhizal fungi release microRNAs. Plett hopes the work could guide development of plants that can better associate with good microbes, reducing reliance on fertilisers. **Michael Le Page**

## Environment



BRIAN VAN DER BRUG/LOS ANGELES TIMES/SHUTTERSTOCK

### Millions more exposed to dirty air from US wildfires

THE extent of the western US hit by extra high levels of two pollutants from wildfires at once has more than doubled in recent decades, exposing many more people to unhealthy air.

After personally noticing a rise in smog and smoke, Daniel Swain at the University of California, Los Angeles, and his team explored the role wildfires play.

They looked at an area of the western US from Washington in the north to California in the south, including Los Angeles (pictured), and as far east as Montana and New Mexico. They divided the area into squares 111 kilometres wide. Using existing and new data, they looked

for extremes in the levels of PM2.5 particulate pollution and ozone between 2001 and 2020.

Over that period, the number of squares experiencing the co-occurrence of the two pollutants more than doubled, from 18.9 per cent to 44.6 per cent. The number of people affected increased too. On one day – 21 August 2020 – about 46 million people were exposed to peaks in both pollutants (*Science Advances*, doi.org/hb6s).

“People who are ‘safe’ from fires are not safe from the air pollution effects even if they live hundreds or even thousands of miles away,” says Swain. **Adam Vaughan**

## Technology

### Factory fire may deepen chip crisis

A FIRE at a factory owned by the sole provider of a vital technology used to make computer chips could worsen an already serious shortage of semiconductors used in everything from phones to cars.

The blaze damaged a plant in Berlin, Germany, owned by ASML Holding. The Dutch company is the world's largest supplier of photolithography systems and the only source of extreme ultraviolet lithography machines. These devices are used to etch circuits onto silicon wafers and create computer chips used by the likes of Apple, IBM and Samsung.

The current global chip shortage is due to problems including the global pandemic, a trade war, droughts and snowstorms. It has coincided with a period of unprecedented demand.

Although semiconductor firms are racing to increase production and governments are signing deals to bring plants to their own shores to guarantee supply, if ASML can't provide as many machines as expected, the shortage could last longer.

ASML Holding declined an interview request, but stated that it was too early to tell how bad the damage was and whether it will hit production. **Matthew Sparkes**

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**Mark Maslin**  
Professor,  
University College London

## The columnist

Simple rituals can boost your brain, says **David Robson** p28

## Aperture

A glimpse inside the remarkable LEGEND experiment p30

## Letters

For a really good laugh, try tickling a flying fox p32

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## Culture columnist

Sally Adee on *Goliath*, a sci-fi novel about gentrification p36

## Comment

# A sign of the times

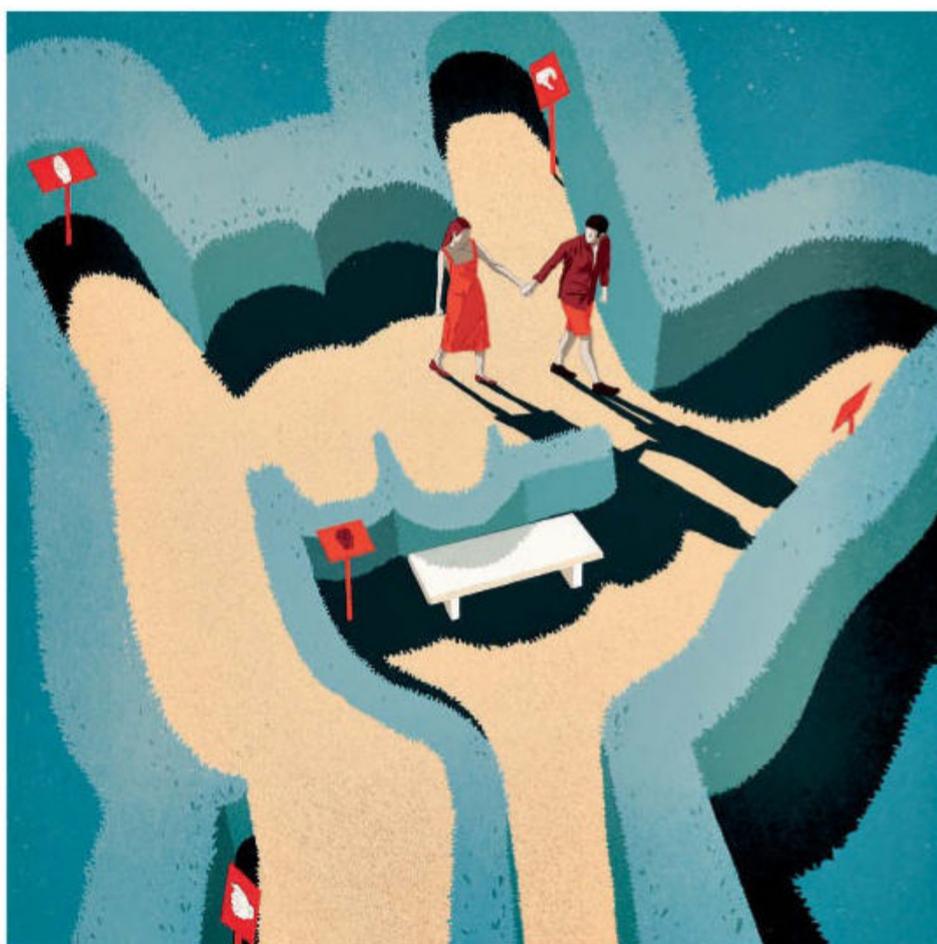
Sign languages are flourishing in many parts of the world. This could bring cognitive benefits for all who learn them, says **Bencie Woll**

**N**OT so long ago, deaf children were punished in the UK for using sign language in the classroom. Recounting his experience in the 1960s, one deaf person told one of my colleagues many years later: “I had a lot of punishments for signing in classrooms... One morning at assembly, I was caught again, then ordered to stand at the front of the class. The headmistress announced that I looked like a monkey [and that she would] put me in a cage in the zoo so the people will laugh at a stupid boy in the cage.”

Thankfully, experiences like this are no longer as common. Sign languages have not only survived, but are now flourishing – so much so that many more people are getting the chance to learn them, which should be celebrated.

British Sign Language (BSL) is used by tens of thousands of people in the UK, including around 90,000 deaf signers. For some of them, such as children with deaf parents, it is the first language they acquire. In the US, more undergraduate and graduate students have enrolled on courses in American Sign Language (ASL) than German each year since 2013.

Currently, the UK Department for Education has a draft BSL curriculum for England on its desk for GCSE students (14 to 16-year-olds), which could come into effect later this year. This would make it a modern language option alongside French, German, Spanish and Chinese. Both



Scotland and Wales have BSL curricula in the works too.

Elsewhere, sign languages are gaining both recognition as official languages and a place on the national curriculum. South Africa has hired 60 instructors to teach South African Sign Language as part of a state-run adult literacy programme, and Jamaican Sign Language was introduced into Jamaica’s national curriculum earlier this month.

That sign languages are thriving should be welcomed for many reasons, including the cognitive benefits that learning them brings. Several studies have found that

hearing people who learn sign languages perform better in tasks requiring spatial transformation abilities – which you might use when taking down directions. Space is an integral part of the grammar of a sign language, with verbs, nouns and pronouns using the space in which they are located as part of their meaning. A series of experiments by Mary Lou Vercellotti at Ball State University in Indiana also found that adult ASL students have enhanced face-processing skills, which are essential to reading emotions.

Learning a sign language can be enlightening, too. In a year-long

study of preschool children by Amy Brereton at Trinity Washington University in Washington DC, hearing children who were learning ASL attained a greater appreciation of cultural diversity, as determined via classroom observations and interviews.

Part of the beauty of learning languages – both spoken and sign – is that you don’t need to be fluent to experience the benefits. In a recent British Academy project I led with my colleague Li Wei at University College London, we highlighted how learning languages shapes the mental functions you use in a range of other fields, from your social awareness to your creativity and grasp of mathematics.

Sign languages today are rich with communities and culture. Up until the 1980s, many deaf people essentially had to exist in the 19th century: no telephones, no radio, no television. But in many countries, social clubs, networks and advocacy groups for deaf signers have given rise to a diverse range of vernaculars. With the internet and social media platforms like Instagram and TikTok, content creators are now sharing these with the world, bringing greater awareness and respect – and increased interest in learning these languages. ■



Bencie Woll is a professor of deaf studies at University College London

## #BrainBooster

### **Make your own luck** Secular rituals really can bring greater success, even for rational thinkers, writes **David Robson**



David Robson is a science writer and author of *The Expectation Effect: How your mindset can transform your life* (Canongate). You can follow him on Twitter @d\_a\_robson

#### David's week

##### What I'm reading

The Galaxy, and the Ground Within by Becky Chambers – a brilliant science fiction that portrays an optimistic vision of the future

##### What I'm watching

Joan Didion: The center will not hold (Netflix) – a wonderfully intimate examination of the US writer's life and career; The Tourist (BBC One)

##### What I'm working on

I'm just finishing a New Scientist special report on the science of happiness

This column appears monthly. Up next week: Chanda Prescod-Weinstein

I AM no coffee snob, but I have started treating the preparation of my morning espresso like a religious ritual. It begins with the counting of the beans – which must number 60, no more, no less. Each subsequent step – from the amount of time they grind (20 seconds) to the long inhale I take before my first sip – is executed as carefully and mindfully as if I were offering a libation to a minor deity.

I fully admit that there is no logical reason to count out exactly 60 beans, one by one, rather than chucking in a spoonful – but the precision is exactly the point. Recent psychological studies show that the creation of daily rituals can bring some surprising benefits to our minds, and the creation of my favourite brew provides the perfect time for me to put that research into practice.

The power of ritual won't be a surprise to tennis stars. Rafael Nadal, for example, chooses to consume his sports supplements in a precise order during each match, while Serena Williams has to tie her shoes in a particular way and bounces the ball exactly five times before each serve.

You might assume that the appeal is purely superstitious. If certain behaviours come to be associated with good performance, we irrationally assume that they are necessary for further success. Much like the placebo effect in medicine, perhaps the belief in enhanced performance creates a self-fulfilling prophecy.

There may be some truth in this. In 2010, German researchers asked participants to try their hand at a bit of golf – specifically putting. When given the golf ball, half the participants were told that it had “turned out to be lucky” for other players. They holed 35 per cent more putts than those who hadn't

been given the expectation of better performance.

For a separate experiment, the researchers asked some participants to bring in their own lucky charms, before taking a memory test. Once again, these people performed better than others who did the test without their favourite trinket. The boost seemed to be linked to feelings of “self-efficacy”. The participants with their lucky charms felt more capable of dealing with the challenge, which then improved their concentration and recall.

Fortunately for the rationalists among us, the latest research

**“It seems that the simple repetition of precise behaviours creates a sense of control in the face of uncertainty”**

suggests that we can all benefit from rituals without any appeal to Lady Luck. Instead, it seems that the simple repetition of precise behaviours creates a sense of control in the face of uncertainty. This reduces our anxiety and improves our mental focus when we face a challenge.

Consider one of my all-time favourite psychological studies, by Alison Wood Brooks at Harvard University. She invited participants into the lab for a spot of karaoke – the song of choice was *Don't Stop Believin'* by US rock band Journey. Some were first assigned the following arbitrary ritual: “Draw a picture of how you are feeling right now. Sprinkle salt on your drawing. Count to five out loud. Crinkle up your paper. Throw your paper in the trash.” The rest were told to sit and gather their thoughts for a minute.

It seems unlikely that any of the

participants seriously believed that the ritual held magical powers. Nonetheless, it increased the accuracy of their singing by a whopping 13 percentage points, as measured by the karaoke machine's pitch-matching software.

Besides establishing a sense of control in stressful moments, rituals can help boost our feelings of self-discipline – which helps us stick to long-term goals. In one examination of healthy eating, for example, participants were asked to sit upright, close their eyes, bow their head and count to 10.

They were subsequently more likely to choose a low-calorie snack rather than a Snickers bar, compared with people in a control group who had performed a set of random movements in any sequence they liked. They were also more likely to endorse statements such as “I felt sharp and focused when making this decision”, suggesting that it had worked by changing their perceptions of their willpower.

Across all of these studies, the most successful rituals are precise, repetitive and follow a rigid order. Beyond those requirements, however, you are free to get creative – simply craft any routine that feels personally meaningful. It could be as simple as performing a fixed set of stretches and listening to the same playlist before public speaking – a strategy that singer Beyoncé uses to prepare for performances.

