

New Scientist

WEEKLY 10 October 2020

EMERGING TRUTH ABOUT COVID-19 SYMPTOMS

*The six distinct groupings
How they can lead to different outcomes
Spotting the disease in children*

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Rival claims to best ever quantum computer

OUT OF

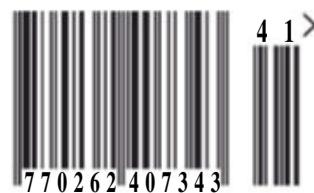
BALANCE

We're getting less steady on our feet

Why that matters, and what you can do about it

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This week's issue

On the cover

34 Out of balance

We're getting less steady on our feet. Why that matters, and what you can do about it



Vol 248 No 3303
Cover image: Diana Bolton

8 Emerging truth about covid-19 symptoms

The six distinct groupings
How they can lead to
different outcomes
Spotting the disease in children

17 Quantum uncertainty

Rival claims to best ever quantum computer

16 First African in the Americas

16 Free-ranging planet
18 Annoying chewing sounds
12 Secrets of cockroach society
13 Babies fed mother's poo

16 News
"So often, historical records leave out so many people, especially women and people of colour"

News

12 Historic mission

A dive through old data also hints at life on Venus

14 Fire and stone

Ancient humans crafted tools with heat

15 Climate cows

Cattle genome edited with CRISPR to make them more resistant to global warming

Views

23 Comment

Facebook has failed to tackle fake news, says Donna Lu

24 The columnist

Chanda Prescod-Weinstein on the threats to astronomy

26 Aperture

A view of Earth from the International Space Station

28 Letters

If life does exist on Venus, we must be very careful

30 Culture

Stephen Hawking remembered in a friend's new memoir



44 Robots everywhere How the pandemic is speeding up automation

Features

34 Balancing act

We are getting less steady on our feet and not just in old age. That is bad news

40 Feng Zhang interview

Gene editing pioneer says the technology could help fight climate change and coronavirus

44 Covid-19's AI revolution

Robots are taking human jobs faster during the pandemic

The back pages

51 Science of cooking

How to make mushroom ketchup

52 Puzzles

Which chairs should be swapped around in a bizarre bistro?

54 Almost the last word

What makes people short-sighted or long-sighted?

56 Feedback

Deadly digit ratios and a condom caper: the week in weird

56 Twisteddoodles for New Scientist

Genies or research scientists?

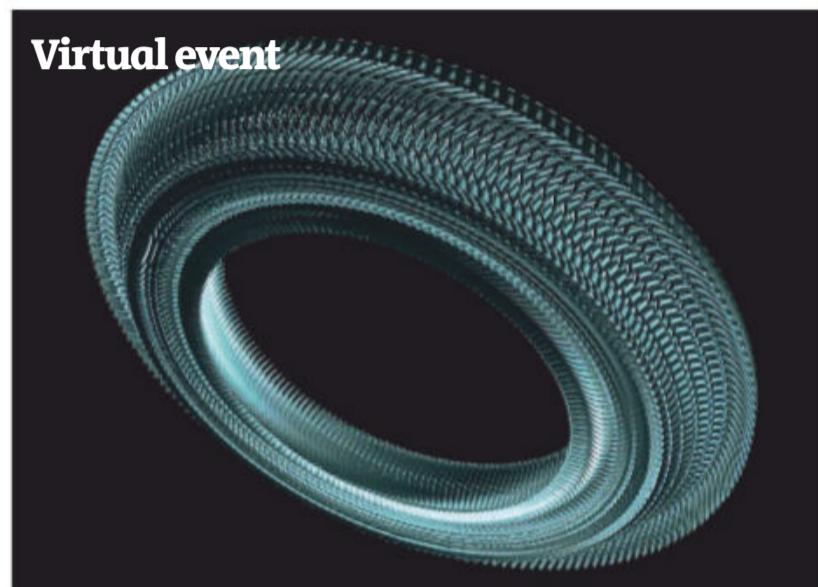
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THITAREE SARMKASAT/GETTY IMAGES

Eat like the past Does the paleo diet increase your biological age?

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Making the cut

Gene editing can help us reduce farming's emissions

ASK most people to list the causes of climate change, and you would expect to hear about oil companies, flights and cars. But, increasingly, we are realising that producing our food has massive environmental impacts. Farming is one of the main drivers of deforestation and global warming, among many other issues.

The flip side of this is that improving the way we farm can have massive environmental benefits. Boosting yields so that we can grow the same amount of food on half the land could save a forest, along with all the carbon that it stores.

One of the best ways to do this is to develop better breeds. The plants and animals we eat have already been transformed by conventional breeding, but it is a slow and clumsy process. Now we have a much more

powerful and precise tool: CRISPR gene editing (see page 40).

Gene editing can be used in two ways. One is to quickly introduce desirable gene variants that already exist in other plants and animals. For instance, some beef cattle have very light coats due to a

"Some CRISPR creations could have undesirable consequences, but these should be judged on a case-by-case basis"

tiny change in one pigmentation gene. This same tiny change has been edited into dairy cows in New Zealand, with the aim of making them more heat tolerant in a warmer world (see page 15).

Gene editing could also be used to make more extensive changes. For instance, many groups are trying to give

extra crops the ability to fix nitrogen, just as peas and beans can. Such crops would need much less fertiliser, reducing emissions of the potent greenhouse gas nitrous oxide.

Another idea is to create crops with deeper roots that release suberin, a rot-resistant molecule found in cork. The idea is to lock away more carbon in the soil to help slow global warming.

Of course, some CRISPR creations could have undesirable consequences, as with any kind of breeding. But these should be judged on a case-by-case basis, because we also have to consider the risks of not embracing CRISPR crops and cows.

It is going to be very hard to reduce the greenhouse gas emissions from farming. Rejecting genetic technologies will make that job even harder. ■

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Donald Trump

The week that shocked the US

After being treated for covid-19 in hospital, US president Donald Trump has been criticised for downplaying the dangers of coronavirus, reports Adam Vaughan

HEALTH experts criticised US president Donald Trump this week for telling people not to “be afraid” of coronavirus, and for removing his face mask on arriving at the White House after being treated for covid-19 in hospital.

His return to the residence on Monday immediately raised questions over whether he would break guidance on self-isolating for 14 days. “Will be back on the campaign trail soon,” Trump wrote on Twitter. Efforts are still under way to trace his contacts, with at least 17 other positive cases linked to the Trump administration.

Anthony Fauci, the US’s leading infectious disease expert, appeared to contradict Trump’s advice. “Obviously, the message

should be that we should try as best as we can to avoid infection. No matter who you are, how old you are, or what your underlying condition is, we should not trivialize it,” he told *The New Yorker*.

Other scientists pointed out the risk that Trump’s flouting of guidelines poses to his staff. “Epidemiologists just wanna vomit,” tweeted Eric Feigl-Ding at the Federation of American Scientists, as he posted a video of Trump unmasking himself to talk.

The exact timeline of Trump’s illness and his health has been fuzzy. While the president publicly

revealed his diagnosis on Twitter just before midnight on 1 October, his doctors later said he had tested positive on 30 September, although one doctor has since retracted this. If true, it would mean that he travelled to campaign rallies and fundraising events, raising fears that he may have become a “superspreader”.

Although Trump said on 5 October that he is “feeling really good”, his condition three days earlier had been described by his chief of staff Mark Meadows as “very concerning”.

The president’s treatments

included the steroid dexamethasone, which has been shown to help patients who need a ventilator. He was also given the drug remdesivir, the effectiveness of which is still unproven, although some trials have shown some promise. Plus doctors administered a dose of an experimental antibody cocktail being developed by Regeneron, as well as zinc and vitamin D.

The shock waves generated by Trump’s illness come against a backdrop of covid-19 cases once again rising in the US. As *New Scientist* went to press, there were nearly 7.5 million cases in the country, with more than 40,000 cases being reported daily, based on a seven-day average. ■

Daily coronavirus news round-up
Online every weekday at 6pm BST
newscientist.com/coronavirus-latest

Symptoms

Covid-19 symptoms rethink

There is more variability in signs of covid-19 than we thought. Understanding them could be key to treatment and reducing spread, finds **Jessica Hamzelou**

HAVE we been getting covid-19 all wrong? As the list of symptoms recognised by health authorities evolves, we are starting to learn that people seem to fall into one of several symptom clusters, and that we might be missing the most important signs of the disease in children.

The findings could help researchers better understand how the virus affects individuals differently, and how an outbreak in a preschool might look very different to one in a care home.

In January, when the world was first alerted to a new coronavirus spreading in the Chinese city of Wuhan, health authorities listed cough, fever and difficulty breathing as key symptoms. People with severe infections developed pneumonia. The illness looked like many other respiratory infections.

With time, that picture evolved and today, both the World Health Organization and the US Centers for Disease Control and Prevention list a plethora of symptoms for covid-19.

“Our understanding of the symptoms is changing all the time,” says Angela Rasmussen at Columbia University Mailman School of Public Health. “At the start, we focused on respiratory symptoms because it’s a respiratory disease, but we’ve learned since that it’s much more complex than that.”

One of the first discoveries was that the virus seems to trigger more severe symptoms in older people, as well as in those with underlying health conditions. But the effect on any individual can vary hugely – many young people have died, too. “We realised it could be very different from one person to another,” says Carole Sudre at King’s College London.

It’s not clear exactly what



REUTERS/MARKO DJURICA

determines how ill a person might get, but there are plenty of factors that could play a role. “All of these people are from different places, they have different diets, genomes and epigenomes, they have different medical statuses and access to healthcare,” says Rasmussen. “All of those things are going to create a unique

4.4 m

The number of people using the Covid Symptom Study app

environment for the virus to replicate and for unique bodies to respond in different ways.”

The way individuals are exposed to the virus could also have an effect, says Rasmussen. Subtly

different variants could trigger different immune responses, for example. The amount of virus a person is exposed to might influence which symptoms they develop, too, as could the route of infection, for instance whether by nose, eyes or mouth.

One attempt to understand how the virus affects people in different ways is based on data from the Covid Symptom Study app, developed by health science company Zoe. Since its launch at the end of March, more than 4.4 million people have signed up across the UK, US and Sweden. App users enter their age, location and health information, and are then asked to report how they feel each day. People can also log any coronavirus tests they have taken.

Patients receiving treatment for covid-19 in an intensive care unit

Based on a sample of 1653 app users, the team behind the app has identified six clusters of symptoms (see “Six types of covid-19”, right).

Three of the clusters are relatively mild. People who fall into the more severe clusters tend to develop fatigue, chest pain and confusion. Those who fall into cluster six often become very unwell (medRxiv.doi.org/gg5dvh).