My coffee ritual was inspired by Beethoven. The composer apparently counted out exactly 60 beans for his brew before starting work each morning. I may not have transformed into a musical genius, or even a karaoke king, but the sense of focus and heightened self-discipline remains long after my cup is dry. ■

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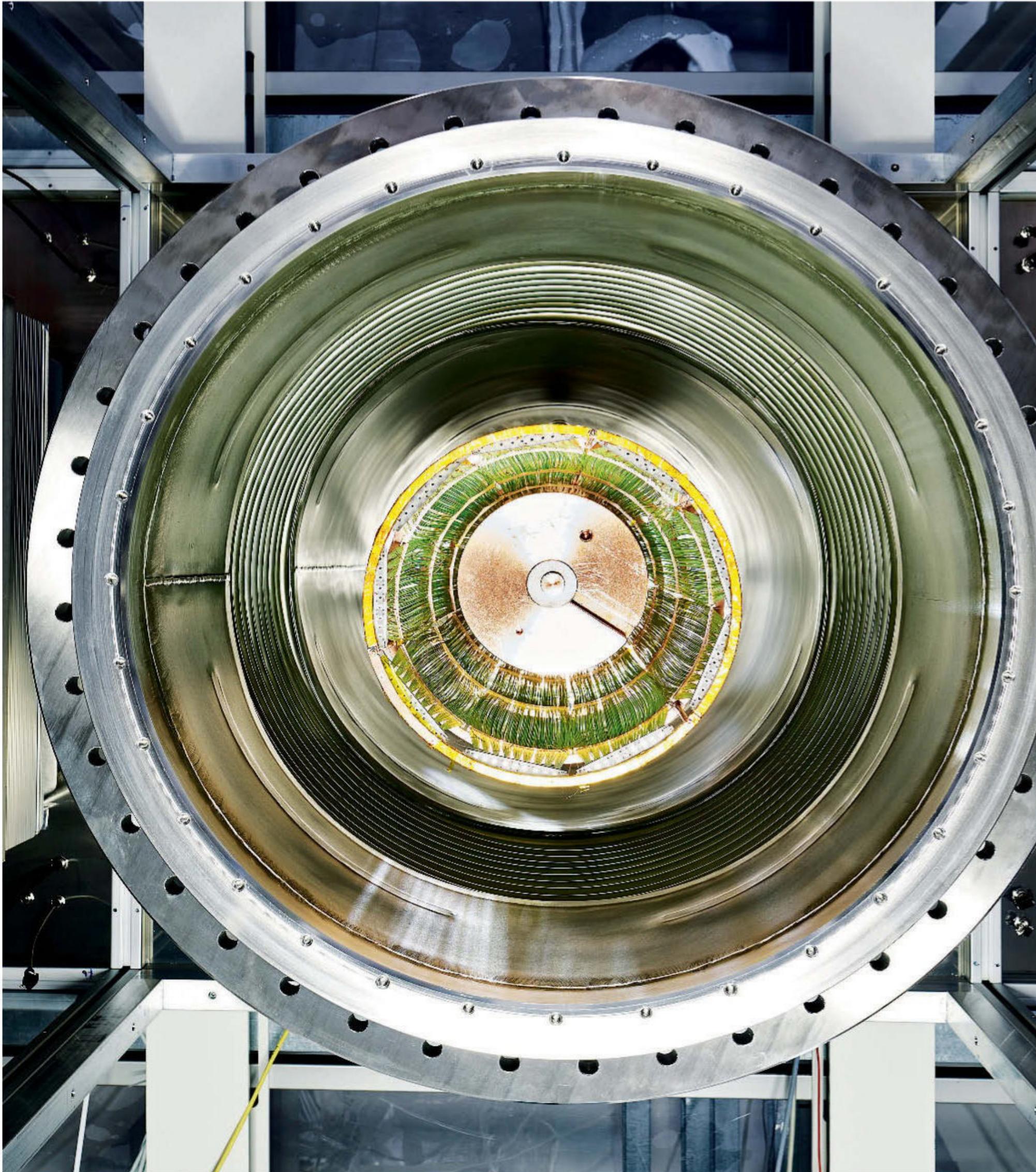


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## Stuff of legend



Photographer **Enrico Sacchetti**

THESE gleaming images, taken by photographer Enrico Sacchetti, show key components of an experiment that could finally shed light on one of the biggest mysteries in modern physics.

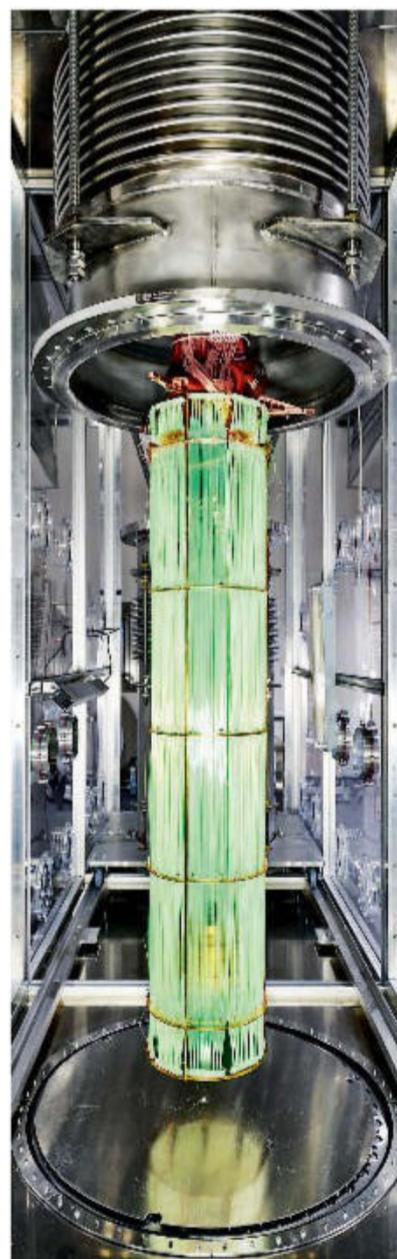
LEGEND is an international project that aims to explain why there is so much more matter than antimatter in the universe. Starting this year, its first stage, called LEGEND-200, will use highly sensitive germanium detectors to collect data for the next five years at the Gran Sasso National Laboratory in Italy.

Antimatter is composed of antiparticles that have the same mass as “standard” particles, but with other properties, like charge, opposite to them. LEGEND-200 is examining the hypothesis that minuscule, light and uncharged subatomic particles called neutrinos – themselves a bit of a mystery – are their own antiparticles. In other words, neutrinos and antineutrinos may be one and the same, and could therefore annihilate a like particle.

LEGEND-200 is probing this possibility by searching for evidence of a rare, theoretical process called neutrinoless double beta decay. This is when two neutrons spontaneously change into two protons, emitting two electrons and two antineutrinos.

A pair of antineutrinos emitted by a doubly decaying germanium nucleus will, in theory, sometimes annihilate each other, leaving only the emission of electrons – proof of an event that selectively destroys antimatter. If this is observed, we will have seen for the first time a process that favours the existence of matter over antimatter, possibly explaining the matter-antimatter imbalance in the universe. ■

**Gege Li**



**Left and bottom right: Two views of LEGEND's scintillation light detector fibre modules with light-capturing fibres (green), part of the equipment needed to try to spot antineutrinos annihilating each other (see main text, right); Above: The assembly of one fibre module; Top: Underside of the cryostat that will be filled with liquid argon and hold the fibre modules**

## Editor's pick

### For a really good laugh, try tickling a flying fox

18/25 December 2021, p 72

From Talia Morris, Cape

Tribulation, Queensland, Australia

Your article on the reasons why we laugh mentions several species of mammal that laugh, or at least produce laugh-like vocalisations.

Unsurprisingly, bats weren't mentioned. However, here at the Cape Tribulation Tropical Research Station where I work, we have frequently observed spectacled flying foxes (*Pteropus conspicillatus*) bursting into what sounds like raucous giggles when having their tummies tickled, an activity they apparently enjoy.

### Fresh mysteries of the snowflakes to consider

18/25 December 2021, p 58 and 81

From Bryn Glover, Kirkby

Malzeard, North Yorkshire, UK

Your two references to snowflakes put me in mind of a question I posed some years ago.

Accepting that no two snowflakes are identical (at least, in nature), but recognising that the six arms of any one flake are as near identical as we can tell, how is it that, as the flakes are forming, each arm of one flake "knows" what the other five are doing, even when they have lost contact with those other five, apart from through the central hub?

### Lessons in stress are proving very useful

4 December 2021, p 38

From Chloe Sellwood, London, UK

Catherine de Lange's article about strategies to deal with stress resonated with me from a personal and work perspective.

I have "retrained" myself to interpret anxiety at the start of a race (be it 5 kilometres, a marathon or longer) as excitement, and I am trying to do the same in my work environment – in emergency

preparedness and resilience in the National Health Service – as the pressures and challenges increase with the omicron variant of the coronavirus.

### Time to let the mind roam is vital for science

11 December 2021, p 26

From Ros Groves,

Watford, Hertfordshire, UK

Regarding "Science is being downsized" by Chanda Prescod-Weinstein, in which she deplors the excess time wasted on administrative tasks and surveys.

We need to realise that many eureka moments in science have occurred as the result of an imaginative mind having the time to freely mull over a puzzle and all its possible answers, without the encumbrance of having to quantify every professional experience, consideration and encounter in terms of a zero-to-10 rating.

### When it comes to mining, less is more

Letters, 18/25 December 2021

From Denise Taylor, London, UK

Reader Charles Joynson suggests that to save Earth, we start mining asteroids for the metals needed for renewable tech. Yes, let's, but not before we have ruined the seabeds!

The answer to our ruinous depredations isn't to spread them, but to alter the way we live. Unfortunately, we seem to be incapable of implementing any change, even if we see it is for the good, that interferes with our species' flawed concepts of what comprises a good life: making money and making life easy for ourselves at the expense of every other living thing, both plants and animals.

### Teaching is at heart of the problem with maths

27 November 2021, p 25

From Sam Edge,

Ringwood, Hampshire, UK

I agree with Michael Brooks that there is a problem with maths in the UK, but it is more to do with those who teach it than its history.

With one notable exception, all the maths tutors I had aimed their teaching at the small number of pupils who, like myself, enjoyed the subject for its own sake. The rest were left floundering. No wonder such people develop an aversion. Perhaps the majority who are learning maths as a compulsory part of the curriculum should be taught by those who themselves struggled with it rather than enthusiasts who can't understand why others find it difficult and irrelevant.

The suggestion that "grouping maths among the humanities" would help is rather telling of the wider problem. STEM subjects shouldn't have been separated from languages, history, art and humanities in the first place. The distinction would have been baffling to a Renaissance thinker or an ancient Greek, Arabic or Indian mathematician.

### Stock advice for tackling the food waste problem

4 December 2021, p 28

From John Vaughan, York, UK

I was going to take issue with James Wong's assertion that wasted food could feed 2 billion people. I was going to say that, in the studies I have seen, the idea that one-third of all food is wasted is only true if you include the parts often considered inedible, like banana skins and broccoli stems.

But it got me thinking: we chuck

a lot of "inedible" veg "waste" into the compost, and we use quite a lot of stock cubes. I am now going to have a go at making my own stock.

From Sue Thompson,

Bury St Edmunds, Suffolk, UK

May I congratulate Wong for his article on the merits of using plastic to keep food fresh, as food waste is a major contributor to climate change. This is a pro for some use of plastic.

### There are other ways to boost trees in climate fight

11 December 2021, p 9

From Colin Heath, Cardiff, UK

Swapping out land for grazing livestock in favour of land for trees, as suggested by plant-based meat pioneer Pat Brown, would be window dressing in terms of what is required to tackle climate change, as trees take 25 years to grow to a useful size on average.

Instead, emphasis on arboreal management, clearing undergrowth from woodland and tending to existing mature trees, especially in urban wasteland areas, would be effective sooner and be more practical.

### Time to rekindle the spirit of Boaty McBoatface?

11 December, p 36

From Rachel Mckeown,

Aberfan, Mid Glamorgan, UK

Colin Stuart refers to issues raised over naming the newly launched, revolutionary James Webb Space Telescope after a figure associated with controversy. Why not allow the public to have their say by opening a suggestion system, creating a shortlist and choosing a winner by a vote? This would increase the sense of personal connection with such an expensive project.

I have no doubt that readers would have excellent ideas about inspiring namesakes, so we can explore the mysteries of the cosmos with an instrument named after a chosen hero. ■



### Want to get in touch?

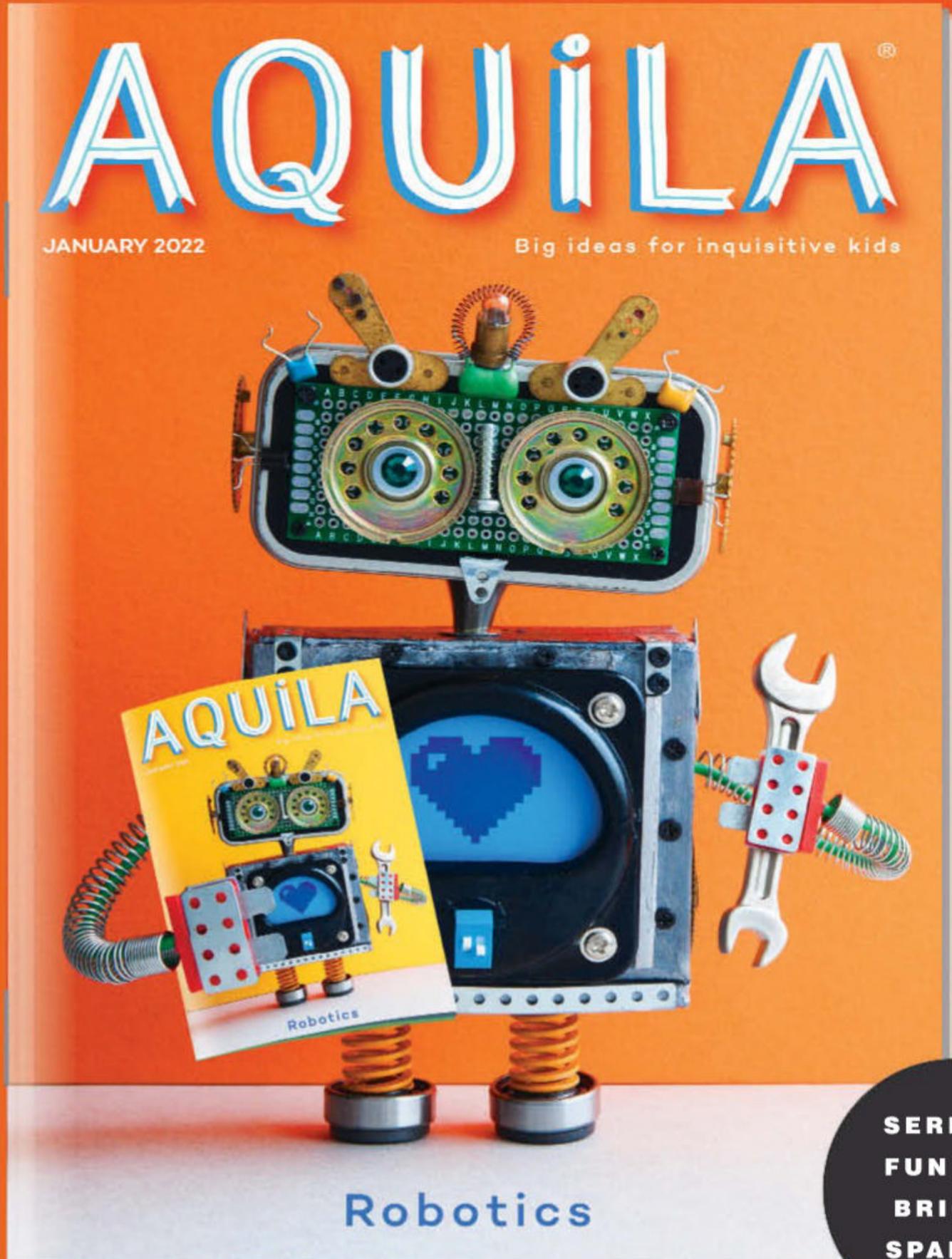
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# Well, this is fun...

There are many ways to get more fun into your life. You just need to stop scrolling for long enough to try, finds **Elle Hunt**



Book

## The Power of Fun: Why fun is the key to a happy and healthy life

Catherine Price

Bantam Press (out 20 January)

CHASTENED by the sight of her newborn baby's face lit up by the blue light of her phone, Catherine Price set about limiting the time she spent in front of screens. The journalist and her husband stopped mindlessly scrolling on social media and started taking 24-hour "digital sabbaths".

By cutting down on her screen time, Price found that she had gained hours in her day – but now, she struggled to know how to pass them. What was missing from her life, she realised, was fun. But what was fun, if not bingeing on Netflix and playing games on her phone?

Price has form in turning "personal issues into professional projects". Her previous book, 2018's *How to Break Up With*

*Your Phone*, was the result of her attempts to quell her overuse. With that problem more or less in hand, she decided to investigate what fun was, so that she could fill her life with more of it. The result is *The Power of Fun*, a practical guide with lessons for all of us, especially as we live through a decidedly not-fun pandemic.

This new book is a kind of spiritual sequel to *How to Break Up With Your Phone*, providing answers to the question of how to replace an all-encompassing habit.

Price comes up with a definition of the most satisfying type of fun, what she calls "True Fun": typically a serendipitous experience that brings together "playfulness, connection and flow", adding a dose of much-needed meaningful engagement to our lives.

It is this confluence of factors, Price argues, that distinguishes the most exhilarating, restorative fun from something fleeting and somewhat superficial, like getting a pedicure or going out to a bar.

That said, less-sophisticated fun

isn't just a frivolous activity that we can simply do without. It, too, can serve as an antidote to stress, making it vital for our physical and psychological well-being.

Price gives examples of True Fun from her own life, such as singing in the car with friends

**"True Fun' is typically a serendipitous experience that brings together playfulness, connection and flow"**

and learning guitar and playing in a group. "There is a reason that our moments of True Fun stand out in our memories: True Fun makes us feel alive," she writes.

As for how to get more of it, Price found it isn't as simple as just spending less time on screens, or trying to squeeze more activities into schedules that are already stretched thin. In fact, it often involves doing less: prioritising rest or sleep, for instance. Or it might mean coming up with a

plan to ensure that household tasks or childcare are shared evenly to make room for moments of pleasure and serendipity.

Price draws from the science of positive psychology in her quest to have more fun, but rigorous research takes a back seat to her own exploration and the findings of her Fun Squad: a global group of about 1500 people that Price recruited from her newsletter subscribers and invited to share their fun-seeking exploits.

Including less from this somewhat self-selecting group and adding more on new psychological research would have helped to bolster the book's scientific standing. However, this might have come at the expense of its practical relevance. The strength of *The Power of Fun* is that it is approachable, anecdotal and inviting. After two years of living through a pandemic, many of us have spent more than enough time trying to force fun into our lives (Zoom quiz anyone?).

The success of Price's self-experimentation provides motivation to at least try to seek out more activities that we actually take pleasure in. And her main point, that we should clear space in our lives for the things that truly mean something to us, is a sound one.

Price quotes the author Michael Lewis: "If you get in the habit of life not being fun, you start to not even notice." Once you have noticed and, more importantly, taken action, there is plenty of fun out there for the taking. Why waste your time on anything else? ■

Elle Hunt is a journalist based in Norfolk, UK

**Unplanned silliness with friends is vital for our health and well-being**



JACOB LUND/ALAMY

# Feel your way

Emotions don't have to be the Achilles' heel of rational thought. They are a key tool in our intellectual arsenal, finds **Gege Li**



## Book **Emotional: The new thinking about feelings**

Leonard Mlodinow  
Allen Lane

**HAVE** you ever become angry about something that, in hindsight, had more to do with the fact that you were having a bad day? Most of us have had moments like this, where we let our emotions get the better of us or allow them to influence our decisions. It isn't necessarily ideal, and we often assume that the involvement of emotions – intended or otherwise – is always detrimental to our ability to make good choices.

Not so, says physicist and author Leonard Mlodinow in his book *Emotional: The new thinking about feelings*. He argues that while it might seem like getting emotional is a bad idea, our feelings actually play an essential role in shaping our thoughts and decisions, helping us to react flexibly to situations and motivating us to pursue our goals.

Drawing on the latest research, Mlodinow guides us through the ways in which neuroscientists are changing their understanding of human feelings – what he calls “the emotion revolution”.

One of the breakthroughs in the science of emotion is the finding that rational thought alone isn't enough to process the masses of information that we are exposed to in our environment. To think effectively, we also need to feel. “Emotion is not at war with rational thought but rather a tool of it,” writes Mlodinow.

This challenges two well-worn assumptions laid out long ago by some of history's greatest thinkers, such as Plato: that the human mind can be split into rational and non-rational parts, reason and emotion, and that harnessing the



SHUTTERSTOCK/MARINAP

There is no need to fight your emotions; they are every bit as important as cold, hard reason

former while taming the latter holds the key to success and making good decisions.

But now that we have the technology to probe the human brain more deeply than ever before, modern science is uncovering the complex neural dynamics that are involved in generating our emotions, and in turn reshaping our knowledge of their importance.

Mlodinow explores how and why feelings evolved in the first place, arising initially from purely reflexive behaviours to environmental stimuli before the “upgrade” of emotion occurred, which provided a more flexible and effective way for organisms to react to the challenges they encountered.

The research also illustrates the universality of emotion and its benefits – scientists have seen emotion-guided behaviours at play in not only humans, but also rodents, fruit flies and bees.

Towards the end of the book, readers are given the chance to determine and reflect on their own emotional profile, using various questionnaires that were developed

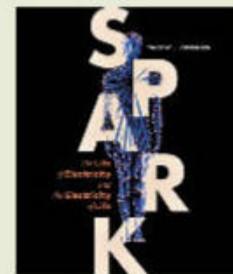
for research into specific feelings like happiness and anxiety. This is one of the more provocative elements of the book: the idea that we can gain power over our emotions by learning to understand and navigate them better. It is a tantalising concept that Mlodinow backs up with numerous studies and anecdotes. He also gives advice on how we can better manage our own emotions and gain more control over our lives.

Though the message of controlling your feelings to ultimately improve your well-being is an important one, it did get repetitive at times. What's more, regular readers of *New Scientist* or of popular neuroscience in general may find the research and the solutions Mlodinow offers, such as meditation and exercise, to be a little predictable.

*Emotional* may occasionally seem like a self-help book, but it is nevertheless an illuminating read that deals well with the complexity of emotion, the emerging science behind it and the fascinating workings of the brain itself. It might just help you remain calm and collected, even on a bad day. ■

Gege Li is a writer based in London

## Don't miss



### Read

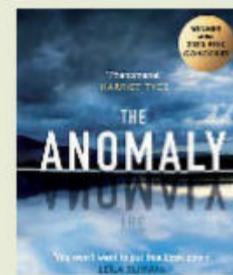
**Spark** is medical physicist Timothy Jorgensen's story of electricity as an essential force in biological life. It features tales of game-changing historical discoveries and the latest uses of electricity in medicine.



### Watch

#### The Case for Conservation

**Optimism** is made by conservationist Martin Harper in this online talk from the Linnean Society of London at 6pm GMT on 20 January. We can prevent extinctions, he argues, if we take the right action now.



### Read

**The Anomaly** by Hervé Le Tellier sold a million copies and won the Prix Goncourt in its original French-language edition. Now translated, it is an ingenious sci-fi thriller about an Air France flight that enters a storm and is changed forever.

## The sci-fi column

**Gentrifying broken Earth** When space colonies offer rich people a way off a ruined planet, it seems like the perfect chance to start again. But the pull of home is a powerful force, finds **Sally Adee**



Sally Adee is a technology and science writer based in London. Follow her on Twitter @sally\_adee



GREMLIN/GETTY IMAGES

**Even a post-apocalyptic Earth retains a certain charm for humankind**

is treated not as an easy punchline but as a way into deeper questions about what we need.

When Jonathan travels from the colonies to Earth, he tours destroyed homes looking for one to fix up. Onyebuchi shows us what he starts with – a shell of a house filled with geological layers of detritus. Then, months later, Jonathan is accepted into the community, which allows him to connect to the lone cable still bringing electricity to the neighbourhood. His wonder and joy at something so ordinary as a working light switch is infectious, especially after the technological marvels he has been taking for granted in the colonies.

By detailing the contrasting textures of the two worlds, Onyebuchi makes it obvious why colony-dwellers start yearning for Earth. Home inspires such longing that people living in the clean, metallic colonies pay handsomely for individual bricks to be salvaged from demolished houses on Earth and sent into space. They fight on auction sites for tiny cacti.

Back on Earth, there are different tensions. Returning residents bring back things that Earth's citizens were only too happy to see the back of, not least social inequality. Even in space, the richest live in the part of the space station with a view of the galaxies, while everyone else faces the unrecyclable detritus – including dead bodies – that surrounds the colonies in a ring.

What will the prodigal Jonathans bring back to Earth apart from their longing for home? And will the people they left behind be interested in anything they have to offer? ■



### Book

#### **Goliath**

Tochi Onyebuchi

Tordotcom

### Sally also recommends...

#### Books

#### **The Unfamiliar Garden**

Benjamin Percy

Hodder

*The highly anticipated second book of The Comet Cycle. Earth's citizens continue to deal with the fallout of a passing comet, which includes a mysterious new superfungus.*

#### **36 Streets**

T.R. Napper

Titan

*A near-future thriller set in Hanoi's old quarter that pits one woman against the megacorps. Author Yudhanjaya Wijeratne called it "cyberpunk with soul".*

SCI-FI dystopias of a ruined Earth are thick on the ground these days, filled with the wreckage of climate change: drowned continents, great extinctions and air that is no longer safe to breathe. In the more hopeful, people leave the planet in search of another world where they can start again, with lessons learned and a determination not to repeat the same mistakes.

In Tochi Onyebuchi's *Goliath*, human nature is eternal. So, while the rich predictably leave for pristine space colonies, abandoning those who can't afford to escape, there is money to be made from tourism to the ruins left behind. Some tourists find themselves captivated by the communities that have emerged, and decide to return to Earth. Gentrification ensues.

The premise is wry and accurate. In a lesser writer's hands, it could lead to lazy and cynical caricatures, but Onyebuchi uses it only as a jumping off point into a deeper examination of the idea of home, and what we will do to get there.

Onyebuchi started out writing

sci-fi for young adults before reaching a wider audience with the multi-award gobbling novella *Riot Baby* in 2020. He has a master's degree in screenwriting, which is on vivid display in his hypnotic descriptions of *Goliath's* two new human worlds.

We explore these through the eyes of several characters, including colony-dweller

**“By detailing the two worlds, Onyebuchi makes it obvious why people start yearning for Earth”**

Jonathan, who looks out into star-spangled black space from a window in a sterile space station straight out of Stanley Kubrick's *2001: A Space Odyssey*. On Earth, we meet Sydney, who watches a dandelion's seeds get nibbled away by wind under a poisoned red sky.

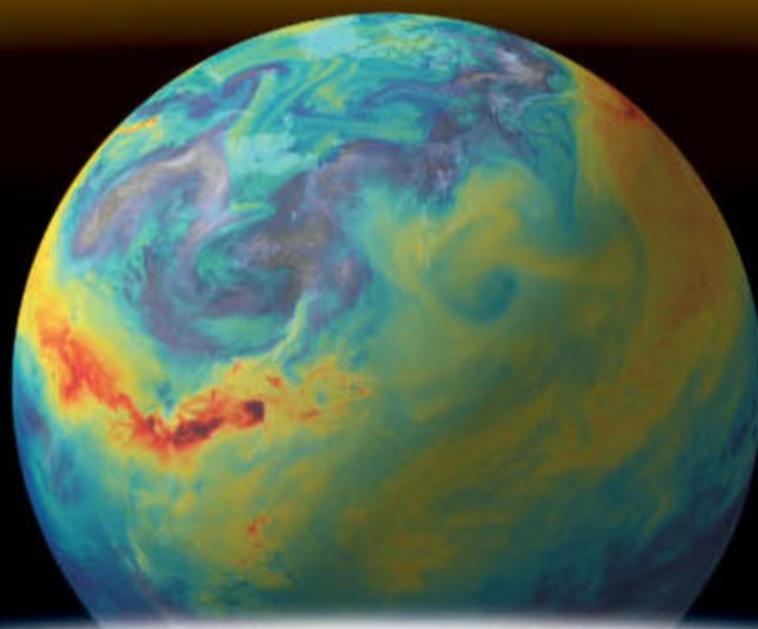
The style is more than matched by the substance of the story, in which Onyebuchi takes his time to explore the main themes. The gentrification issue, for example,