“If only the upper respiratory system is affected, then the risk of going on to need hospital and breathing support is much less,” says Claire Steves at King’s College London, who co-authored the

study. "When... a person gets symptoms all over their body – not just nose and throat, but also muscles, chest, tummy and brain – that's when they are more likely to need hospital support."

Personal predictions

Sudre, who is also on the study team, hopes that recognising a person's symptoms in this way might help health professionals predict the level of care someone could need.

The findings could also help inform who gets a test for the coronavirus. In the UK, for example, the government currently advises that only those with fever, a persistent cough or a loss of taste or smell get tested. Given the variability of symptoms – and that many people won't have any at all – these criteria will undoubtedly miss cases.

Researchers are also trying to figure out how symptoms develop over time. Typically, the symptoms listed by the UK government tend to appear anywhere between two and 14 days after infection. "It could be too late, and you may have already infected people," says Sudre. Her colleagues are investigating which symptoms are most likely to develop first. So far, it appears that headache and fatigue seem to strike earliest – which might also be symptoms we easily dismiss.

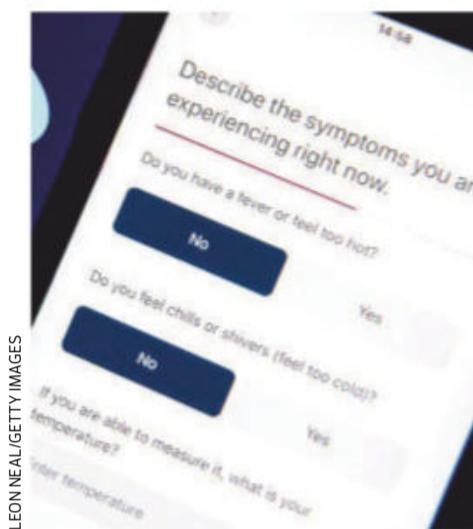
Children seem to be affected differently, and another set of symptoms might be more appropriate for spotting covid-19 in them. Young children in particular seem to experience an infection very differently to adults.

That's what Tom Waterfield at Queen's University Belfast and his colleagues found when they assessed the symptoms of

992 children being treated for various illnesses across the UK. Sixty-eight were confirmed to have had the coronavirus. Waterfield's team compared their symptoms with those of children who hadn't had the virus.

"Our study is showing a big range of symptoms with lots of overlap," says Waterfield. His team used a computer model to work out which were most predictive of covid-19, rather than of other common infections. While many of the children had a fever or a cough, for example, these symptoms were also linked to other viruses. "If you want a symptom that could give you a high pickup with the least number of extra tests, it would be diarrhoea and vomiting," he says.

The current UK testing strategy would have missed 24 per cent of



LEON NEAL/GETTY IMAGES

symptomatic children, the team found, but including diarrhoea and vomiting in testing criteria would mean that 97 per cent would have been detected (medRxiv, doi.org/fcgg).

The key symptoms in younger children also seem to look different to those seen in older

The Covid Symptom Study app asks users to log their symptoms

children. Teenagers are much more likely to report changes in their senses of taste and smell than young children, although young children might simply struggle to express the problem.

This fits with other research suggesting that the way the virus spreads in teenagers is closer to that in adults, but we still don't know why this might be the case.

"It might have to do with differences in the immune system between young and old," says Petter Brodin at the Karolinska Institute in Stockholm, Sweden. Some researchers think it may be related to ACE2 receptors, which the virus binds to. Children may express fewer of these receptors in their noses and throats.

It also suggests that the coronavirus is spreading in a different way among young children. While it is largely thought to spread via large

"If you want a symptom that will give the highest pickup with fewest tests, it is diarrhoea and vomiting"

Six types of covid-19?

A team from the Covid Symptom Study has split the disease into six types:

1 Flu-like symptoms, no fever

Headache, loss of smell, cough, sore throat and aches and pains, but no fever. Around 1.5 per cent of this group will go on to require breathing support in hospital.

2 Flu-like symptoms with fever

Similar to group 1, plus a loss of appetite and fever.

3 Gastrointestinal

Diarrhoea alongside loss of smell and appetite, headache, sore throat and chest pain. Typically, no cough.

4 Fatigue

This cluster is considered more severe than the previous three,

as 8.6 per cent require breathing support. Fatigue accompanies headache, loss of smell, cough, chest pain and fever.

5 Confusion

Another severe category. People experience confusion in addition to symptoms listed in cluster four. Around 10 per cent will require breathing support.

6 Abdominal and respiratory

Considered the most severe cluster, because almost half will require hospitalisation, and around a fifth will need breathing support. Symptoms include headache, fever, loss of smell and appetite, cough, sore throat and chest pain, along with shortness of breath, diarrhoea and abdominal pain, muscle pain, confusion and fatigue.

droplets and smaller aerosols in the air, the prevalence of diarrhoea and vomiting in young children suggests that poor bathroom hygiene might play more of a role for them, says Waterfield.

Fatigue was another common symptom among the children in Waterfield's study, and he worries that many will continue to experience this after they have recovered from the initial infection. This has become a trend in many adults, who describe experiencing symptoms of "long covid" for weeks or months after they first became unwell. ■

Doctor's diary

UK doctors may struggle to cope with covid-19 this winter

Selma Stafford

LIFE as a general practitioner slowly started returning to normal after the summer. I saw only one patient with "long covid" and none with covid-19 symptoms during September. The local "hot hub" that I helped to set up to deal with people who potentially had covid-19 closed on 28 August amid single-digit cases in the area.

Sadly, it wasn't to last. Last week saw record numbers of daily diagnosed cases in the UK, reaching well in excess of 7000. Restrictions are tightening, and however the government chooses to handle things, many people will become unwell.

I am worried. Doctors' surgeries are likely to get overwhelmed again, and there is no doubt that more patients will be redirected to emergency departments.

One of the difficulties facing us as doctors will be assessing people with symptoms also seen in covid-19. Meningitis in children and young people can present with a high temperature and is far more dangerous than covid-19. Many adults – especially those who smoke or have breathing

problems – get chest infections in winter, which are also clinically indistinguishable from covid-19.

The key to making a correct diagnosis and giving appropriate treatment will be the availability of fast and accurate testing. But currently, children and adults with new covid-19 symptoms have to self-isolate because they can't access a test, fuelling disruption. It also means vulnerable older

People line up for flu vaccinations at a doctors surgery in Kent, UK



PAUL LAWRENSON/ALAMY LIVE NEWS

people might have to self-isolate and so lose some of the care and company they may receive.

Then there is flu, the known unknown. Every year, vaccine manufacturers predict which flu strains to protect against. In a good year, when the actual flu viruses match the vaccine, you are over 40 per cent less likely to get ill from flu if you get the vaccine than someone who hasn't had it. In recent years, the number of annual UK flu deaths has varied from 4000 to 22,000, and 88 per cent of those who died were over 65.

We don't yet know what flu and covid-19 circulating in the population at the same time will mean. Social distancing and an increase in hygiene awareness may reduce the spread of flu.

While we also don't know whether people will get both at once, covid-19 and flu both disproportionately affect older people and the risk increases with age. Having two illnesses with such targeted victims will make this winter stressful and possibly dangerous for older people.

We need to hope that flu vaccine manufacturers have forecasted well, and can produce enough vaccine doses for increased demand. My own practice has run out until our next delivery in a few weeks. Whatever happens, the winter will be tough, but we must be able to minimise the harms. The availability of flu jabs and coronavirus tests will be vital. ■

Selma Stafford is a GP and educator in Brighton, UK, and clinical director of the Sussex MSK Partnership. Follow her @selmaalabama. This is her second diary for New Scientist

Analysis

Can vitamin D offer protection against the coronavirus?

CLAIMS that vitamin D can protect us against the effects of coronavirus abound, but so far scientific evidence doesn't back them up.

Vitamin D is made in the skin through the action of sunlight, and is also found in foods such as oily fish. It helps build strong bones and plays a role in the immune system, including helping to kill infected cells.

In June, the UK's Scientific Advisory Committee on Nutrition

(SACN) concluded that there isn't strong enough evidence to support the idea that the vitamin can help ward off infections like colds.

What about covid-19? Several researchers have said that vitamin D has potential to protect people from being infected, or if they are, to help reduce their illness.

Some supporting evidence has started to accrue. However, most is in the form of observational studies, which can be misleading because they don't prove that low vitamin D causes infections, just that it correlates with them. For instance, one such study found that people

admitted to hospital with covid-19 had half the risk of death if they had adequate vitamin D levels.

The best way to assess the benefits of vitamin D supplements would be trials giving them to people with covid-19 to see if it helps their symptoms. One such study from Spain found that people in hospital with covid-19 who received high doses of vitamin D were less likely to need intensive

"Patients with covid-19 were less likely to need intensive care if they received vitamin D"

care than those who didn't get it.

However, the study involved just 76 people. The trial also only tells us that vitamin D seems to help hospital patients, not that it works as a prevention method. It is promising, but a larger study is needed, says Susan Lanham-New, who is a member of SACN.

All experts seem to agree that most people in temperate climates like in the UK become vitamin D deficient over winter. As such, if only to support strong bones, they should take a vitamin D supplement every day, from October until March. ■

Clare Wilson

Thursday 22 October 2020 6pm BST

UNLEASHING INNOVATION:

HOW WILL THE GOVERNMENT'S BOOST TO SCIENCE SPENDING PAY OFF FOR BRITAIN?

Earlier this year, the UK government announced a dramatic increase in research and development spending. By 2027, R&D spending will rise to £65 billion or 2.4 per cent of GDP compared with just 1.7 per cent in 2017. The goal is to turn the UK into an innovation superpower – but how?

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Potential sign of Venus life supported by old NASA data

Leah Crane

WE HAVE another hint that there really is phosphine – a gas that may be a sign of life – in the clouds of Venus, and it comes from old data collected by a spacecraft that visited the planet in 1978.

Last month, Jane Greaves at Cardiff University in the UK and her colleagues announced that they had found phosphine in the Venusian atmosphere after using two telescopes to spot it absorbing light that bounced through the clouds of Venus. They couldn't link that phosphine to any known chemical processes of the planet, leading them to suggest the possibility that it came from living organisms.

"There was some controversy in terms of the veracity of the signal, and I was inspired from that to look for other evidence that could support that detection," says Rakesh Mogul at California State Polytechnic University, Pomona. He and his colleagues re-examined data from NASA's Pioneer Venus Multiprobe, which measured the masses of various compounds as it sank into the crushing Venusian atmosphere in 1978.

Mogul and his colleagues found previously unreported signs of phosphine consistent with the levels that Greaves's team spotted from Earth, along with other chemical compounds that are expected to form as phosphine breaks down (arxiv.org/abs/2009.12758).

Data like this, from a mass spectrometer, is notoriously difficult to interpret, so this finding isn't completely definitive, says David Grinspoon at the Planetary Science Institute in Arizona. "I'm still not 100 per cent ready to declare



there's definitely phosphine in the clouds of Venus, but it's more strongly indicated now than it was before there was this second hint."

Mogul's team also reported signs of several other molecules, such as methane and nitric oxide, that we didn't expect to be present in Venus's clouds. That isn't necessarily surprising, says Grinspoon. "If phosphine is there, then there's some

If phosphine is there, then there's some chemistry that we didn't know about going on"

chemistry that we didn't know about going on there." That wouldn't just mean the addition of phosphine to our current models. "There would be other things too," he says.

Methane in particular is interesting because it has long been considered a potential biosignature, although there are other ways to make it. "If there is life in Venus's clouds – which is, of course, extremely speculative at the moment – we would

An illustration of the Pioneer Venus Multiprobe

expect a ton of biosignatures, not just phosphine," says Clara Sousa-Silva at the Harvard-Smithsonian Center for Astrophysics in Massachusetts, who worked with Greaves on the phosphine discovery.

We still have a long way to go before we understand Venus enough to figure out where phosphine and these other unexpected compounds come from, she says. Combing through old data with new eyes is a start, but eventually we will need more space missions to really understand what is going on.

"It's amazing that here we are, trying to glean every bit of meaning out of data that is from a spacecraft that was launched in 1978, when we know how to build instruments that would absolutely nail this answer if we sent them to Venus today," says Grinspoon. "If anything, it's a testament to how unexplored Venus is." ■

Animal behaviour

First cockroach species seen to have workers and a queen

Michael Marshall

COCKROACHES can team up. A South American species is the first cockroach known to live in group nests with workers and a queen, like honeybees or leafcutter ants.

"All cockroaches are solitary," says Peter Vršanský at the Slovak Academy of Sciences in Bratislava – or so everyone thought. Some animals, such as honeybees, are eusocial: not only do they live in large groups and work together to tend to the young, but most individuals don't reproduce.

Vršanský and his colleagues spent 20 years looking for living specimens of the cockroach *Melyroidea magnifica*, which has barely been seen since it was identified in cloud forests around the Rio Bigal nature reserve in Ecuador in 1912. Local conservationist Thierry Garcia at the Sumac Muyu Foundation in Ecuador finally found a nest in 2017.

The cockroaches nested in bamboo or hardwood trees in groups of several hundred. They spend a lot of time inside the nests, which explains why they were so hard to find. "There was one week where not one cockroach was outside," says Vršanský.

The adult cockroaches had bright red heads and green abdomens. There were also tiny black larvae.

The team found one individual 1.25 times larger than the others with white wings. This was tentatively identified as the queen, but Vršanský says more evidence is needed to be sure (*The Science of Nature*, doi.org/fb47). "We would need to prove that it is the only individual which lays eggs," he says. Yet in two months of observations, they never saw the other cockroaches laying eggs, which suggests they are sterile workers.

The finding highlights how little is known about cockroach behaviour, says Vršanský. "We know nearly nothing." ■

Babies fed mother's faecal matter

A small amount mixed with breast milk altered gut bacteria in babies born by C-section

Clare Wilson

SOME babies born by caesarean section are being given tiny doses of their mothers' faeces to try to improve their gut bacteria. This shouldn't be tried without medical supervision, doctors warn.

"There may be pathogens in the mother's microbiome," says Willem de Vos at the University of Helsinki, Finland. The doctors doing the work tested for these, ruling out a third of the mothers recruited for the trial.

Some studies have shown that babies born by C-section have different gut bacteria to those born vaginally, perhaps because they aren't as exposed to their mothers' microbes while they are born. It has been proposed that this is why such children have slightly higher rates of allergies, asthma and obesity.

Some groups have tried to mimic vaginal birth by wiping the mouths of babies born by C-section with their mother's vaginal fluid. This made their gut bacteria more like those of vaginally born babies, but not identical to them.

Mothers' faecal bacteria may colonise a baby's gut, as women in

labour often defecate, and people delivering babies in the past would often have had faecal bacteria on their hands, says de Vos.

His team recruited 17 women who needed C-sections for medical reasons. Three weeks before their operation, they each gave a stool

Babies born by C-section have different gut bacteria to vaginally born babies

sample, which was frozen. Ten women were ruled out from the study, six due to signs of harmful microbes, such as group B streptococci bacteria.

For the rest, a few milligrams of faeces was mixed with breast milk and given to the babies in their first feed. After three months, the infants' gut bacteria were more similar to those of babies born vaginally than those of babies

who didn't have this intervention, according to data from other studies (*Cell*, doi.org/fb2j). The team is now doing a placebo-controlled trial with 40 babies.

In a larger ongoing study in Sweden, babies are brushed with a gauze that has had contact with a swab put into the mother's anus.

Some researchers say using faecal bacteria in trials like these carries risks. "No matter how well you screen for harmful bacteria, you are limited in what you can detect," says Peter Brocklehurst at the University of Birmingham, UK.

Gut bacteria in babies born by C-section may differ not due to how they were born, but the reasons the surgery was needed, says Kjersti Aagaard at Baylor College of Medicine in Houston, Texas. "We seem awfully ready to label women who have caesareans as endangering their babies, but we have no evidence that's true."

"People have jumped on the bandwagon that the microbiome is the mechanism – that's still far from proven," says Brocklehurst. "Until it's proven, why would you try to manipulate that? You could do more harm than good." ■



MARTIN VALIGURSKY/ALAMY

Technology

Control a fleet of drones with just one smartphone

A SYSTEM that lets one person guide a fleet of drones could help survey crops or buildings, or identify people in search-and-rescue missions.

The human operator manages the fleet, but can take over a single drone, using a tablet computer or even a smartphone. And several operators can share control.

Similar technology controls drones in spectacular light shows,

but this system, called MultiFlyer, allows real-time instructions rather than just preprogrammed choreography. The drones can also carry cameras or sensors.

Nir Tel-Oren at Israel Aerospace Industries (IAI), which developed MultiFlyer, says such drone fleets could provide aerial monitoring for disaster relief or agricultural surveys. They could also inspect bridges, cooling towers and power lines faster than single drones.

MultiFlyer uses helicopters from Alpha Unmanned Systems in Spain, which fly for 90 minutes. The

system can integrate other types of drone, though, and drones can be swapped in flight, with new ones joining as others drop out to refuel or recharge. Theoretically, the fleet can maintain a continuous presence for an unlimited period this way. Tel-Oren says the only limits to the size of the fleet are bandwidth and the complexity of the mission.

IAI sells MultiFlyer only for

"The human operator manages the fleet, but can take over a single drone using a smartphone"

non-military use and declined to comment about potential military applications. It features an optical navigation system that doesn't rely on GPS, making it suitable for military situations in which signal jamming might be an issue.

Gary Mortimer, an expert on drones based in the UK, says the technology has great potential for tasks such as infrastructure inspection, but notes that current US regulations require special arrangements for single-pilot, multi-drone operations. ■

David Hambling

Humans

Earliest use of controlled fire

Stone tools and blades were shaped with heat at least 300,000 years ago

Michael Marshall

ANCIENT humans used controlled fire to modify their stone tools at least 300,000 years ago.

Previously, the oldest hard evidence of controlled fire use was from Pinnacle Point in South Africa, 164,000 years ago. "We just doubled it," says Filipe Natalio at the Weizmann Institute of Science in Israel. He and his colleagues studied 300,000-year-old flint tools from the deepest layer of Qesem cave in Israel. The cave was occupied between 420,000 and 200,000 years ago, and the people who lived there regularly lit fires.

Careful heating can change the crystal structure of rocks and make them easier to shape into tools such as blades. However, until now it has rarely been possible to determine which stone tools have been heated. Some bear characteristic fractures, which indicate they were heated, but these don't always form.

"It can also be misleading," says Mareike Stahlschmidt at the Max Planck Institute for Evolutionary Anthropology in Germany. That is because stones also fracture when they freeze.

Natalio's team has developed

a method that uses spectroscopy to examine the atomic structure of stone tools, revealing any alterations caused by heating.

"We can see fire where you don't see it visually," says Natalio. The team found that many of the stone tools from Qesem cave had been heated. Primitive flakes were heated to over 400°C, but the more advanced blades were heated more gently, to temperatures of around 250°C (*Nature Human Behaviour*, doi.org/fcf7).

These lower temperatures were

less likely to shatter the blades when people worked them, but also required more control over the fire. Natalio says the blades probably weren't placed directly in the fire, which would be too hot, but instead buried in sediment with a fire on top – a trick some people still use to slow-cook large pieces of meat.

"Such heat treatment would

Stone blades unearthed from the deepest layer of Qesem cave in Israel



FILIPE NATALIO

indicate complex behaviour," says Stahlschmidt. "People are intentionally changing the properties of a raw material to get what they need."

It is unclear who the inhabitants of Qesem cave were. The oldest evidence of *Homo sapiens* is from around 300,000 years ago in Morocco, and there is no evidence of modern humans outside Africa before 210,000 years ago. There is good evidence that Neanderthals had control of fire, and other hominins may also have done so. The cave has only yielded one hominin tooth, and it is so badly eroded that the species of its owner can't be identified.

It also isn't clear when ancient humans first began using fire, and when they learned to control it, as opposed to opportunistically making use of natural wildfires.

Ash and burnt bone have been found in Wonderwerk cave in South Africa and dated to 1 million years ago, and fires burned at Gesher Benot Ya'aqov in Israel to nearly 790,000 years ago. But Stahlschmidt says neither site has unambiguous evidence for controlled use of fire. ■

Climate change

Using renewables seems to cut carbon more than nuclear

NATIONS that embraced renewable energy have significantly cut their carbon emissions, but those pursuing nuclear power have failed to do so, researchers have found.

Nuclear and renewables are seen as two key ways for governments to decarbonise, but whether one is more effective for tackling climate change hasn't been fully addressed. With several countries on the brink

of deciding whether to back new nuclear plants to meet carbon targets, the answer matters.

To find out, Benjamin Sovacool at the University of Sussex, UK, and his colleagues looked at carbon dioxide emissions and GDP over 25 years. They found that in 117 countries using renewables, CO₂ emissions per capita dropped from 0.69 tonnes on average during 1990 to 2004 to 0.61 tonnes in 2000 to 2014. These latter figures include a further six countries.