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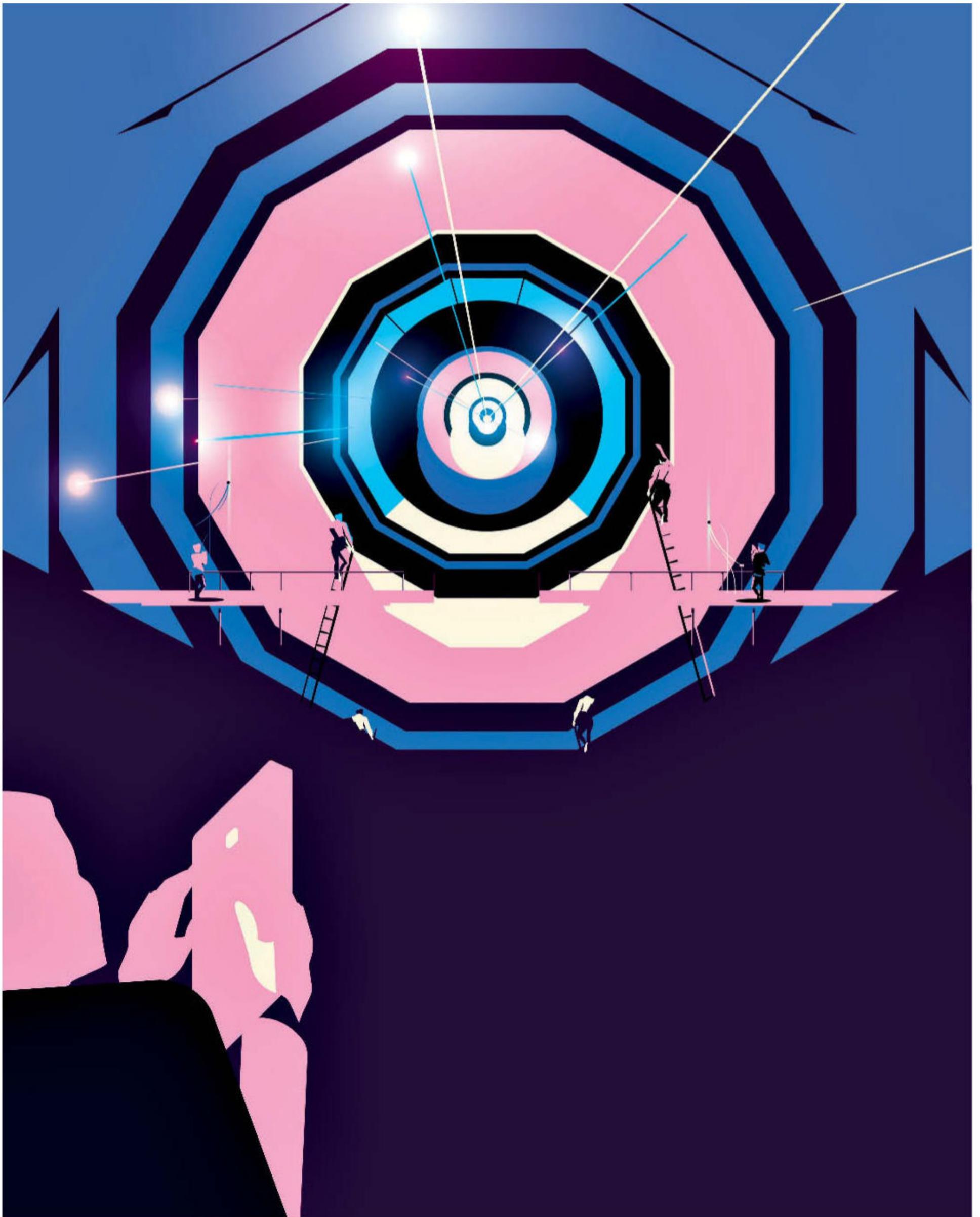
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MARCUS MARRITT

# Dawn of a new physics?

Hints from particle smash-ups at the Large Hadron Collider are firming up. We could finally be looking at a new force of nature and a deeper theory of reality, says physicist **Harry Cliff**

**A**T HALF past six on the evening of 20 January 2021, amid the gloom of a long winter lockdown, a small team met on Zoom to share a moment they knew might change physics forever. “I was literally shaking,” says Mitesh Patel at Imperial College London. He and his team were about to “unblind” a long-awaited measurement from the LHCb experiment at the CERN particle physics laboratory near Geneva, Switzerland – one that might, at long last, break the standard model, our current best picture of nature’s fundamental workings.

The measurement concerns subatomic particles known as “beauty” or “bottom” quarks. Over the past few years, their behaviour has hinted at forces beyond our established understanding. Now, with the hints continuing to firm up, and more results imminent, it’s crunch time. If these quarks are acting as they appear to be, then we are not only seeing the influence of an unknown force of nature, but perhaps also the outline of a new, unified theory of particles and forces.

That is a big if – but many particle physicists are on tenterhooks, myself included. “I’ve never seen something like this,” says Gino Isidori, a theorist at the University of Zurich, Switzerland. “I’ve never been so excited in my life.”

For all its dazzling success in describing the basic ingredients of our universe, the standard model of particle physics has many shortcomings. It can’t explain dark matter, the invisible stuff that keeps galaxies from flying apart, or dark energy, which seems to be driving the accelerating expansion of the universe. Nor can it tell us how matter survived the big bang, rather than being annihilated by an equal amount of antimatter. What’s more,

it has several apparently arbitrary features that beg deeper explanations. Clearly, the standard model isn’t the whole picture. To complete it, we need to break it.

The saga of the beauty quarks began in the mid-2000s when Gudrun Hiller, a theoretical physicist then at the University of Munich, Germany, was panning for insights in a flood of data from the Belle experiment in Japan and the BaBar experiment in California. These “B-factories” produced beauty quarks by colliding electrons with their antiparticles, positrons. The beauty quarks would live for an instant – around 1.5 trillionths of a second, on average – before decaying into other particles.

## A strange beauty

Hiller was particularly interested in an extremely rare decay where a beauty quark transforms into a strange quark, the third heaviest of six types of quark (see “The standard model: A new addition?”, page 40). In doing so, it emits two oppositely charged muons, heavier versions of electrons. Rare decays such as these are very valuable, as they could be strongly influenced by unknown forces of nature, should they exist. The idea is to make the most precise measurement possible of such decays and compare them with the most precise predictions theorists can muster using the standard model. If the two disagree, you have evidence for a new force.

The trouble was, theoretical predictions of how often a beauty quark should transform into a strange quark and two muons were plagued by uncertainties from quantum chromodynamics (QCD), the theory of the strong force that governs how quarks interact with one another within the standard

model. This made it very hard to make any meaningful comparison with experimental measurements – any discrepancy could be down to the imprecision of the predictions. “We realised that we hit a wall,” says Hiller.

Undeterred, she and her collaborator Frank Krüger realised that if you look at how often this decay occurred compared with a similar decay that spits out electrons instead, the nasty uncertainties from QCD cancelled out. The ratio of the two decays could be predicted very precisely – but would be sensitive only to forces pulling on the electrons and muons with differing strength. That was a long shot. All known forces pull on the two particles equally, and the assumption was that any undiscovered forces would do so too, meaning Hiller and Krüger’s ratio wouldn’t reveal anything new.

A decade later, collisions at CERN’s Large Hadron Collider (LHC) began producing a torrent of beauty quarks, which were recorded and analysed by the LHCb experiment, one of four large particle detectors on the 27-kilometre accelerator ring beneath the French-Swiss border. Now, physicists could really start to put these rarest decays under the microscope. As they did so, intriguing anomalies began to emerge.

The first came when early measurements suggested that decays producing a strange quark and two muons happened less often than the standard model predicted. Then, in 2013, the LHCb experiment released a new measurement that analysed the angles that the particles produced in these decays went flying out at. This time, there were even stronger hints of deviations from the standard model. And yet there were still sufficient theoretical uncertainties to leave room to quibble.

Could Hiller and Krüger’s ratio help? In ➤

2014, LHCb released the first measurement comparing how often beauty quarks decayed into muons and electrons. To almost everyone's surprise, the data once more disagreed with the standard model. Beauty quarks appeared to be decaying to muons less often than to electrons. Analysis concluded there was less than a 1 per cent chance the deviation was purely down to some random statistical wobble in the data. This was still a long way short of the gold-standard statistical significance required to declare a discovery in particle physics, which corresponds to a 1 in 3.5 million chance of the result being a fluke.

## Strong deviations

Still, when you combined the measurements of the muon-to-electron ratio, the angles and how often the decays happened, a coherent picture did seem to be emerging. Since then, almost every time a measurement has been updated with yet more beauty quark data, the deviations from theory have become stronger.

Almost, because there was one notable exception. When the Hiller-Krüger ratio was updated with more data in 2019, the measured value moved towards the standard model value. "We really thought we had it," says Patel,

who led the work. "We ended up feeling gutted." So, when Patel and his colleagues met on Zoom in January 2021 to unveil a new measurement, emotions were running high.

University of Cambridge experimental physicist Paula Alvarez Cartelle pushed the button to reveal the result. The measured value

## "These anomalies could be the real deal"

of the ratio had stayed almost exactly the same, but the error on it had shrunk, creating an unmistakable tension with the standard model prediction. There was now less than a 1 in 1000 chance the discrepancy was a statistical fluke. Everyone on the call erupted. "There was an awful lot of swearing," says Patel. However, the team also felt the weight of responsibility; they knew the result would create huge excitement. As Alvarez Cartelle puts it: "You don't want to think, 'I just broke the standard model',

but at the same time you're a bit, 'Oh shit!'"

Anomalies come and go in particle physics, and no measurement of the muon-electron ratio on its own has yet crossed the threshold of statistical certainty for it to be regarded as a definitive discovery. But there is a coherency to what have become known as the "B anomalies" that has led a growing number of physicists to regard this as the real deal. "I've turned into a believer," says Ben Allanach, a theorist at the University of Cambridge. "There's always healthy scepticism, but the fact that it's coming from lots of different angles and saying the same thing is pretty convincing."

In which case, what could be causing these anomalies? Allanach has spent the past few years trying to figure that out. For him, the most promising candidate is a force carried by a hypothetical particle known as a Z prime. This would be very heavy, electrically neutral and, crucially, would interact with electrons and muons with different strengths. This could explain why beauty quarks decay into muons less often than to electrons – the Z prime is stopping them.

This could also explain one of the most mysterious, seemingly arbitrary features of the standard model: the fact that matter particles come in three "generations". The first comprises the familiar particles that make up most ordinary matter: the electron, the electron neutrino and the up and down quarks. The second contains heavier copies of these particles: the muon, muon neutrino, charm and strange quarks. And the third generation is heavier still: the tau, tau neutrino, top (or "truth") and beauty quarks. The existence of these generations has long been a puzzle, as has the peculiar fact that the masses of the matter particles vary so wildly, with the top quark being around 350,000 times heavier than the electron.

The different generations could be explained if the beauty quark anomalies are revealing the presence of a new force that acts almost exclusively on the third generation of particles. "The model I'm working on contains a symmetry which means that if you squint a bit, only the third generation is allowed to have a mass," says Allanach – which would explain why these particles are so heavy.

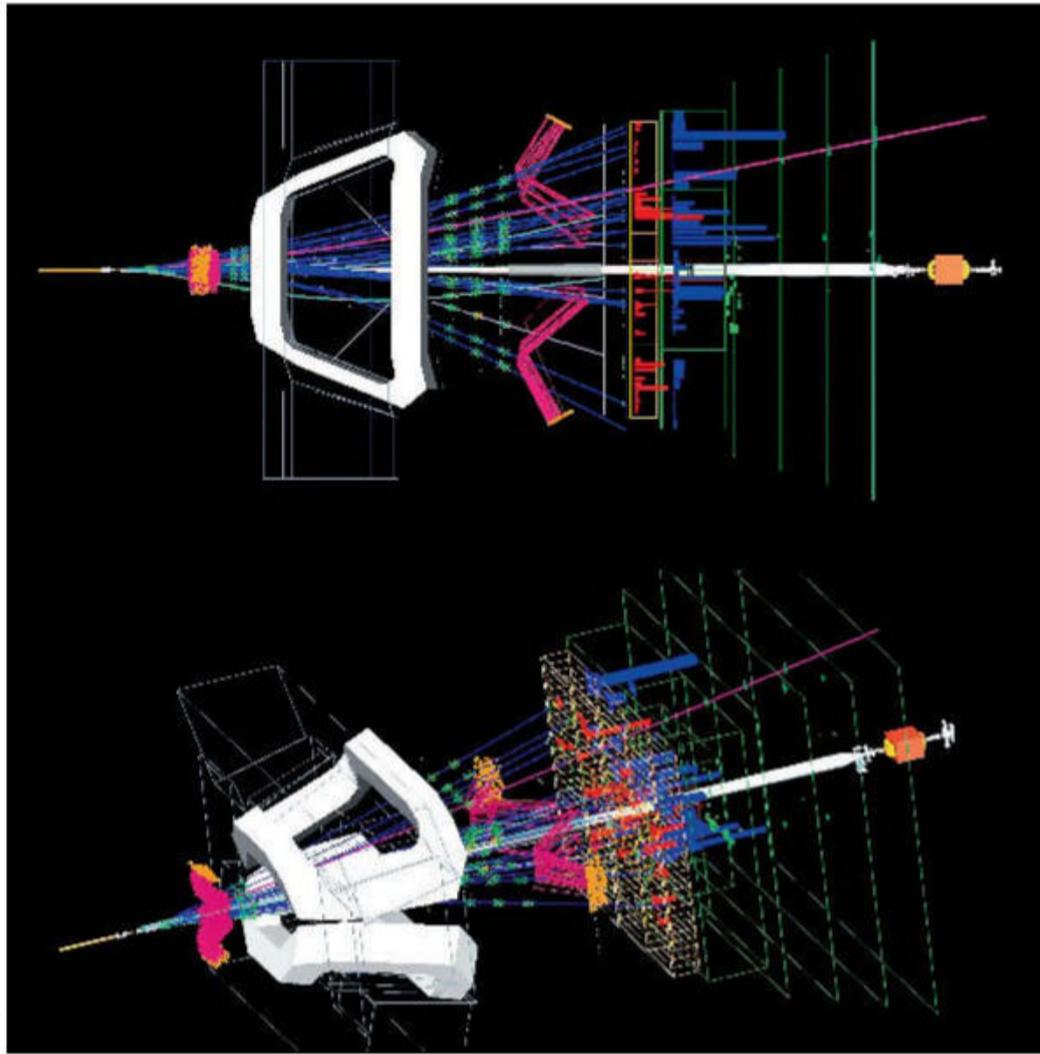
The implications of this new force wouldn't end there. In the second half of the 20th century, physicists discovered that the three forces of nature described by the standard

## The standard model: A new addition?

The collection of particles in the standard model of particle physics explain the workings of all visible matter and three of the fundamental forces, but not the fourth, gravity

		MATTER			FORCE CARRIERS	
		1st generation	2nd generation	3rd generation		
FERMIONS	QUARKS	up <b>u</b>	charm <b>c</b>	top or truth <b>t</b>	BOSONS	PHOTON <b>γ</b> electromagnetism
		down <b>d</b>	strange <b>s</b>	bottom or beauty <b>b</b>		<b>W &amp; Z</b> weak force
		Increasing mass →				GLUON <b>g</b> strong force
	LEPTONS	electron <b>e</b>	muon <b>μ</b>	tau <b>τ</b>		HIGGS BOSON <b>H</b> mass giver
		electron neutrino <b>ν<sub>e</sub></b>	muon neutrino <b>ν<sub>μ</sub></b>	tau neutrino <b>ν<sub>τ</sub></b>		
						NEW FORCE CARRIER?