However, in the same periods, the 30 countries using nuclear stayed

largely flat, shifting from an average 0.52 tonnes of CO₂ per capita to 0.51. The two groups of countries overlap because some fall into both. Renewables included wind, solar, hydro and biomass energy (*Nature Energy*, doi.org/fcf6).

"If you're focusing on what we can do to mitigate emissions in the next 15 years, pursue renewables and not nuclear," says Sovacool.

"If you want to mitigate emissions in the next 15 years, pursue renewables not nuclear"

The reason for the results isn't clear – the work found a correlation, not a causation – but Sovacool has ideas. Nuclear power is restricted due to treaties limiting the spread of nuclear weapons, as material from reactors can be used to make bombs. Renewables aren't, enabling more countries to learn from one another, such as Germany benefiting from Chinese economies of scale on solar.

Other reasons may be that renewables are cheaper, quicker to build and more socially acceptable, says Sovacool. ■

Adam Vaughan

Physiology

Can you see into the heart by looking at the face?

Grace Browne

WE MAY BE ABLE TO TELL SOMEONE'S HEART RATE AT A GLANCE, WHICH COULD HELP US INTERPRET EMOTIONAL STATES.

Alejandro Galvez-Pol at University College London and his colleagues showed 120 volunteers videos of two people positioned side-by-side. The heart rate of one of the individuals was shown on the screen, in the form of a square that changed colour from black to red with every heartbeat.

The participants were then asked to say who they thought the heartbeat belonged to. On average, they guessed correctly 58 per cent of the time, more than would be expected by chance.

Fatima Felisberti at Kingston University London says the findings are further evidence that humans have evolved to detect changes in blood flow in the faces of people we interact with – blushing being a classic example.

We know that people can tell their own heart rate to some degree, says Micah Allen at Aarhus Institute of Advanced Studies, Sweden, "but it is really quite curious and fascinating to see that we can actually discern this information about other people, just by perceiving their faces".

This ability may help us understand the actions or intentions of other people, suggests Galvez-Pol's team (*PsyArXiv*, doi.org/fbzh).

"It could be that this ability to implicitly 'read' the heartbeats of other people from their face is something we evolved so that we can more easily align our beliefs and feelings with others," says Allen.

One limitation of the study is that the team didn't test whether people could detect a higher or lower heart rate without the on-screen prompt. "It is still a bit unclear precisely what information participants use to complete the task, but that is an interesting research question itself," says Allen. ■

Crisper

Cattle gene-edited to survive climate change

Michael Le Page



CROWN RESEARCH INSTITUTE AGRESEARCH

CRISPR genome editing has been used to create a cow with grey patches instead of black ones, so it will absorb less heat. The aim is to reduce heat stress in the animals caused by global warming – which, ironically, is in no small part due to emissions and deforestation from cattle ranching.

"Genome editing is a promising approach to rapidly improve and adapt livestock to changing environmental conditions," says Goetz Laible at AgResearch in New Zealand. "On a global scale, even modest improvements in productivity from colour-diluted cattle would translate into substantial environmental benefits."

New Zealand dairy cows already become heat stressed for nearly 20 per cent of the time they are being milked, which can halve yields. Heat also reduces fertility, says Alison Van Eenennaam at the University of California, Davis. "It's hard to get them pregnant during the heat." Dairy cows need to have a calf every year or so to maintain milk production.

Cattle with black or mostly black coats, like Holstein Friesian dairy cows, are thought to suffer more from heat stress. Laible and his colleagues decided to find out if they could benefit from lighter coats like those of some Highland beef cattle, caused by a tiny change in a gene involved in pigmentation called PMEL.

2

Calves were born with gene-edited colouring

Using standard breeding techniques to cross beef cattle with dairy cattle would result in offspring that weren't ideal for producing either milk or meat. Instead, Laible's team used CRISPR to change the PMEL gene in fetal skin cells from a male Holstein Friesian that were growing in a dish. Cloning was then used to generate embryos for implantation. Two calves were born, with dramatic changes in coloration (*bioRxiv*, doi.org/fcch).

One calf had to be put down after birth and the other died

The grey patches on this calf are intended to reduce heat stress

of an infection at four weeks old. These health issues are thought to be the result of the cloning process, rather than the genetic editing. Cloning isn't necessary to produce CRISPR-edited cows, so the researchers will avoid it when they create more calves with this trait, says Laible.

Peter Hansen at the University of Florida and his colleagues have shown that predominantly white cattle regulate body temperature better and have a lower reduction in milk yield than black cattle. So the New Zealand team's approach could work, he says, but the effect may be small.

Other teams are creating more heat-tolerant cattle by introducing a gene variant for shorter hair. The "slick mutation" has already been introduced into some Holstein cows via normal breeding.

A US company called Recombinetics has also gene-edited this trait into Angus beef cattle. The first calf, called Genzel, was born in Brazil on 14 July 2018. Angus beef cattle produce twice as much meat as the Nelore breed popular in Brazil, but can't cope with tropical heat. In theory, heat-tolerant Angus cattle could double Brazil's beef production without increasing the environmental impact.

The world's 1.5 billion cattle are experiencing more heat stress because of global warming, but they are also a major cause of climate change, with livestock farming producing about 18 per cent of global greenhouse gas emissions. ■

Archaeology

The first African to travel to the Americas?

Colin Barras

A 15TH-CENTURY skeleton buried at the first European settlement in the Americas probably belonged to an African woman. She died in her mid-20s, within about five years of Christopher Columbus's first voyage to the Americas, and decades before the transatlantic slave trade started.

"I think it's possible that she may have been the earliest known individual of African origin to participate in European efforts to establish a settlement in the Americas," says David Wheat at Michigan State University, who wasn't involved in the analysis.

Columbus first reached the Americas in 1492. The following year, he journeyed there again from Spain in a bid to establish a permanent settlement, ultimately reaching what is now the Dominican Republic and building La Isabela, the first European town in the Americas.

The colonists experienced a high mortality rate because of disease and hunger. Many ended up in the settlement's cemetery where, in the 1980s, archaeological investigations unearthed the remains of about 100 people.

Now, a team led by T. Douglas Price at the University of Wisconsin-Madison has had another look. The group examined the skeletons of 21 people and measured the strontium isotopes in tooth enamel, which are influenced by the geology of the region where the tooth's owner grew up.

Unsurprisingly, 20 of the individuals had a strontium isotopic signature matching that seen in medieval skeletons unearthed in southern Spain. But the final person – a woman in her mid-20s when she died –



had a signature more typical of someone from western or central Africa (*Current Anthropology*, doi.org/fbjz).

A decade ago, members of the same team analysed DNA taken from La Isabela skeletons that hinted at genetic markers similar to those seen in some people from sub-Saharan Africa. But the evidence was unclear, says team member Hannes Schroeder at the University of Copenhagen in Denmark. "It's proven really difficult to generate enough [genetic] data

Graveyard in what was once La Isabela, Dominican Republic

at Arizona State University. "Archaeology can be used to give us a more full and complete picture of the past."

William Keegan at the University of Florida says the idea is plausible, but adds that the strontium isotopes in teeth may change if someone spends several years in a new place. "It's also possible she was someone from Spain who lived in Africa for a period of time before going to the Americas," he says.

Assuming the woman was from Africa, John Thornton at Boston University says she may have been from the historical region of Senegambia.

"She could have been a servant or slave, but she also could have been a free person," says Wheat. "If she was married or closely associated with an Iberian man or family, that relationship probably would have been more important in determining her social status and identity than her skin colour." ■

1493

Founding year of first European settlement in the Americas

from these samples to say for certain," he says.

The new result is striking given that there is little written evidence that women or people from Africa were present on Columbus's 1493 voyage.

"So often, historical records leave out so many people, especially women and people of colour," says Kelly Knudson

Astronomy

An Earth-mass rogue planet is roaming the galaxy

Leah Crane

A PLANET that is about the same mass as Earth seems to be floating on its own through space. It is the smallest such rogue planet we have ever spotted, but there are probably many more in the galaxy.

Usually, we find planets beyond our solar system using observations of the light from the planet's host star. Rogue, or free-floating, planets have no host star, making them difficult to spot. Astronomers have only found a handful, and most are far more massive than Jupiter.

These were mainly spotted using gravitational microlensing, which occurs when a planet passes in front of a brighter object and the planet's gravitational pull bends that object's light. The size of the planet can be measured based on how long the lensing persists.

Przemek Mróz at the California Institute of Technology and his colleagues found the shortest microlensing event ever seen, lasting just 41.5 minutes, using the Optical Gravitational Lensing Experiment in Poland and part of the Korea Microlensing Telescope Network (arxiv.org/abs/2009.12377). The shortness of the event suggests the object has a similar mass to Mars or Earth, depending on how far away it is, which the team couldn't determine.

The group ruled out the planet having a star within about eight times the distance between Earth and the sun. "If there is a more distant star, we can't detect it in the light curve of the microlensing event", so we can't be entirely certain that this small world is really free-floating, says Mróz.

Astronomers expect that while systems of planets are forming, it should be fairly easy to kick small worlds out of orbit and turn them into rogue planets. "We estimate that Earth-mass free-floating planets may be as common as stars in the Milky Way," says Mróz. ■

Quantum uncertainty

Multiple companies are claiming the mantle of most powerful quantum computer ever, but who really leads the pack? **Leah Crane** investigates

QUANTUM computing firm IonQ says its new machine is more practically powerful than those of its competitors. The new device has 32 qubits. Unlike ordinary bits, which can store only a 0 or a 1, qubits can store a combination of these states, allowing quantum computers to process a much greater amount of information.

IonQ's machine doesn't have more qubits than any other computer (see "Top of the qubits", below). However, the firm says the device's quantum volume – a metric that accounts for the

Peter Knight at Imperial College London. "This will be regarded as a tremendous advance."

IonQ has managed to create a device with such a high quantum volume by trying to make qubits that are as error-free as possible. Instead of using superconducting chips that are similar to ordinary computer circuits, as many other quantum computers do, IonQ's machine uses single ions as qubits and manipulates them with lasers.

"The qubits themselves are perfect, although there are some errors that we add when we use them," says Chris Monroe, IonQ's chief scientist. The device's error rate is less than 1 per cent, he says, making it more accurate than most other quantum computers on the market.

"It doesn't have more qubits than anybody else, but they've reduced their errors in such a way that they're almost perfect, and that gives them this additional oomph, this additional power," says Knight. "With a modest number of qubits, they've achieved a great deal more."

But whether IonQ's device

"The qubits themselves are perfect, although there are some errors that we add when we use them"

number of qubits, their error rate and a few other key properties – far surpasses that of rival machines. IonQ's device has a quantum volume in excess of 4 million, compared with the previous record of just 64.

This means IonQ is closer to being able to solve practical problems. "It's not hype," says



is actually better than its rivals' isn't necessarily clear, says John Preskill at the California Institute of Technology. "I'd say the most obvious competitor is Google's Sycamore device," he says. In 2019, Google claimed that Sycamore used 53 qubits to solve a problem that couldn't be cracked in a reasonable amount of time by any classical computer, a milestone called quantum supremacy.

Monroe says the IonQ device is "sort of on the edge" of achieving quantum supremacy. A classical

IonQ's ion-trap quantum computer has 32 qubits, but some rivals have more

supercomputer could still solve the problems that this quantum computer can, yet it might take weeks to months to do so, he says. "But as long as the quantum computer is faster, it's still useful."

"If you want to measure power of a quantum computer in terms of how difficult it is to simulate with a classical computer, it doesn't smell right to claim that a quantum computer with 32 qubits is more powerful than a 53-qubit device," says Preskill. It is hard to directly compare the two because they are fundamentally different types of quantum computer, but the difficulty of simulating a quantum computer grows exponentially with an increase in the number of qubits, he says.

Monroe says IonQ is already working on doubling the number of qubits in its device, which will make it a billion times harder to simulate with a classical computer. Since the company has focused on producing high-quality qubits, even increasing their number by a small amount should provide a significant boost to quantum volume. ■

Top of the qubits

"By far the largest and most powerful quantum computer in existence today" has been announced by quantum computing firm D-Wave, but others in the field point out that both classical and quantum computers exist that exceed its capabilities.

The device has 5000 qubits, more than any other quantum computer currently available, yet researchers say it has limited use. "What they've built isn't quite a quantum computer, it's a piece of bespoke hardware that can solve a particular type of problem easily,"

says Ciarán Gilligan-Lee at University College London.

D-Wave's device is called Advantage, but doesn't achieve quantum advantage, a technical benchmark that would represent a major breakthrough. "Quantum advantage means demonstrating that, in a realistic setting with a practical problem, you can do something no classical computer could do," says Gilligan-Lee. "We have not done that yet."

D-Wave hasn't published any results showing that its device can outperform other computers,

whether quantum or classical. Mark Johnson at D-Wave says the firm isn't trying to achieve quantum advantage, but rather to provide customers with an advantage over the systems they currently use.

"With many of these things, you could probably get a team of PhD computer scientists and they could probably come up with a classical algorithm that could surpass [the Advantage system] for a particular problem, but not every company is going to have access to an army of computer scientists," he says.

Psychology

Human chewing can annoy us more than a chomping animal

Jason Arunn Murugesu

PEOPLE who are annoyed by the sound of chewing find it less vexing if they think it is made by an animal or other non-human source.

"I think most people can relate to having some level of aversion to certain sounds," says Miren Edelstein at the University of California, San Diego, but people with severe cases are said to have a condition called misophonia. "Individuals with misophonia experience aversion that is so severe and debilitating that it has a major impact on their well-being and quality of life."

Edelstein and her colleagues wanted to find out if it was just the sounds that people find distressing, or if the wider context of a noise can influence how it is perceived. The team looked at 20 self-identified misophonics and a control group of the same number of people.

The team first presented them all with audio clips of human chewing and clips that sounded similar, such as an animal chewing or someone walking on gravel.

They then repeated these sounds, but this time explained what the participants were hearing – though they sometimes lied. In this second round, the participants were asked to say what they thought was producing the sound.

Finally, the team showed the participants the video that went with each audio clip, revealing the full context. In each round, participants were asked to rate how uncomfortable each sound made them feel on a scale from 1 to 10.

Those with misophonia found human chewing sounds three times as unpleasant on average as those without the condition. Misophonics also found human chewing 36 per cent less annoying if they incorrectly believed the noises came from non-human sources, as opposed to when they correctly identified the sounds ([bioRxiv](https://doi.org/fb3m), doi.org/fb3m).

Analysis Biodiversity

Biodiversity summit draws pledges from global leaders

To save nature, countries will need to agree to ambitious targets and stick to them, says Adam Vaughan



CARL DE SOUZA/AFP VIA GETTY IMAGES

AT A virtual UN biodiversity summit last week, global leaders gathered to tackle the destruction of nature. "We need to respect nature, follow its laws and protect it," said China's president Xi Jinping. However, he stopped short of a biodiversity equivalent of his recent climate announcement, when he pledged that China would achieve carbon neutrality before 2060.

UN secretary general António Guterres said "humanity is waging war on nature", arguing that governments should put nature at the centre of covid-19 recovery plans. Narendra Modi of India and Boris Johnson of the UK were among many other leaders lining up to declare the importance of protecting the natural world.

This followed a 10-point "leaders' pledge for nature" signed by the EU, Canada, Mexico, Costa Rica, Kenya, New Zealand, the UK and dozens of other countries. The promises included shifting to more sustainable agriculture and, vitally, setting "transformational" new biodiversity targets.

The reason for this wave of pledging and speechifying is a landmark biodiversity summit in

Kunming, China, next year, called COP15, where governments are due to hash out new targets for 2030 on everything from slowing extinctions to stopping pollution. The pandemic-postponed event is the nature equivalent of the 2015 Paris climate summit.

The need for far greater action has been on stark display lately. Reports last month have shown all 20 of the biodiversity targets the world set for 2020 were missed, animal populations are down 68

68%

The amount animal populations have declined since 1970

per cent since 1970 and two in five plant species face extinction. "By and large, we are not doing well," said Elizabeth Mrema at the Convention on Biological Diversity on 28 September.

She has said the sheer number of heads of state speaking is a sign of progress. But will words make a difference to species being lost and habitats being polluted?

Robert Watson, former chair of IPBES, the international science

A burnt area of Amazon rainforest reserve in Para, Brazil

group that last year warned a million species are at risk of extinction, says: "It's important. Given the COP has been delayed, having today's summit keeps the issue in front of governments, the public and the business community. I thought the leaders' pledge was extremely good."

The pledge wasn't signed by China, the US, Brazil, Russia and Australia, countries home to rich biodiversity. Watson says it was no surprise Brazil and the US didn't sign – their leaders have undone environmental protections – but China's omission is disappointing, given it is hosting COP15.

The proof of last week's goodwill will be in targets agreed in Kunming. A recent draft of these floats the idea of having some form of protection on 30 per cent of the world's land by 2030, which would double the current protected area, meaning a dramatic acceleration is needed for that goal alone. And it is only one of 20 targets.

There are signs that some governments are willing to act. On 28 September, the UK was one of several countries to pledge to protect 30 per cent of land by 2030, up from 26 per cent in England today. Conservationists welcomed the move, but told *New Scientist* that far more work is needed to improve the health of animals and habitats in existing protected areas. Biodiversity in these areas can be worse than in non-protected areas.

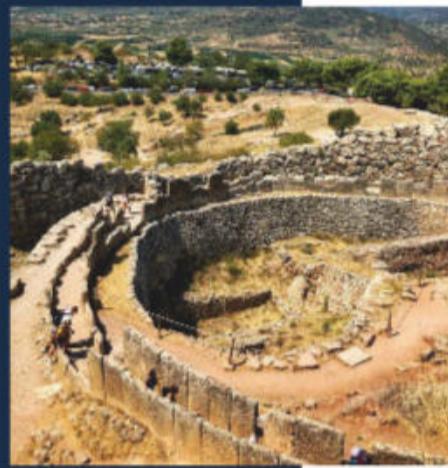
Watson says success will need national pledges, akin to the ones countries put forward on carbon cuts in 2015. "It's great to have global goals, but we need national action," he says. ■

Thinking about exploring the world again?

While travel has been little more than a dream over the past few months, we know that many of you are now eager to pencil in your next adventure and as we've had so much interest from our readers recently, we've decided to start taking bookings again for later next year, with flexible deposits and safe touring protocols in place.

Whether you're ready to book or just want to carry on dreaming for a little longer, we hope you enjoy browsing some of the new tours we've created for 2021.

Visit newscientist.com/tours
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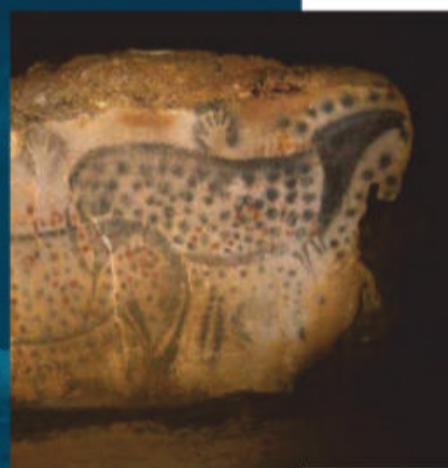


RUSSIA

Saint Petersburg: The history of Russian science

7 days | 27 August and 8 Oct 2021

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ANTARCTICA

The science of the Antarctic: A fly-cruise expedition

17 days | 17 November 2021

A unique fly cruise expedition exploring the world's largest ocean sanctuary. Follow in the footsteps of the great explorers, whilst marvelling at imposing icebergs, ancient glaciers and ice floes onto volcanic beaches.

Zoology



BLICKWINKEL/ALAMY

Nearly blind mole rats have eyes that sense magnetism

SOME mammals are able to detect magnetic fields, but where the sense originates has long remained elusive. Now, the organ that houses magnetic sensors in mole rats has been identified.

Kai Caspar at the University of Duisburg-Essen in Germany and his colleagues have found that the Ansell's mole rat (*Fukomys anselli*) uses its eyes for magnetoreception.

Previous research has suggested the eyes of this species of mole rat, which is nearly blind, may contain magnetoreceptors. In birds, the eye is also linked to magnetic sensing.

To confirm this, the team studied 40 Ansell's mole rats, 22 of which had their eyes removed. Those without eyes didn't change their foraging or socialising behaviour. However, there was a change in the orientation of nests they built.

Many rodents build nests in particular orientations. The researchers placed the Ansell's mole rats in a circular arena in which magnetic fields could be used to artificially change the direction of magnetic north. They found that the animals with intact eyes always built nests in the magnetic south-eastern quadrant of the arena.

Those without eyes built their nests in random orientations, suggesting that their magnetic sense had been disrupted (*Journal of the Royal Society Interface*, doi.org/fb3k).

This is the first time that a specific organ housing magnetoreceptors has been identified in mammals. The actual receptors haven't yet been identified, but the researchers think they may contain magnetite, a magnetic iron ore. Donna Lu

Solar system

Ice and sun help to shape a flat world

THE oddly flat surface of Arrokoth, an object on the edge of the solar system, may be the result of material boiled away by the sun.