If anomalies in the way beauty quarks decay firm up, they could be our first glimpse of a [new force-carrying particle](#) that would explain why matter particles come in three generations, each heavier than the last – and perhaps even unify the leptons and quarks by acting on both sets of particles



CERN, LHCb

**Painstaking analysis of particle decays in the LHCb detector is uncovering unexpected anomalies**

three-colour strong force with red, green and blue quarks, while the leftover fourth colour is carried by the leptons. Leptons are really just differently coloured quarks.

This is heady stuff – but the challenge now is to prove that these anomalies are the real deal. Isidori, for one, is convinced. “For me, the evidence is already very solid,” he says. But not everyone agrees. Although a series of unfortunate statistical flukes now seems like a very unlikely explanation given the range of different anomalies, the looming spectre is the chance of a conspiracy of missed biases, either in the theoretical predictions or the experimental measurements, or perhaps both.

New measurements are already under way at LHCb to confirm the picture and test for hidden experimental effects. In October 2021, my University of Cambridge colleague John Smeaton and I performed a new measurement of the Hiller-Krüger ratio using an unexplored part of the LHCb data sample. It revealed very similar effects to those seen in March, strengthening the case for a new force.

Meanwhile, the growing excitement around the anomalies has awoken the two big beasts of the LHC, the ATLAS and CMS experiments. In 2012, they discovered the Higgs boson, the long-predicted standard-model particle that gives all other fundamental particles their mass, and are now beginning to think about ways they might spy the predicted Z primes or leptoquarks. In Japan, the Belle II experiment is gradually accumulating data that will allow it to independently check several of LHCb’s results. Later this year, an upgraded LHCb will begin collecting data at a far higher rate than before, allowing us to seek out even rarer decays where the anomalies could be even stronger.

If the emerging picture is confirmed, we are in for a revolution in our understanding of the constituents of nature that could reveal a deeper structure beneath the standard model, while perhaps even giving us a handle on the nature of dark matter or the strange properties of the Higgs boson. If that happens, it will be the greatest discovery in fundamental physics since the standard model was put together. The stakes are high and the game is on. ■



Harry Cliff is an LHCb physicist based at the University of Cambridge. He is author of *How to Make an Apple Pie From Scratch: In search of the recipe for our universe*

model – the strong and weak forces and electromagnetism – could each be described using a mathematical symmetry. In the 1970s, there was a big push to bring all three forces together under a single bigger symmetry, to create a so-called grand unified theory, which promised to unify these forces and the matter particles into one elegant structure.

The problem was that the various grand unified theories predicted that protons should decay, while every experiment performed failed to see any sign of that. What’s more, the energies required to probe these theories are over a trillion times higher than even the LHC can achieve, meaning that the new particles they predict are well out of experimental reach. As a result, the quest to unify the forces and the matter particles has been stalled for decades.

The B anomalies appear to be resurrecting aspects of the old grand unified theories, but at far lower energies than anyone had expected. “What we’re doing is putting in a tiny bit of symmetry – it’s an element of a grand unified theory, but it’s only a little one,” says Allanach. He believes that the hints of a new force we are seeing at the moment could be a low-energy remnant of a much grander symmetry that only becomes apparent at very high energies. In other words, we might be catching a glimpse of the edge of a grand unified theory.

Hiller pioneered an alternative explanation for the B anomalies that goes further still – a

particle known as a leptoquark. Again, a leptoquark would be the carrier of a new force. This force would transform quarks directly into electrons, muons and taus, collectively known as leptons – hence the particle’s name. Unlike Z prime models, leptoquark models also aim to explain a second set of anomalies that have appeared in another type of beauty quark decay, this time to charm quarks, while pointing to a unified theory that’s much closer at hand in terms of energy scales.

**The colour violet**

Isidori is a proponent of leptoquarks. He says the models represent a “change of paradigm” compared with the old grand unified theories. While the old ones looked for symmetries that unified all three forces, the modern leptoquark models instead unify leptons with quarks.

They do this by differing from the standard model in a crucial way. In the standard model, the equivalent of electric charge for the strong force, which acts on quarks, is known as “colour”. It comes in three varieties, red, green and blue. Leptons don’t carry colour, so they don’t feel the strong force. In leptoquark models, however, there is a fourth colour, sometimes labelled violet, which arises from an enlarged version of the symmetry that describes the strong force. This larger symmetry then breaks down into the usual

# An American catastrophe

The mystery of why all cat-like animals disappeared from North America for millions of years is finally being cracked, finds **Chelsea Whyte**



KEN BARBER/ALAMY; SCHANKZ/SHUTTERSTOCK; ADVIA IMAGE/SHUTTERSTOCK; KOKTARO/SHUTTERSTOCK



**L**OOKING out over an expanse of scrubby sagebrush, it is hard to imagine that the high desert in eastern Oregon was once home to large creatures that resembled sabre-toothed cats. The land here is mostly dry and grassy, punctuated by sharp hills. There isn't a lot to crouch behind while waiting to ambush prey, and little in the way of trees to climb or sharpen claws on: in some places, the only sign of plant life is a layer of lichen on the rust-coloured slopes. But it wasn't always like this. "These animals made their home here as early as 35 million years ago, when this part of Oregon was covered in dense jungle," says Nick Famoso, a palaeontologist at the John Day Fossil Beds National Monument in Oregon. "It was such a subtropical land that bananas grew here. We've collected their fossilised seeds."

This was part of the territory of the nimravids, ancient beasts also known as false sabre-toothed cats. Fossilised remains indicate that for more than 12 million years, seven of the 10 known nimavid genera inhabited North America from Florida to New Mexico and up beyond what is now the Canadian border. Then, around 23 million years ago, they disappeared. The trail went cold, and the fossil record suggests that there were no cats on the continent for the next 6.5 million years. What caused them to die off? And what allowed felines to finally populate North America 16.5 million years ago? Palaeontologists have long puzzled over this so-called Cat Gap. Finally, they are finding some answers.

Nimravids were named by US palaeontologist Edward Drinker Cope in the late 1800s. At first, they were classified as members of the cat family, with whom they share some key traits. One of the characteristic features of cats is that they have teeth specialised for eating meat. "They have knife-blade-looking teeth in the back of the mouth where molars are, and canine teeth up front that are well-adapted for killing things," says Famoso. Cats also have retractable claws and a tail that helps with balance. "All cat-like things tend to have those three structures," he says. "True cats do, and nimravids have them, too."

However, by 1880, Cope had noted that some nimavid features didn't match up with what is expected in cats. Certain structures of their inner ears and teeth, as well as passages for their nerves and blood vessels, differed from those of felines, says Paul Barrett, a palaeontologist at the University of Oregon. What's more, instead of walking on their toes like cats, nimravids had a flat-footed walk like bears. They also had five toes on each back paw, unlike the four found on every feline from lions to house cats.

For two centuries, the question of whether nimravids were cats or merely cat-like remained open. "There has been this quibbling back and forth," says Barrett. "Nimravids have gone from being cats to being their own family and back again." Finally, in the 1980s, phylogenetic analysis – which examines evolutionary connections of species – solved the issue. "You throw all the characteristics into a computer model and see what shakes out," he says. "And nimravids have been shown to be their own family." They aren't felines, but feliforms.

## Fearsome grins

Short faces and elongated canine teeth gave these not-quite-cats particularly fearsome grins. Nevertheless, they filled the same role in their ecosystems as modern wildcats do today. The ones living in North America came in a wide range of sizes. *Eusmilus* – found in what is now Wyoming, North Dakota and South Dakota – stood about a metre high, with the look of a long-bodied leopard. Its name translates to "true sabre". *Nimravus*, or "ancestral hunter", was about half as tall and ranged throughout western North America to parts of South Dakota. *Nanosmilus* was the smallest, as its name suggests. It was similar in stature to a modern bobcat, a type of lynx that is about twice the size of a house cat, and its fossils have been found in Nebraska.

Other family members had ranges that extended from the Rocky mountains to the west coast of North America. They include *Pogonodon*, or "beard tooth", together with the two earliest nimravids found in North America – *Hoplophoneus*, whose name translates to "armed murderer", and *Dinictis*, the "terrible cat". *Dinictis* first appears 35.5 million years ago and was around until about 23 million years ago, making it one of the last known survivors of the group. The other is *Dinaelurus*, which is recognised from a single specimen found at the John Day fossil beds.

Then the nimravids disappear. Currently, the Cat Gap is thought to have lasted some 6.5 million years, but the length of this supposed cat-free period has changed over the years with the discovery of new fossils and revisions in taxonomic analysis of old ones. That raises the question of whether it is simply an anomaly. Perhaps nimravids persisted, but we haven't found their remains. Famoso points out that you need the right environment for fossilisation to occur, and there could have been periods when bones simply weren't deposited in rock that has persisted for tens of millions of years. Alternatively, we may have ➤

# Bring back the jaguars!

Although North America is no longer inhabited by cat-like nimravids (see main story), it is home to the world's third largest cat species. Jaguars (*Panthera onca*) are thought to have arrived here from Eurasia via the Bering land bridge less than 1 million years ago, long after nimravids became extinct. Once found across the southern US, they eventually settled in the mountains of Arizona and New Mexico. But in the 20th century, they were driven close to extinction, with the US government paying hunters to kill predators known to target livestock.

Killing jaguars is now illegal in the US, but today there is just one lone specimen in the country: a male filmed in the Santa Rita mountains, Arizona, in 2016. Now, conservationists say the time is right to bring these cats, which can still be found in Mexico and regions further south, back from the brink in the US. A study published in 2021 found that an area of about 80,000 square kilometres across Arizona and New Mexico has enough water and prey to support a population of between 90 and 150 jaguars for at least 100 years.

"What we know about jaguars is they're supremely equipped to survive in a multitude of ecosystems, which is not unusual with top-level predators," says Michael Robinson at the Center for Biological Diversity in Tucson, Arizona. Making space for them to thrive on their native lands in the US would let them once again play their role in the ecosystem there, which could set off a domino effect. "Stalking predators, such as the felids, lead to evolutionarily induced behaviours in prey animals. They're part of what keeps the deer and elk incredibly alert," he says.

Large cats can still pose a threat to livestock, but the region's economy is based less on cattle ranching than it once was. The study suggests that with careful management of fences and water sources, local people could live peacefully with jaguars. Better yet, big cats could drive ecotourism in the area, just as reintroduced wolves have done in Yellowstone National Park.

already found fossils that fill the gap, but we don't yet know it. "As long as we keep museum collections properly maintained, they are clues. It's like a fingerprint from a cold case that maybe should have been analysed," says Ashley Poust at the San Diego Natural History Museum in California. Indeed, he and his colleagues have recently reanalysed one specimen that appears to push back the origins of nimravids in North America. "It was just mislabelled in the collection here," he says.

Nevertheless, the consensus is that the Cat Gap is real, that new discoveries may shrink it but they won't close it altogether. "Now that we have an understanding of the Cat Gap, we can go back and look at the collections to see just how big it really is," says Poust.

The bigger question is how did nimravids go from prowling far and wide across North America to dying out. One theory is that volcanic activity played a role. Nimravid fossils have been found in abundance just east of the Rocky mountains, where the land under their paws was undergoing major changes during the

**La Garita Caldera in Colorado once caused problems for nimravids**



**“The ‘Cat Gap’ that followed the nimravids’ demise lasted 6.5 million years”**



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height of their existence. From about 50 million to 25 million years ago, an ancient tectonic plate called the Farallon plate was spreading under North America. When it met the Pacific plate at the western edge of the continent, the result was explosive. Across what is now Colorado, Utah, Nevada and further south into Mexico, there were dozens of volcanic eruptions. The largest of these occurred around 28 million years ago, creating the La Garita Caldera in Colorado, which is 75 kilometres across at its widest point. Volcanic ash spewed out and blanketed the region with 5000 cubic kilometres of material. For comparison, the 1980 eruption of Mount St Helens in Washington expelled 2.5 cubic kilometres of debris.

The energy of the La Garita eruption may have been partly due to its silica-rich magma. “The higher the silica, the more explosive an eruption can be,” says Peter Lipman at the US Geological Survey, who discovered and studied the caldera. More silica gives the liquid rock higher viscosity, which can help trap more sulphur and carbon dioxide. Then, when the molten material rises and decompresses, the gases are released and create bubbles that explode. “Everything would have been killed by the heat of the ash alone for at least 150 kilometres beyond La Garita,” he says. “Beyond that, ash that went up higher in the atmosphere would certainly reduce sunlight and temperatures for a year or two.”

“It would have been devastating for the flora and fauna,” says Barrett. And nimravids were no exception: some of the best-preserved specimens come from sites rich in ash layers. “Some did bite it. But the nimravids seemed to persist through these cataclysmic events,” he says. Poust also thinks that although the 10-million-year flare-up of volcanic activity may not have been easy for individual nimravids, it doesn’t explain why they went extinct altogether.

If volcanism didn’t finish them off, what did? Beginning around 23 million years ago, there was a period of massive cooling and drying. Forests gave way to grasslands, which would have affected the animals that nimravids hunted. “Prey species at the time were going extinct, so that is probably related to why the predators followed soon after,” says Barrett. Nimravids were at a disadvantage when attempting to adapt. They had evolved to be hypercarnivorous – meaning most of their diet

**A 37 million-year-old nimravid from the genus *Hoplophoneus*, which means “armed murderer”**



CECILE MANTOVANI/REUTERS/LAMY

was meat – with blade-like teeth towards the front of their mouths used for stabbing, and jaws that allowed them to open their mouths to 90 degrees to better pierce prey. Behind the stabbing canines sat pairs of carnassials: sharp, triangular teeth that fit together like puzzle pieces. “They’re like horrible scissors,” says Poust. As they slide past one another, the bottom teeth grind against the top and hone them to a point. “From the moment they stop drinking milk to the moment they die, they need to use that tool,” he says.

### The perils of hypercarnivory

Such specialisation often leads to an evolutionary dead end, and if hypercarnivory caused the extinction of nimravids, they wouldn’t have been the only ancient animals to succumb to an over-reliance on meat-eating. It also played a part in the demise of several species of wild dogs in North America around 11,000 years ago. Even today, a set of more general-purpose teeth has been key to the survival of various large predators. “If you’re a black bear, you can eat almost anything. You can eat garbage. That’s part of why they do a better job of dealing with living near big cities and today’s tigers often don’t,” says Poust.

There is some evidence that late nimravids had started to adapt to the changing environment. As dense forests gave way to grasslands, they would have needed to run faster and over longer distances to catch their prey. “One of the last nimravids of the Oligocene, *Dinaelurus*, seems to have a similar morphology to what we see in cheetahs today,” says Barrett. Its skull is tilted in a similar way.

“It has a distinct bend, which you find in other animals that are adapted for running at high speeds, because it puts the eyes in a place where you more easily see what’s quickly coming towards you,” he says. *Dinaelurus* also has bigger sinus cavities than other nimravids, allowing it to take in more oxygen as it ran.

But even this evolution wasn’t enough. By 23 million years ago, nimravids were gone from North America. The continent was free of cat-like creatures. Then, around 6.5 million years later, the cooling climate that paved the way for the nimravid extinction gave their feline successors access to the continent. Sea levels dropped as glaciers grew, exposing the Bering land bridge that connected Siberia to Alaska. Across it came *Pseudaelurus*, a lynx-sized cat that was an agile tree-climber. It flourished in the expanding conifer forests in North America, which were also made possible by plant migrations over the bridge. Another group of cat-like animals called barbourfelids also arrived, and new analysis suggests that they were nimravids originating in Africa.

These felines and feliforms finally brought an end to the Cat Gap. Eventually, around 5 million years ago, the barbourfelids died out. However, *Pseudaelurus* persisted and is thought to be the common ancestor of everything from North America’s mountain lions to bobcats and even the fluffballs currently occupying the best spots on many sofas. ■



Chelsea Whyte is a news editor at *New Scientist*

# How to hack your personality

Who you are changes throughout life – and the latest research suggests you can deliberately alter your character.

**Miriam Frankel** investigates

**I** AM a conscientiousness objector. No, not a conscientious objector: I have never been drafted into the army. What I object to are meticulously colour-coded diary entries, weekly meal plans and home organisation à la Marie Kondo – all of which are neatly captured by a personality trait I score particularly low on: conscientiousness.

This has never been a major issue, even if it has made me feel like a disorganised outcast, especially when spending time around other mothers in my London suburb. You know, the sort of people who always arrive at parties or play dates on time, with everything they might possibly need, looking composed.

But recently, I started to wonder what my life might be like if I were more like them. I thought about how exhausting things can be: the last-minute panics, the mess, the lost keys, the missed appointments. I thought about the potential benefits for my health and well-being if I could change all that. At the very least, surely everything would be a lot easier.

Traditionally, psychologists believed personality to be more or less fixed over your lifetime. Not any more. Now it seems personality evolves throughout life, and in recent years, several studies have even demonstrated that it is possible to transform your personality on purpose. Given certain personality traits are linked to life satisfaction, and even better mental health, this could have a substantial impact on many people. It seems almost too good to be true, and psychology has a slightly shaky reputation when it comes to its findings holding up to scrutiny. But I was curious, so I decided to have a go for myself.

When psychologists talk about personality, they are referring to our habits of thought, emotion and behaviour as they manifest over





years or decades, as opposed to those that vary over shorter timescales such as days or hours. But measuring personality is tricky. These days, most psychologists use the Big Five model, which divides our personalities into five independent traits: extroversion, agreeableness, conscientiousness, openness to experience and neuroticism, otherwise known as emotional stability.

The Big Five model has its critics. It was developed based on a statistical technique called factor analysis, which showed that words used to describe personality in surveys could be grouped into five distinct traits. Some researchers have an issue with the lack of a deeper, underlying explanation for this arrangement. Others argue that it can't capture all aspects of personality, including "dark traits" such as psychopathy or Machiavellianism – or even humour. Even so, as the most widely accepted among psychologists, the model forms the basis for much of the research into personality.

The Big Five traits are typically assessed by questionnaires, which ask people about their thoughts, feelings and behaviour. This involves agreeing or disagreeing with statements such as "tends to be lazy" or "is efficient, gets things done". And this is where my personality modification started, with a test called the Big Five Inventory-2.

I got a maximum score on openness to

**“People can change pretty dramatically pretty fast”**

experience, suggesting I prefer novelty to routine and the big picture to details. I also had reasonably high scores on extroversion and agreeableness, but was a bit low on emotional stability, suggesting that I am prone to anxiety, in particular. Finally, on conscientiousness, I got a deeply unimpressive 44 out of 100, despite a high score on its component related to productivity. The overall trait result was dragged down by my score on the component to do with organisation: a shameful 6 out of 100. "You'd make an ideal academic," says Brent Roberts, a psychologist at the University of Illinois, when he reviews my results.

### **Shifting traits**

My personality type is partly down to my DNA, with studies of twins showing that genes can explain about half of the differences in personality traits. The flipside is that there is plenty of scope for experiences in adulthood to leave their mark. Indeed, although many of us assume our personalities are set in stone once we reach a certain age, psychologists have demonstrated over the past two decades that personality traits change over a lifetime.

One study by Roberts and his colleagues showed that, on average, we increase on measures of nearly all the personality traits between 20 and 40 years of age. Between 40 and 60, we continue to become more conscientious and emotionally stable, while agreeableness rises after 50. Beyond the age of 60, we become less open and extroverted, and more conscientious, perhaps as a result of shrinking social circles.

The changes are pretty big, too. Psychologists often measure personality change in terms of "standard deviations", with a shift from being maximally introvert to maximally extrovert equating to a difference of about three standard deviations, for example. According to Roberts, specific traits shift by up to one standard deviation across the course of someone's life, especially conscientiousness and emotional stability.

Change can occur over shorter time intervals, too. In 2017, Roberts and his colleagues analysed 207 previously published studies on the efficacy of psychological treatments, which simultaneously tracked participants' personalities. They found people who had successful treatment for conditions such as depression, anxiety and eating disorders became not only more emotionally stable, but also increasingly extroverted and open during the course of the intervention. These changes, of up to half a standard



JIM HOLDEN/LALAMY

**Could forcing yourself to be organised alter your underlying nature for good?**

Mathias Allemand, a psychologist at the University of Zurich in Switzerland who led the study, thinks they weren't just seeing a placebo effect. If that had been the case, he argues, the changes would be unlikely to persist three months after the end of the intervention, which they did. In fact, many people continued to develop in line with their goals after the experiment had ended and the coaching had stopped. What's more, says Allemand, personality change involves a new way of looking at the world, so it makes sense that it should be more vividly experienced by the participants themselves.

This is just one study, of course. And if the recent history of psychology has taught us anything, it is that we shouldn't trust splashy studies that haven't been replicated. Except that this study was largely repeating several smaller, previous ones. Nathan Hudson, a psychologist at Southern Methodist University in Texas, says the work represents a "nice replication" of his own research on college students. He says it is great to see that the effect holds for a large, general group of people and adds that the observer reports are a valuable addition. A 2020 meta-analysis of 12 of his own previous studies on volitional personality change in college students, however, found slightly smaller effects. Other researchers have found similar results, too.

Now it was my turn to try. You have to be very motivated, Allemand told me. "It's not easy at all." It is also a good idea that anyone who wants to hack their personality educates themselves about the benefits of the changes they are trying to make, he says. I looked into the advantages of being conscientious and discovered there is some evidence to suggest people with higher levels of conscientiousness are generally healthier, live longer and do better at studies and work than people with low levels. I was motivated.

In terms of how you go about making the change, you can pretty much sum it up with the phrase "Fake it till you make it". I mainly used a long list of tasks published in the appendix of a 2019 paper by Hudson and his colleagues, and written in order of increasing difficulty. If you want to become more emotionally stable, for example, try to find positive details in negative situations and, when you feel upset with someone, spend 2 minutes reflecting on their good

deviation, were still present a year later.

Shifting personalities over our lives or in response to a treatment programme is all well and good, but I wanted to know whether I could change on purpose. Intriguingly, there is fresh evidence to suggest it is possible. For a study published last February, Roberts and several colleagues attempted to change one personality trait in each of 1523 Swiss participants who had a mean age of 25. Each person was coached by a smartphone app called PEACH, which gave them specific tasks, such as to talk to new people if they wanted to become more extroverted or write down all the important birthdays for the year ahead in their calendar if they wanted to become more conscientious.

It is easy to see that our personality traits can influence how we think and behave. But the idea behind personality change is that our thoughts and behaviour could also influence our personality traits. Given that people typically change in predictable ways as they age, it is reasonable to assume this is partly down to committing to various roles and expectations, the researchers argue. When we decide to study hard at university, for example, the change in behaviour eventually becomes automatic and is integrated into our personality.

After three months, the researchers found that those participants who wished to boost

emotional stability, extroversion or conscientiousness – which was the majority of the group – had succeeded. They had changed these personality traits by between a third and a half of a standard deviation. That is up to half the shift an average person can experience in a lifetime. "People can change pretty dramatically pretty fast," says Roberts. "That's been the big surprise for us."

The study involved self-reporting via questionnaires, which is problematic because we may not always have an accurate understanding of our feelings and behaviour. But the researchers also gathered evaluations from "observers" – friends and family of the participants. These evaluations also revealed personality change, albeit not to the same extent as reported by the participants themselves.

**“Fake it till you make it pretty much sums up how to change personality”**

# How to be a bit more...

## EXTROVERTED

Easier challenges include chatting to a waiter, saying hi to a cashier or making a positive comment on someone's social media feed. Next steps include inviting a friend for coffee, writing down questions you may ask them, or attending a social gathering. Also consider opening up to a friend about a problem, joining a club, asking an acquaintance out for dinner or organising a social outing.

## EMOTIONALLY STABLE

Write down something you're grateful for daily, keep a journal about your day, exercise for at least 15 minutes (and increase this over time) and schedule 30 minutes for an activity you enjoy. When you worry, visualise the best-case scenario, give money to charity, try to find positive details in negative experiences and, if you're feeling hurt or angry, reflect on the circumstances of the situation.

## AGREEABLE

A good start would be to smile, give compliments, pay for someone's coffee and write about nice things you have done for others. Joining a charity, taking other people's perspective or forgiving someone who has hurt you can also be helpful. For the ambitious, conflict resolution training could further boost these efforts.

## OPEN

Simple tasks include listening to a new podcast, going to an art gallery or trying food you have never had before. You could also spend 30 minutes a day reading a novel, reflect on the good qualities of a song you don't like, watch a debate and try to understand both sides or ask a friend about their view on a controversial topic and aim to understand it.

qualities (see "How to be a bit more...", left).

For me, the challenge was utterly daunting – and I only had four weeks to change. I decided to complete at least two tasks each day, rather than at least one per week, as was suggested to the participants in Hudson's study. This involved excruciatingly boring chores such as organising the app icons on my phone and laying out the next day's clothes the night before. I also made a habit of carefully proofreading my emails before sending them. And I didn't stop there. I planned virtually every hour of each day in my online calendar, with constant reminders about transcribing interviews, going to the gym or writing 500 words. I did a lot of thorough cleaning without procrastination, volunteered to take responsibility for doing dull tasks for others and banned wine on weekdays.

After four weeks, I took the same personality test again. My conscientiousness score had risen to a more respectable 56 out of 100, with organisation up from 6 to 25. Some of my other personality traits had changed by a few points here and there too. My openness score was intact, but it seems I had become a bit more agreeable and emotionally stable. This could be related to my change in conscientiousness, but it is more likely to be down to the fact that results on personality tests can fluctuate a bit from day to day, which is why scientists often measure them repeatedly in experiments – giving a much more reliable picture than my DIY project.

Did I really change my personality or did I just learn a new skill? Coral Dando, a psychologist at the University of Westminster, UK, argues that while the Swiss study was "well designed" with "sharp" analysis, it is open to question whether we can actually change our personality in this way or whether we are just altering our behaviour, and interpreting it as a more fundamental shift than it is. She adds that the research field would benefit from more replication across different population samples in diverse cultures and contexts.

Assuming for a moment that all this does stand up, the science of personality change raises other questions – not least whether it would be a desirable thing, should we all decide we want to change? Research certainly suggests the vast majority of people want to modify some aspect of their personality. It is easy to see the benefits, particularly when it

comes to conscientiousness and emotional stability. "I had some conversations with the people who participated in the interventions, and they told me that not only did it change their personality, but also their life," says Allemand, because it altered how they viewed the world and most likely how others responded to them.

## Self-acceptance

Roberts agrees, and says the focus really ought to be on emotional stability. Indeed, according to one school of thought, personality change programmes might help to reduce mental health problems. Neuroticism, for example, is linked to anxiety and depression. "If we can get people to not be so vulnerable to life events, which is essentially emotional stability, it may have cascade effects which will diminish the likelihood of experiencing various forms of psychopathology," says Roberts. But at this stage, we don't know if volitional personality change is permanent.