This body, more than 6 billion kilometres from the sun in the Kuiper belt beyond Neptune, was visited by NASA's New Horizons spacecraft in 2019. The probe took images that revealed Arrokoth as a strange world with two flattened lobes joined by a neck.

Now Yuhui Zhao from the Chinese Academy of Sciences and her colleagues think they know how this strange shape came to be: the sun turned ices on Arrokoth's surface known as super-volatiles from solid to gas – a process known as sublimation – when it first formed 4 billion years ago.

Super-volatiles are ices that have a particularly low sublimation point. Carbon monoxide, for example, sublimates at about

-240°C. While it is unclear which ices would have been present, Arrokoth's distance from the sun and resulting low temperature means that only super-volatiles would probably sublime.

It is likely that this process resulted in a flattened appearance because of the way Arrokoth spins. It rotates around the path of its orbit around the sun in a way that means two sides – what are now the "front" and "back" – are exposed to the sun more than its other sides, resulting in prolonged heating on them that produced its flattened peanut shell shape (*Nature Astronomy*, DOI: 10.1038/s41550-020-01218-7).

Whether Arrokoth's shape is unique in the Kuiper belt depends on how rare super-volatiles and its unusual rotation are. "It should not be unique," says Ladislav Rezac at the Max Planck Institute in Germany, a co-author on the paper. "But that depends on these two probabilities, which we do not know." Jonathan O'Callaghan

Healthcare

Surgical risks rise for some black children

BLACK children in the US are twice as likely to die from some types of surgery as white ones are.

Brittany Willer at Nationwide Children's Hospital in Columbus, Ohio, and her team looked at US data on paediatric operations between 2012 and 2017 on 270,000 children. Among these, they concentrated on 10,425 youngsters who needed a second emergency operation to deal with surgical

complications, looking for any racial disparities among them.

They split these children into four risk groups, based on surgical history and illness, and found that high-risk black children were twice as likely to die from these kinds of operations as white children were. Intermediate-risk black children were 1.9 times as likely to die. Low-risk groups showed no differences.

"It is well-known that African-Americans have poorer surgical outcomes than whites. It is likely due to a complex interaction of factors such as social determinants of health, access to high-quality speciality care and implicit biases," says Willer, who presented the work at a virtual meeting of the American Society of Anesthesiologists on 3 October.

"These findings are no surprise as black-white racial disparities have been historically persistent for every age group," says Gwenetta Curry at the University of Edinburgh, UK. Jason Arunn Murugesu



PHILIPPE LISSAC/GETTY IMAGES



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Really brief



MARCELLA CORCORAN

Plants face 'age of extinction'

Some 40 per cent of Earth's plants are at risk of extinction, twice as many as previously thought, while many fungi are also under threat. "We are living in an age of extinction," says Alexandre Antonelli at the Royal Botanic Gardens, Kew, in London, which puts out an annual report on the state of the world's plants.

Zoombombing is an inside job

Online meetings are being disrupted by insiders, not hackers. Chen Ling at Boston University and her colleagues analysed requests to engage in Zoombombing. About 70 per cent of people making such requests on the forum 4chan had legitimate access to the meetings involved (arxiv.org/abs/2009.03822).

Big bottom helps runners win gold

A large gluteus maximus, the muscle that forms your bottom, is key to achieving top running speeds. The volume of this muscle accounts for 44 per cent of variability in sprint times among athletes (*Medicine & Science in Sports & Exercise*, doi.org/fb3g).

Bioengineering

New kind of artificial blood vessels made

ELECTRONIC blood vessels created from metal and plastic could be used to replace arteries damaged by cardiovascular disease.

Xingyu Jiang at the Southern University of Science and Technology in Shenzhen, China, and his team made the vessel by printing a layer of liquid metal ink, containing gallium and indium, onto a flexible polymer membrane. The metal functions as an electrode.

Conservation



GPS-equipped decoys could help crack turtle egg poaching

FAKE eggs can be used to track the movement of sea turtle eggs illegally removed from beaches.

Helen Pheasey at the University of Kent in the UK and her colleague used GPS-enabled decoys (pictured) to follow the trafficking of eggs in Costa Rica. The decoy egg, called InvestEggator and made on a 3D printer, was developed by conservation organisation Paso Pacífico to fight wildlife poaching.

The fakes resemble turtle eggs in size and shape and contain a GPS transmitter, SIM card, charging ports and a battery. The team placed one decoy into each of 101 turtle nests on four beaches in Costa Rica. This

The group then rolled up the polymer into a cylinder to create a "blood vessel" about 2 millimetres wide. The team showed that sending electrical pulses to the electrode stimulated living endothelial cells, which line real blood vessels, to gather and proliferate on the inside of the artificial version. Engineered vessels that encourage this process are less likely to result in blood clots, the group says.

The vessel could also be made more permeable by applying an electrical field to it to deliver drugs to neighbouring cells. The

team was able to use this to deliver a green, fluorescent protein to blood vessel cells around the artificial vessel.

To test how well these vessels work in living systems, they were used to replace arteries taking blood to the brain and face in six rabbits. Over three months, they allowed sufficient blood flow to both regions and didn't produce an inflammatory response. The researchers also noted that the new vessels functioned as well as natural carotid arteries, with no sign of narrowing (*Matter*, doi.org/fb3r). DL

Technology

Wasp-like tube could help extract tumours

A SURGICAL device inspired by parasitic wasps could make it easier and less painful to remove certain tumours and blood clots.

Parasitic wasps inject their eggs through a long, thin, tubular organ called an ovipositor into living hosts. The organ's blade-like valves, which run the length of the tube, slide up and down, moving the eggs using friction.

Aimée Sakes at Delft University of Technology in the Netherlands and her team have built a tool based on the same principle to extract bits of tissue, like tumours and blood clots, from people.

Currently, surgeons performing minimally invasive surgery can remove tissue by sucking it out through a tube, but this is more difficult if the tube is made longer and thinner to reach further or to allow for smaller incisions.

The new device is 7 millimetres wide, 8 centimetres long and lined with six independently moving steel blades. Its ability to transport material was tested by extracting various consistencies of gelatin or mince to mimic human tissue.

It worked well regardless of tube length, but is slower than suction (*Frontiers in Bioengineering and Biotechnology*, doi.org/fb3q). Christa Lesté-Lasserre

Signal Boost

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



The Society of Occupational Medicine (SOM) was established in 1935 as a professional charity to support occupational and workplace health. It informs policymakers, employers, and employees as to evidence-based approaches to workplace health, supporting improvement in current policies.

Through its journal, *Occupational Medicine*, SOM tackles the most pressing issues facing occupational and workplace health today such as reviewing the evidence on airborne transmission of covid-19, the best approaches to control covid-19 transmission in hospitals and support staff. SOM also supports potential authors and trains article reviewers.

During the covid-19 lockdown, SOM campaigned to protect health care workers, highlighting the conflict between their duty to care for patients and the need to protect themselves and loved ones. SOM has supported the development of more effective policies on

issues such as PPE with regulators and Government and the need for universal access to occupational health has been highlighted during this covid-19 crisis.

Recently, SOM convened multidisciplinary expert groups, producing evidence-based toolkits for people returning to work with organisations such as Acas, the Chartered Institute of Personnel Development, the mental health charity Mind and Business in the Community. Currently, with partners, a "covid age" tool is being developed that helps assess an individual's overall vulnerability to covid-19.

SOM commissions leading researchers at universities and research institutes to improve understanding of key workplace health issues.

Recent reports include a research synthesis around the mental health of doctors and the value of occupational health research.

- SOM is a small charity and needs support to:
- Fund research that promotes, protects, and improves good health at work during and after the covid-19 pandemic.
 - Increase its capacity to offer evidence-based guidance on key issues (such as protecting gig economy workers) to Government.
 - Draw together multidisciplinary expertise to identify and tackle new issues arising in the workplace such as the best way to improve mental health at work.

Want to help?

For more information go to som.org.uk. To donate, telephone 0203 910 4534 or email finance@som.org.uk. We can claim gift aid for UK taxpayers

The columnist

Chanda Prescod-Weinstein on threats to astronomy **p24**

Aperture

A view of Earth from the International Space Station **p26**

Letters

If life does exist on Venus, we must be very careful **p28**

Culture

Stephen Hawking is remembered in a friend's memoir **p30**

Culture columnist

Wasteland 3 is full of hard choices, says Jacob Aron **p32**

Comment

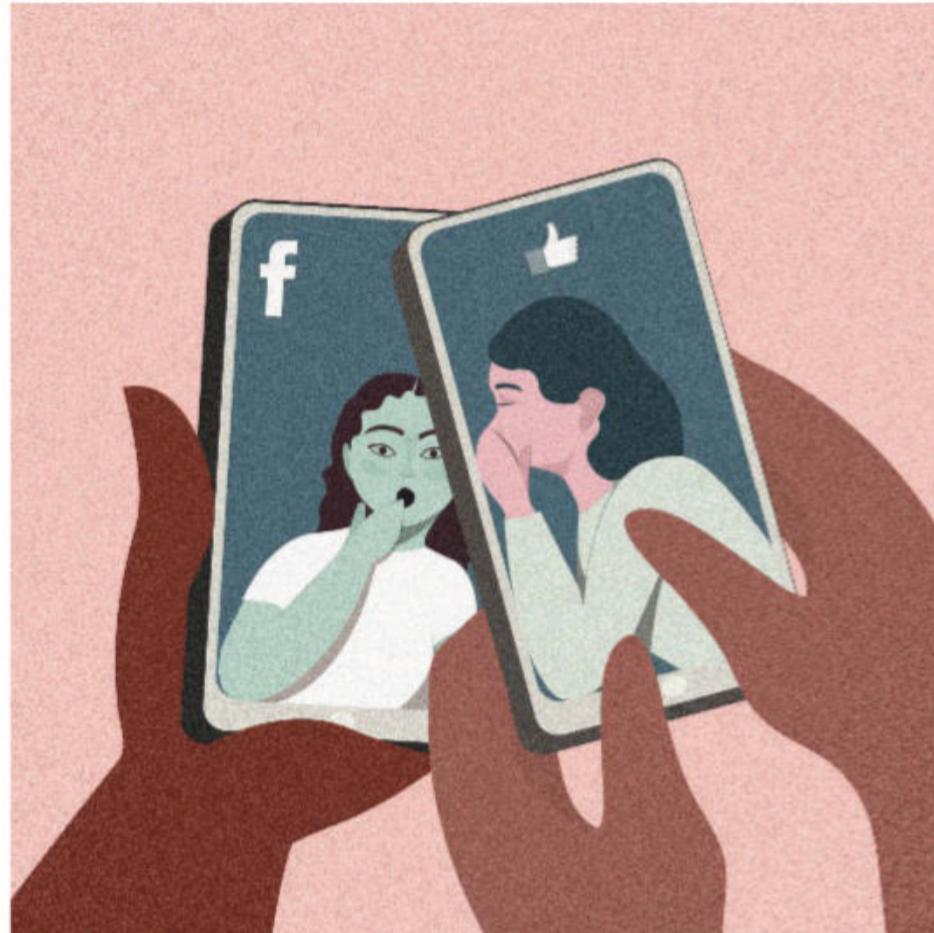
Failure on fake news

Facebook has long promised to get to grips with misinformation on its platform, but its attempts so far have been poor, says **Donna Lu**

IT IS less than a month until the US presidential election, and Facebook's misinformation problem is as rampant as ever. Despite pledges from the social media firm to tackle hate speech and false content on its platform in the wake of interference during the 2016 US elections, progress has been glacial.

In a fraught year marked by the coronavirus pandemic, widespread protests over racial inequality and severe wildfires in the US, the consequences of fake news are more serious than ever. According to one estimate, health misinformation on Facebook has been viewed 3.8 billion times in the past year. A Cornell University study released on 1 October suggests that US president Donald Trump has probably been the largest single driver of coronavirus misinformation. The researchers analysed 38 million English-language articles published by traditional and online media between January and May that covered prominent misinformation topics.

They found that mentions of Trump comprised just under 38 per cent of the "misinformation conversation". The most prevalent topic was bogus miracle cures for covid-19, driven in part by Trump's touting of hydroxychloroquine – a drug that has been shown not to have any beneficial effects for covid-19 – and his speculation that using disinfectant internally could treat the virus. Trump has since been diagnosed with covid-19.



Facebook has been under widespread scrutiny for its failure to moderate content and its continued policy of not fact-checking political ads. After the chaotic first US presidential debate, the Trump campaign ran hundreds of Facebook ads peddling a conspiracy theory that Democratic candidate Joe Biden wore an earpiece during the debate. Within a day, these had reached around 10 million of the platform's users.

Last December, Facebook pledged \$130 million towards an oversight board that would have the power to independently moderate content posted to the

platform. Once active, the board will hear appeals from individual users over content removal decisions. The first members were announced in May, but the board still isn't operational. In July, the board announced it wouldn't be up and running until late autumn.

Even if it launches ahead of the US election, it is unclear what effect arbitration from the board would have on the sheer quantity of hate speech and misinformation circulating daily on Facebook, given that decisions could take up to three months to adjudicate.

In July, major advertisers including Coca-Cola and Unilever



Donna Lu is Australasia reporter at New Scientist. She tweets @donnadlu

participated in a boycott of advertising on Facebook and Instagram, as part of a Stop Hate for Profit campaign protesting against the platform's inaction on hate speech and misinformation. It was the largest advertiser boycott in Facebook's history, but when the firm's several million advertisers are taken into account, it wasn't very damaging to the company's bottom line.

"We're not gonna change our policies or approach on anything because of a threat to a small per cent of our revenue, or to any per cent of our revenue," Facebook CEO Mark Zuckerberg told staff ahead of the protest.

Last week, civil rights campaigners and academics including Jonathan Greenblatt, CEO of the Anti-Defamation League, and Yael Eisenstat, former head of election integrity operations for Facebook's political ads, launched what they call the "real" Facebook oversight board. Their aim is to hold the platform to account around election-related issues, such as misinformation and voter suppression.

Despite scrutiny, advertising boycotts and public pledges, however, Facebook has failed to make any significant improvements since the last US election. It seems that nothing short of government regulation will make a real difference. ■

Field notes from space-time

Going up in smoke California's wildfires came worryingly close to burning down a treasured observatory. Sadly, fires aren't the only threat to astronomy, writes **Chanda Prescod-Weinstein**



Chanda Prescod-Weinstein is an assistant professor of physics and astronomy, and a core faculty member in women's studies at the University of New Hampshire. Her research in theoretical physics focuses on cosmology, neutron stars and particles beyond the standard model

Chanda's week

What I'm reading

*I have begun what is likely to be a year-long trek into Jeffrey C. Stewart's 944-page *The New Negro: The life of Alain Locke*.*

What I'm watching

*My friends and I recently finished all of the *Insidious* films and really enjoyed them.*

What I'm working on

I am in the closing stages of editing what will be the final draft of my book!

This column appears monthly. Up next week: Graham Lawton

AS a teenager, I read Dennis Overbye's history of cosmology, *Lonely Hearts of the Cosmos*. I was fascinated by the stories of now-dead men clashing, sometimes angrily, over measurements of what we would come to call the Hubble-Lemaître constant, which measures the rate of expansion of space-time.

Georges Lemaître first connected this idea with astronomical observations in 1927, and Edwin Hubble published the idea in English – along with substantive data to support it – in 1929. To achieve this, Hubble used the 2.5-metre Hooker telescope at Mount Wilson Observatory, which was state-of-the-art equipment at the time. Mount Wilson is in California's San Gabriel mountains, which are just north-east of where I grew up, east of downtown Los Angeles.

A few weeks ago, I wept while reading an open letter from the observatory's chairman Sam Hale about a fire that was approaching the facility where Hubble changed how we saw the universe. Hale didn't know if the observatory would still exist the next day, as the Bobcat Fire raged through the Angeles National Forest. I had to go to bed knowing I would find out in the morning if the facility and the many LA county TV and radio communications towers nearby had survived.

For the next two weeks, I went through that cycle repeatedly – bad late-night news about an approaching fire would arrive and an urgent search for webcam footage would ensue. Each time, as I watched the flames nearly lick the observatory, I thought about fire as a natural phenomenon in the universe. Fire is hot gas and sometimes plasma, one of the natural states of matter. Our sun is a large ball of gas and plasma

produced by continuous nuclear explosions. The flames of our sun are magnificent and beautiful, so different from the ones that have ravaged California.

At the time of writing, the observatory has made it through the fire, which is now around 60 per cent contained. Yet Bobcat came within 6 metres of its structures. Towards the end of this saga, the *Los Angeles Times* published an editorial proposing that the observatory is probably going to burn down someday, given the perennial fires that have been worsened by California's new

"This year, it sunk in that there is nothing stopping Amazon and SpaceX from blighting low Earth orbit with satellites"

normal under climate change. Meanwhile, my mother tells me that the air around LA may not clear up for another month, making it harder for people to breathe and to get a clear view of the night sky.

Until last month, I hadn't thought too much about the extent to which fire was going to become a long-term disruption to astronomy. Yet the western US has been covered in fire or smoke for what feels like months now. The climate catastrophe has hurt so many people, and in 2020, it has finally hit astronomy too. Hooker hasn't been the world's largest telescope since 1949, but it is still a popular destination for non-scientists who love to stargaze, and budding students of astronomy can still make good use of an instrument that size.

Climate change isn't the only human activity that threatens

astronomy. This year, it sunk in that there is nothing stopping SpaceX and Amazon from blighting low Earth orbit with their new satellite constellations, forever altering our capacity to see the universe from our planet's surface. Facilities like the Vera C. Rubin Observatory, where I am a member of the dark matter working group, must now plan to have all of their future images of distant galaxies and other objects disrupted by thousands of satellites that make image analysis much harder.

The day I read Hale's letter was the same day it became public that Venus may have life. As I read press coverage of the announcement and wondered whether we would rush to send spacecraft there, I thought about the push to build the Thirty Meter Telescope on Mauna Kea in Hawaii despite the objection of many Native Hawaiians, and also NASA's recent announcement about plans to mine the moon. We seem to leap from one planet-scaping moment to the next, some that we think we want to happen and others that we are aggrieved by. All of them are products of human hubris.

I don't believe in the supernatural, which means I understand that whether the winds blow in a way that helps the fire burn the observatory is somewhat random and in the moment. Fire is a natural and even important occurrence, one that Native Americans knew how to manage far better than the settler colonisers who took over their land. Like colonialism, the fact that the climate is getting warmer and the conditions for fire were so heightened isn't an accident. It is a choice that a small group of humans has made on behalf of everyone else over and over again, and it threatens us all. ■

15 October 2020 6pm BST/1pm EDT

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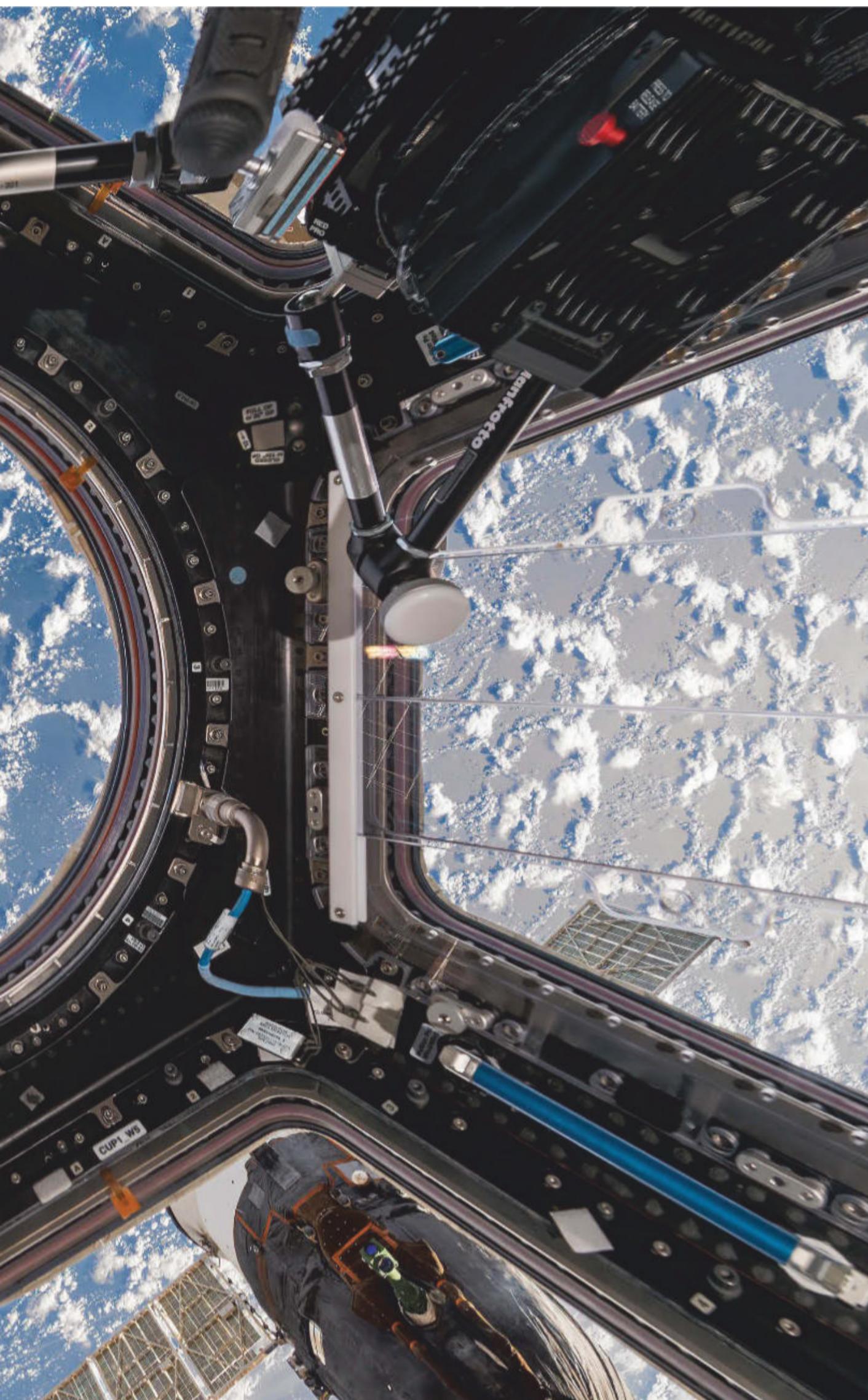
With the pandemic predicted to exacerbate mental health issues, psychologist and podcaster Kimberley Wilson's guide to protecting long-term brain health has never been more important. Join us for this online lecture to hear how lifestyle habits can make a difference, discover the science underpinning them and get practical advice to use right away.