There may be a dark side, too. Companies might pressure staff to undergo personality change training against their will, for example. Another murky area is exactly how we change in response to interventions, particularly if we don't have researchers around to guide us. Personality traits may be linked and overlap in different ways in different individuals, so that if you increase your score on one trait, such as extroversion, you also tend to increase in another, such as openness. If you want to work on one aspect of your personality, you may end up changing in ways you didn't expect.

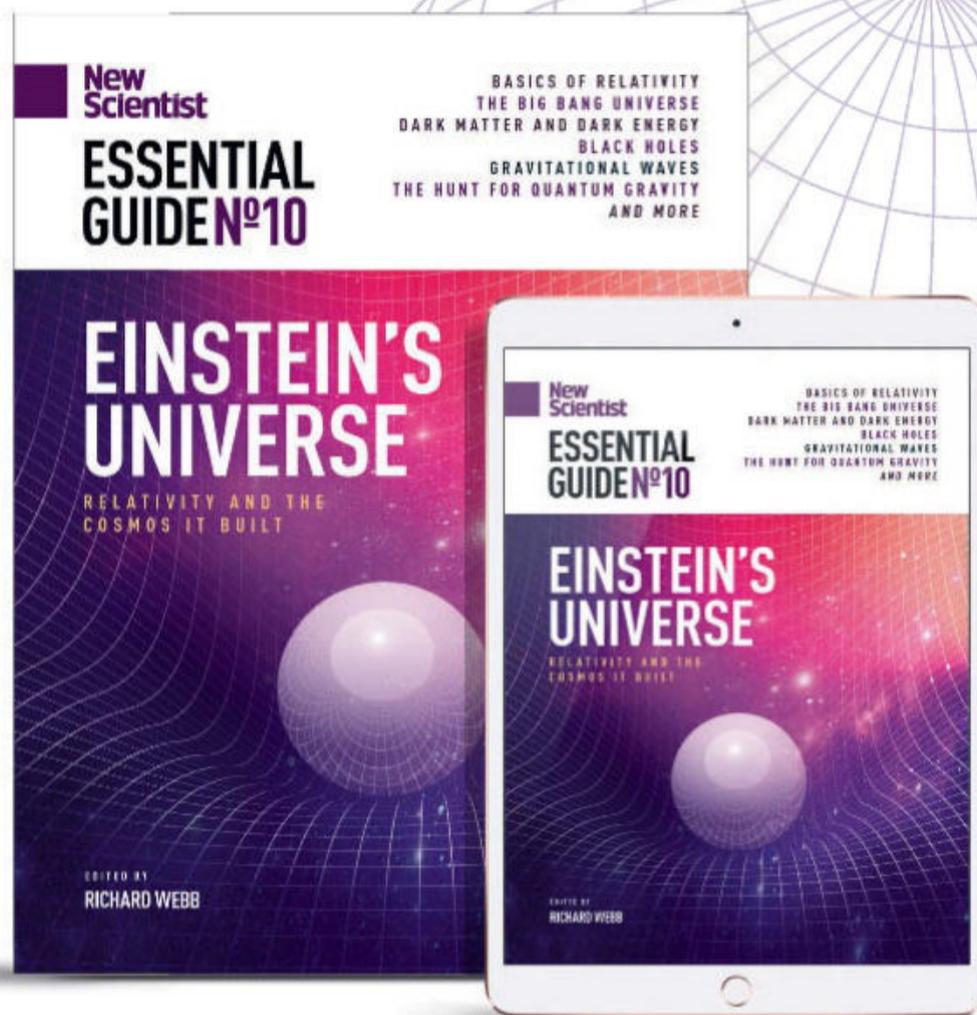
So before you rush off to create a better version of yourself, it is probably worth considering what it means to alter who you are, and what might constitute a good reason for embarking on personality change. If it can boost health and well-being, that seems sensible enough. But what if you are just feeling pressured by societal norms? As Allemand says, most people don't actually suffer because of their personalities, and there is something to be said for self-acceptance. ■



Miriam Frankel is a science journalist based in London.

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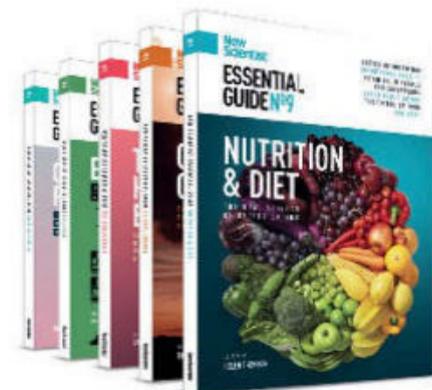
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# The back pages

## Puzzles

Try our crossword, quick quiz and logic puzzle **p53**

## Almost the last word

The universe is expanding, but into what? **p54**

## Tom Gauld for *New Scientist*

A cartoonist's take on the world **p55**

## Feedback

Boozing hamsters and nominative determinism **p56**

## Twisteddoodles for *New Scientist*

Picturing the lighter side of life **p56**

## Citizen science

# Spot some shooting stars

These celestial shows leave clues to their origin in their wake. You can help astronomers unravel the mystery, says **Loyal Liverpool**



Loyal Liverpool is a science journalist based in Berlin. She believes everyone can be a scientist, including you. @layallivs

## What you need

Access to Radio Meteor Zoo via [zooniverse.org](https://zooniverse.org)

I WANT to hunt for shooting stars, but it's cold outside so I'm starting the search from my living room. You can do the same by joining the Radio Meteor Zoo project online.

If you have ever seen a shooting star, you were probably witnessing a small solid object called a meteoroid whizzing into Earth's atmosphere from outer space. Meteoroids orbit the sun on various trajectories at tens of kilometres per second, sometimes ending up on a collision course with Earth. We see this as a meteor flying through the atmosphere, commonly referred to as a shooting or falling star.

The Radio Meteor Zoo project is calling for volunteers to help identify signs of meteors in radio data collected during meteor showers, which occur when many meteoroids pass through Earth's atmosphere in parallel. You can find the project on the Zooniverse citizen science platform.

As meteoroids fly through the atmosphere, they leave trails of ions and electrons behind that temporarily reflect radio waves transmitted from stations on Earth. These reflected waves can then be detected, and it is these reflections that you can search for in radio spectrograms online.

It is a lot easier than it sounds – all you have to do is draw boxes around all the characteristic bright peaks, known as meteor echoes, that you find on the spectrograms. Researchers, including Stijn Calders and Hervé Lamy at the Royal Belgian Institute for Space Aeronomy and their colleagues,



MARIUS HEIL/EYEEM/GETTY IMAGES

can then use the meteor-echo data to work out the mass, speed and trajectory of the meteoroids. That is because the duration of each meteor echo is related to the size of the meteoroid that caused it. The insights gathered could help modellers make predictions about the activity of the comets from which many meteoroids originate, says Calders.

But the researchers need help to dig through the deluge of data flowing in via the Belgian Radio Meteor Stations network – more than 10,000 spectrograms are generated every day. Automatic algorithms can help with signal classification, but so far none are as astute as the human eye.

Fortunately, thousands of volunteers have already lent a hand by participating in the

project since it launched in 2016. “Thanks to these volunteers, we have analysed more than 35 different meteor showers,” says Calders.

At the moment, the project is processing data from the 2021 Geminids – a meteor shower derived from an object called 3200 Phaethon, which was discovered in 1983 and is thought to be an asteroid. This makes the Geminids unusual, because most meteor showers originate from comets, which are icy and dusty, rather than asteroids, which are rockier.

To learn more about these celestial events and to join in, visit Radio Meteor Zoo online. ■

Citizen science appears every four weeks

## Next week

Science of cooking

These articles are posted each week at [newscientist.com/maker](https://www.newscientist.com/maker)

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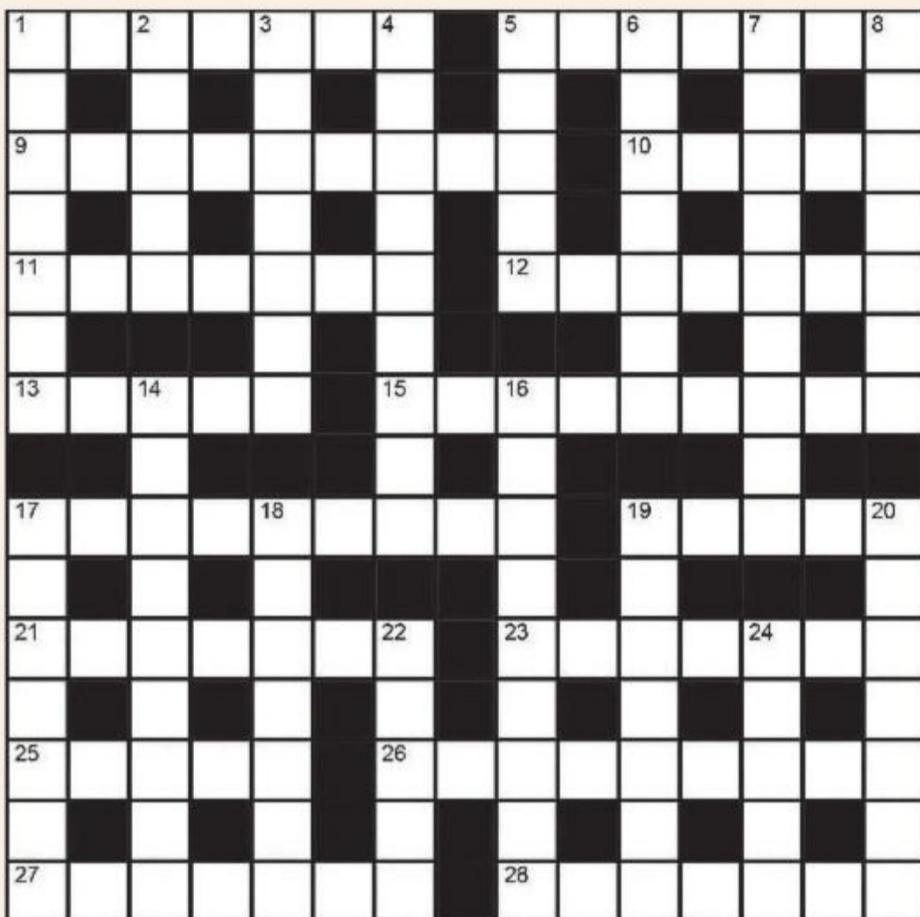
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\*Source: Google Analysis Jan-Dec 2021

## Quick crossword #99 *Set by Richard Smyth*



**Scribble zone**

Answers and the next cryptic crossword next week

### ACROSS

- 1 Ca (7)
- 5 Inflammation of part of the bowel (7)
- 9 Am (9)
- 10 Alkyl with nine carbon atoms (5)
- 11 Ga (7)
- 12 Mushroom rib (7)
- 13 Fatty skin secretion (5)
- 15 Sound reflection (9)
- 17 Seventh prime number (9)
- 19 Poisonous (5)
- 21 Clam, limpet or squid, for example (7)
- 23 Tube inserted into the body for medical purposes (7)
- 25 Molars, incisors and canines (5)
- 26 Outliers; aberrations (9)
- 27 Wax derived from ozokerite (7)
- 28 Ear bone also called the hammer (7)

### DOWN

- 1 Manufactured fuel comprising H<sub>2</sub>, CO, CH<sub>4</sub>, ethylene and volatile hydrocarbons (4,3)
- 2 Charles \_\_\_\_, 19th-century Scottish geologist (5)
- 3 Ir (7)
- 4 Software function based on a form letter (4,5)
- 5 Humped ungulate (5)
- 6 Series of science-fiction novels by Edward E. Smith (7)
- 7 Minimal computer operating system (9)
- 8 Complex formed by a dissolved substance and its solvent (7)
- 14 Machine with conical toothed parts (5,4)
- 16 Noise associated with faster-than-sound travel (5,4)
- 17 Bodily; of or relating to the body (7)
- 18 Zeroes (7)
- 19 John \_\_\_\_, a 19th-century Irish physicist (7)
- 20 Load-bearing frame of a car (7)
- 22 Series of links (5)
- 24 Liquid by-product of metabolism (5)

## Quick quiz #134

- 1 Which naturally occurring isotope of uranium is the most abundant?
- 2 What was the first UK satellite to be launched by a UK rocket?
- 3 Jan Janský was credited with the designation of what into four major groups?
- 4 Along with John Bardeen and William Shockley, who invented the point-contact transistor in 1947?
- 5 What is the only living species in the raptor family Sagittariidae?

Answers on page 55

### Puzzle

*set by Rob Eastaway*  
**#150 A jigsaw puzzle**

**Logan pulled an old jigsaw box off the shelf and gazed at the picture of a carousel on the lid. Under the picture in big, bold type it stated "468 pieces".**

**He tipped out the contents. It didn't look like 468 pieces. He started to count, but realised it would take a long time. What if he just counted the edge and corner pieces? That might be quicker, and if any of those pieces were missing, that would confirm that it wasn't a complete jigsaw.**

**If only Logan knew how many edge pieces there were, including corners. Since there was nothing unusual about the shape of the jigsaw, how many should he expect to find?**

*Solution next week*



**Our crosswords are now solvable online**

[newscientist.com/crosswords](http://newscientist.com/crosswords)

## In hot water

**I am right-handed and I find it difficult to accurately judge the temperature of bathwater with my left hand. Why?**

**Jacky Pett**

*Hampshire, UK*

If you have used your right hand to test the temperature of the bathwater all your life, then it has been trained to know what the “right” temperature is to within a fine tolerance, whereas your left hand only knows roughly within a broad tolerance.

I am a right-hander and use my right hand to test the bathwater. However, I find that the temperature that is right for this hand is often wrong for the rest of me. My right hand is less sensitive to hot or cold on the skin than my left hand, wrists or elbows, which are all better places for testing bathwater.

This means that water I can put my right hand into may be uncomfortably hot or cold for other parts of my body. I suspect

**“Your non-dominant hand is often used reflexively like a shield to prevent something bad from happening”**

this is related to the ability of many cooks to easily hold dishes that others find too hot.

This hypothesis is complicated by me being left-handed for some things and not others, partly due to being told to write with my right hand at school. So my right-handedness may not be a valid comparison.

**Selina Dussaye**

*Perth, Western Australia*

Repeated use of a dominant hand for tasks like checking the bathwater may mean that there are more neural pathways in the brain dedicated to analysing information received through the sensory receptors in that hand.



SHUTTERSTOCK/BACHKOVA NATALIA

## This week's new questions

**Wakeful winter** Why are there no birds that hibernate?

**Jim Stone**, *Great Hucklow, Derbyshire, UK*

**Face up to it** On a cold night, why does our body require clothing or bedding yet our face remains warm without covering? **Bonita Ely**, *Marrickville, New South Wales, Australia*

**Daniel Casasanto**

*Department of Psychology, Cornell University, Ithaca, New York, US*

This is the first time I have heard of someone being able to discriminate temperature better with their right hand than with their left.

Whether this pattern is found in people more generally is an open question.

If so, here is a possible reason why it could happen. People use their dominant and non-dominant hands differently. The dominant hand is used for more “approach-related” actions, in which you engage with the world around you in an intentional way.

The non-dominant hand more often performs “avoidance-related” actions, in which you are

responding reflexively to prevent something bad from happening. I call this the sword and shield pattern of hand use.

The person asking this question is reporting less temperature sensitivity in their non-dominant “shield hand”. It would make sense, evolutionarily, for the shield hand to have reduced sensitivity given that it is more likely to be injured in the service of classic avoidance actions, such as fending off attack.

This is just a hypothesis. An easy way to test it would be to find out whether, on average, right-handed people have less sensitivity to temperature (and presumably also to pain) in their shielding left hand, whereas left-handed individuals have less sensitivity in their right hand.

Bears, bats and many other creatures hibernate in winter, so why not birds too?

## Into the void

**The universe is expanding, but what exactly is it expanding into?**

**Andrew Taubman**

*Queens Park, New South Wales, Australia*

By definition, the universe is everything, so there is nothing external to it for it to expand into. It is not expanding into anything as such – everything is expanding.

**Richard Swifte**

*Darmstadt, Germany*

It is all too easy to think of the big bang and the resulting expanding universe as being like an ordinary explosion, with everything expanding out from a central point.

A better analogy is to consider the surface of an inflating balloon where the surface is a two-dimensional equivalent of our three-dimensional universe.

The balloon fabric is space; dots marked on this surface (equivalent to galaxies) will move apart as the balloon expands, but only because the fabric (space itself) is expanding, and without any central point for the expansion.

The balloon is expanding into the third dimension, but here the analogy is more problematic. Is our universe also expanding into a higher dimension?

If the universe is all there is, and isn't part of a larger multiverse, then there is nothing outside it (not even a vacuum, which is still space), so it probably makes no sense to ask what it is expanding into.

**Nick Canning**

*Coleraine, County Londonderry, UK*

A two-dimensional being on the surface of an expanding balloon can observe all distances in its surface world getting larger. It can't see the third dimension into which the balloon is expanding.



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**Tom Gauld**  
for *New Scientist*



We three-dimensional creatures see all the distances between galaxies expanding, indicating an inflation of space, but we can't perceive extra space dimensions beyond our three, into which the expansion is taking place.

**Roger Leitch**  
Bath, UK

There are two parts to the answer to this question.

First, when mathematicians and physicists want to describe space – any space – the mathematical tools and techniques they use don't depend in any way on the space being part of a higher dimensional space. So they can, for example, do geometry on the surface of a sphere without considering that the sphere is embedded in our everyday three-dimensional space.

Four-dimensional space-time is more complicated than the surface of a sphere, but the idea is the same. It is possible to calculate the shortest distance between two points, for example.

**“A finite expanding universe conjures up the idea that it would have a boundary, separating it from something beyond”**

Second, if space is expanding into some higher dimensional space, we can't, with our current knowledge of physics, know anything about it. And it may even be beyond our comprehension.

**Mike Follows**  
Sutton Coldfield, West Midlands, UK  
This isn't a question that physics can answer with our present knowledge or without some form of qualification.

The trite answer is that both space and time were created at the big bang about 14 billion years ago, so there is nothing beyond the universe. However, much of the universe exists beyond the observable universe, which is maybe about 90 billion light years across.

Because the universe is

homogenous on this scale, we imagine that what is beyond our observation looks much the same as what we can see.

If the universe is infinite, there is nothing beyond it, by definition. A finite expanding universe conjures up the idea that it would have a boundary or edge, separating it from something beyond. Of course, the universe has at least four dimensions (three for space and one for time) which is nigh on impossible for us to visualise.

However, space could be represented as two dimensions, confined to the gossamer-thin surface of a sphere. You could travel in any direction on the surface without encountering an edge. If the radius were to increase, the “universe” would expand as ours does, but it wouldn't be expanding into anything.

Finally, we could speculate that our universe is part of a multiverse with many other universes beyond our own, but it is unlikely that we are expanding into them. ■

## Answers

### Quick quiz #134 Answers

- 1 Uranium-238
- 2 Prospero
- 3 Blood
- 4 Walter Brattain
- 5 The secretary bird (*Sagittarius serpentarius*)

### Cryptic crossword #74 Answers

**ACROSS** 1 Bilayer, 5 Blush, 8 Litterbug, 9/21 Dry Ice, 10 Weird, 11 Scalene, 12 Rheumy, 14 Pathos, 17 Flounce, 19 Pares, 22 Cochineal, 23 Gland, 24 Osmosis

**DOWN** 1 Below, 2 Lattice, 3 Yield, 4 Robust, 5 Big data, 6 Undue, 7 Huygens, 12 Rafting, 13 Menaced, 15 Harness, 16 Velcro, 18 Omega, 19 Prism, 20 Salts

### #149 All in a spin Solution

As the circumference of the plate cog is five times that of the teacup cog, most people's first answer is that the cup will rotate five times. This isn't correct.

The centre of each teacup rotates at a distance of 3 metres from the centre of the plate. A circle's circumference is  $\pi \times 2r$ . The centre of each teacup – and also its circumference – must therefore travel  $\pi \times 6$  metres to return to its starting position.

As its circumference has length  $\pi \times 1$  metres, the number of teacup rotations is therefore  $6\pi \div \pi = 6$ .

## Boozing hamsters

Feedback has a soft spot for hamsters, whose hoarding and nesting behaviours are similar to our own. Our feeling of oneness only increases with an article in *The Atlantic* forwarded to us by Peter Hamer: "You have no idea how hard it is to get a hamster drunk".

Hamsters have a high tolerance for strong alcohol, we read, scoring low on a special scale of falling over sideways no matter how much they imbibe. We wonder how the statistics are skewed if you're just going round and round on a wheel at the time, but nevertheless we add hamsters to our pile, accumulated over aeons, of animals that science says can take their booze.

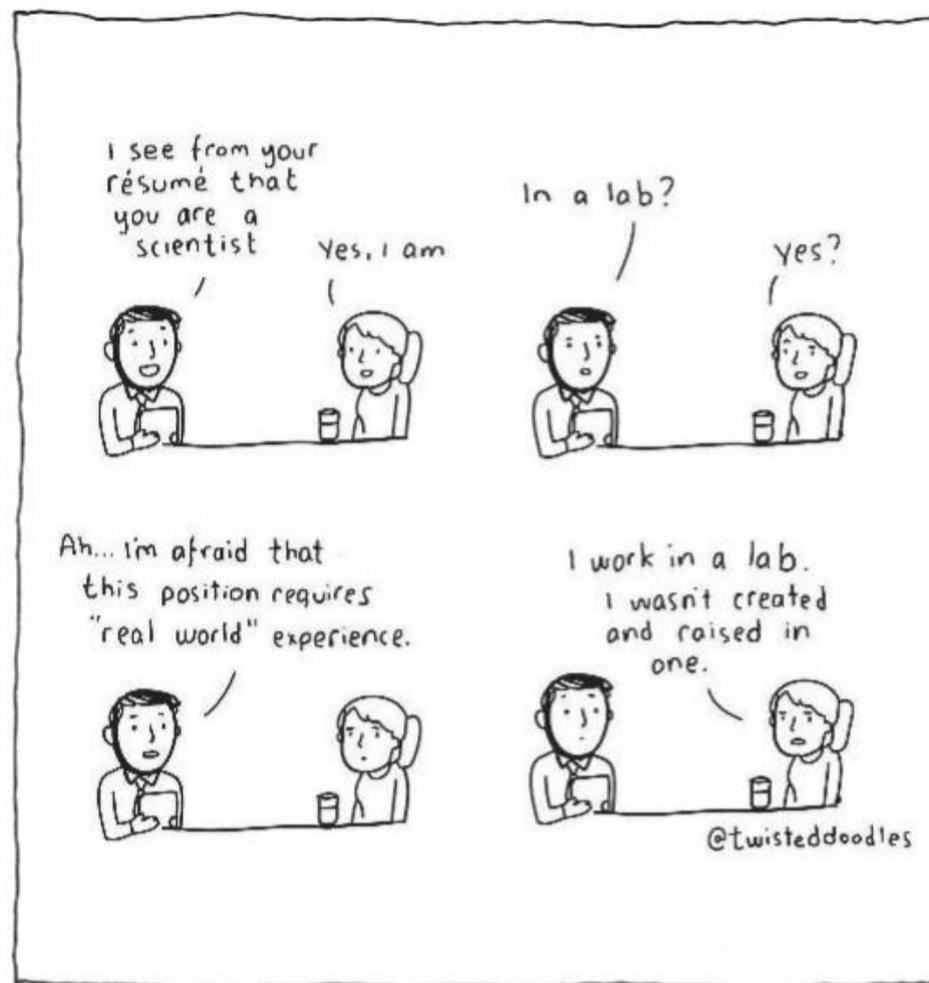
This list includes bonobos, chimpanzees and bats, which is just as well, because getting entangled with an inebriated bat is a thought that doesn't bear much thinking about. It most definitely doesn't include cows, horses, rampaging elephants and the cedar waxwing bird. Their frequent collisions with fences and glass windows in the Los Angeles area were shown in 2012 to be down to the fruit of the Brazilian pepper tree fermenting in their internal food storage pouches.

Don't try that at home. This being Dry January, we burrow deeper into our extensive piling system and root out a 1995 paper from the journal *Physiology & Behavior* that we were saving for bedding material. Entitled "Tomato juice, chocolate drink, and other fluids suppress volitional drinking of alcohol in the female Syrian golden hamster", it provides a way to get your hamster off the wheel and onto the wagon: ply it with calorie-rich hot chocolate. We rarely say no to that, either.

## What's in a name?

"I know it's a bit early to get up this year, but nominative determinism won't go away just because you're having a lie-in," writes Mike Egan from County Meath in Ireland, ignoring the squeaking of our treadmill. We have only ever expressed that as

## Twisteddoodles for New Scientist



### Got a story for Feedback?

Send it to [feedback@newscientist.com](mailto:feedback@newscientist.com) or New Scientist, Northcliffe House, 2 Derry Street, London W8 5TT

Consideration of items sent in the post will be delayed

a hope, Mike, not an expectation. Elizabeth Economy is a senior adviser at the US Department of Commerce, he writes. Others point out that Mark Rocket is the chief executive of Kea Aerospace based in New Zealand, and duck lover Alan Gosling was named last week as the first person known to have contracted bird flu in the UK. *Vegetation of the Peak District* is a book passably reviewed by *Nature* on publication in 1913 that remarkably appears still to be in print, authored by C. E. Moss. Our sincere thanks to all as ever.

## Big in Basingstoke

A tweet from Basingstoke and Deane Borough Council sent in by Gwynneth Page indicates that we may have followers in that jewel of northern Hampshire. "Our street cleansing team have been sweeping

leaves from the borough's streets as part of our annual leaf clearance schedule," they announced on 5 January. "Since October, the team have collected 560 tonnes of leaves – the equivalent to 112 adult elephants!"

Gwynneth confesses difficulty in visualising a pile of leaves equal to an elephant in weight. Us too, but we reckon that, spread out thinly, the whole lot would cover an area about the size of Basingstoke.

## Pitch perfect

How much is that in football pitches? Courtesy, in a convoluted way, of an exchange of letters about measurement standards in the *Financial Times* drawn to our attention by Michael Zehse, we find ourselves consulting the *The FA Guide to Pitch and Goalpost Dimensions* for a steer.

If that sounds like fun, it is, revealing a line-up of recommended football pitch sizes ranging from 40 by 30 yards for the little 'uns to 110 by 70 yards for the fully sized. Pre-revolutionary units still reign supreme in this corner of Merrie Olde England. We make that a full factor 6.4 range in football pitch sizes, which is a satisfyingly variable measurement standard. Just don't complain about shifting the goalposts, they can be anything from 12 to 24 feet apart.

## Ashes to ashes...

Congratulations to "Huntingdon in Bloom" – the Cambridgeshire town has received an Outstanding commendation in the Green Solutions category of the Royal Horticultural Society's Community Awards 2021. Our thanks to Ralph Platten for pointing out that "of particular note is the recycling of heat generated by the UK's first electric crematorium to warm a glasshouse that will be used to propagate and grow plants for the town's flowerbeds, containers and community projects". Charming.

## Elementary, again

"And finally" is a phrase that strikes fear into the hearts of UK TV news viewers, indicating the imminent arrival of Whimsy. So, and finally, Dave Hawke from Devizes, UK, wins some form of kudos, not just for rocking one of the few English place names not stressed on its first syllable (Penzance; Carlisle; the -hamptons; feel free to go on your own mental journey), but for a late-breaking reply to our call for elementary names (11 December 2021).

He introduces us to the Um siblings, Ray D, Barry, (H)erbi, Ceri, Reni, Ruby and Moly B. D., "lastly not to forget Uncle Nick Hall". Thank you, Dave, although if you're looking for Pseudo Names, it is *Private Eye* you're after. But frankly it's Dry January, and we'll do anything for laughs. ■

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