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Super sea view



Photographers **Roland Miller** and **Paolo Nespoli**. Image courtesy of NASA and ASI

EARTH's vast oceans look particularly spectacular when glimpsed through a flurry of wispy clouds from the International Space Station as it orbits 400 kilometres above the planet. This collaborative shot taken from Cupola, the ISS's observation module, was created by Chicago-based photographer Roland Miller and Italian astronaut Paolo Nespoli.

The module's seven windows allow astronauts to observe spacewalks and other operations outside the ISS. They are also ideal for enjoying panoramic views of Earth and space. Cupola's outlook, especially from its 80-centimetre central window, is a massive improvement on the small portholes astronauts used before the module was installed in 2010.

This image is one of 200 in *Interior Space: A visual exploration of the International Space Station* by Nespoli and Miller. The book documents the workings of everything from the ISS's labs and equipment to its research facilities on Earth. The shots of the space station's interiors were taken by Nespoli under Miller's direction.

Miller says the book's photos "tell a broad visual story of the overall ISS program". *Interior Space* is being published by Damiani to mark the 20th anniversary of continuous human habitation of space aboard the ISS on 2 November. ■

Gege Li

Editor's pick

If life does exist on Venus, we must be very careful

19 September, p 7

From Yannis Gourtsoyannis and Anjaneya Bapat, London, UK

As medical microbiologists, we find the possibility of microbes on Venus tantalising. After all, our speciality could be on the verge of becoming an interplanetary discipline.

Though the existence of Venusian microbes remains improbable, it is worth pausing to consider the risks inherent in the next step of this scientific endeavour, the possible collection of Venusian atmospheric material to examine for evidence of microbial life.

We should proceed with utmost caution and within a robust regulatory framework that would constrain the whims of impulsive space capitalists or competing nation states. Currently, high-risk terrestrial pathogens are handled in specialist labs that are isolated from nearby communities and have sophisticated security. Governments accredit the labs according to international standards.

Were we to obtain samples of Venusian origin, it would be incumbent on us to create something even more secure: labs in which all sample analysis is done away from Earth, whether on purpose-built space stations or in lunar or Martian research facilities.

We may well encounter a microbial organism that is utterly unlike any pathogen we know, with incubation periods, dormancy capabilities and transmission dynamics distinct from our terrestrial experience so far.

Some of us can tell people apart by how they walk

19 September, p 36

From Ametrine Lavender, Hebden Bridge, West Yorkshire, UK

I read your article on using gait to identify people with great interest. I am prosopagnosic, or face-blind, along with up to 2 per cent of the population. Some prosopagnosics

have been using gait and posture to help us identify people for pretty much all of our lives.

Your article says that gait recognition requires a huge amount of computing power. Maybe law enforcement agencies could employ prosopagnosics alongside or instead of computerised systems?

From Andrew Shead, Tulsa, Oklahoma, US

Monty Python's Ministry of Silly Walks was ahead of its time in promoting countermeasures to gait analysis. The masked man hirpling down The Strand isn't necessarily the Lord moving in mysterious ways, but a concerned citizen who wishes to remain anonymous.

Death toll shows the chaos virus has unleashed on us

19 September, p 10

From David Rimmer, Hertford Heath, Hertfordshire, UK
Your article on the global coronavirus toll as it neared 1 million deaths shed light on the chaos endured by human beings this year.

But the information from the authorities has been conflicting, not least in the UK. The answer to your question "Can we trust the numbers?" seems to be no.

Since the UK government changed the definition of a death from covid-19 to one that occurs within 28 days of a positive test, the picture has become more blurred. At the time of writing this letter, the number of deaths in the UK from covid-19 is just under 42,000, but the number of excess deaths calculated from the UK average death rate over five years is at least 70,000 since mid-March.

Meanwhile, the death figures in Russia and China seem

suspiciously low, but that is another matter.

From Dave Evans, Johannesburg, South Africa

The figure of 1 million global deaths needs to be put into context. It is about 0.015 per cent of the global population and is equivalent to those that malaria kills in 30 or so months – every 30 or so months.

Time to launch the fight back against unreason

19 September, p 24

From John Hastings, Whittlesey, Cambridgeshire, UK
After reading Graham Lawton's worrying column about QAnon conspiracy theories, I suggest we adopt a "reality slogan" to fight back. In highlighting the inescapable fact of the laws of nature, physicist Richard Feynman came up with a good one in his report on the Challenger space shuttle disaster: "Nature cannot be fooled."

A heap of sand isn't really so difficult to define

5 September, p 36

From Allen Reynolds, Auckland, New Zealand
There is an answer to Eddy Keming Chen's question, "how many grains of sand can you take away from the heap and still call it a heap?"

"Heap" has a three-dimensional vibe as a noun, and especially as a verb. Three or fewer grains can form a layer at most, unless you are really good at balancing sand grains, and then it is a cairn. So, we get to the four that make a wee pyramid.

Yes, it would be a small heap, but so would Chen's million-grain heap – at best some 180 layers of a

triangular pyramid, a few hundred millimetres on each edge. Both insignificant on the cosmic scale.

Chen's question is similar to "how many philosophers can you remove and still call it a department?" – an experiment some managers might threaten if the staff continue to spill sand in the tea room.

We may have to step in to do the job of wildlife

26 September, p 16

From Geoff Harding, Sydney, Australia

Plummeting wildlife populations, particularly of mammals and birds, must place the forests and savannahs of the world under increasing stress due to a lower rate of soil fertilisation by faeces and a lower rate of seed dispersal.

Considering the importance of forests and grasslands for carbon sequestration, it may become beneficial to take measures such as artificial fertilisation.

Look away if you don't like the sight of wealth in space

19 September, p 51

From Albert Beale, London, UK
According to Abigail Beall's Stargazing at home article, you can see Elon Musk's SpaceX satellites with "a bit of luck". If I looked up and found my view of the night sky polluted by the sight of a billionaire's vanity project, I would consider it a misfortune.

Thanks for praising the merits of Darwin's theory

Leader, 26 September

From Graham Revill, Clachaig, Argyll, UK

You brought a lump to my throat with your piece on the triumphs of evolutionary science. At long last, a small victory in these unsettling times. I have often quoted the sentence, "The voices of evolution's detractors have largely fallen silent, worn down by the patient drumbeat of reason." Thank goodness and thank science. ■



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EPS-SG PROGRAMME SCIENTIST

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My friend, Stephen Hawking

Stubborn, funny and a man of iron behind a frail facade. This is the Stephen Hawking remembered by fellow physicist Leonard Mlodinow, finds **Gege Li**



Book

**Stephen Hawking:
A memoir of friendship
and physics**

Leonard Mlodinow

Allen Lane

WHEN physicist Stephen Hawking died in 2018 at the age of 76, the world mourned. But after the loss, there remains the enormous legacy of the scientist and the man to consider.

And what a legacy. Renowned for decades of work on cosmology and black holes, with *A Brief History of Time* selling more than 25 million copies since its release in 1988, Hawking reshaped our understanding of some of the trickiest areas in modern physics.

Among his achievements was the discovery of something now named in his honour, Hawking radiation. The once-derided idea that black holes emit radiation made him famous. He ended up widely considered the greatest mind of his time and was even dubbed “master of the universe”.

Despite the acclaim, there is still much to discover about Hawking. In *Stephen Hawking: A memoir of friendship and physics*, theoretical physicist Leonard Mlodinow offers an intimate glimpse inside the famous scientist’s life, ranging from early days at university and diagnosis aged 21 with amyotrophic lateral sclerosis (ALS, the motor neurone disease that gradually paralysed him) to his later status as an international celebrity.

After co-authoring two books with Hawking, Mlodinow isn’t short of stories, particularly from time spent working together on their book *The Grand Design*. Hawking lived a colourful life often fraught with hardship, and



NG IMAGES/ALAMY

the possibility of death was never far away. Far from letting this be a setback, it is what Hawking credits for his achievements.

“It helped me focus,” he tells Mlodinow after dinner one night.

Even so, Mlodinow admits that initially he couldn’t help but feel sorry for Hawking, living with a condition that required round-

“Over time, the initial pity Mlodinow felt for Hawking would evaporate like one of Stephen’s black holes”

the-clock care and eventually left him unable to speak or voluntarily move anything but his eyes, brows and mouth. However, writes Mlodinow, “over time all that pity would evaporate like one of Stephen’s black holes”, adding that it “occurred to me that Stephen

Hawking said his medical condition helped his focus

had proved himself to be an iron man in a frail man’s facade”.

That view becomes one that readers will also be inclined to adopt as Mlodinow looks back. On one visit to Cambridge, where Hawking studied, worked and lived for over 50 years, Mlodinow tells how Hawking keenly advocated for a punting trip.

Despite Mlodinow’s concerns about dangerous consequences, Hawking was all smiles as he directed himself onboard, signalling with his eyes and mouth, and was fed strawberries and champagne. “Danger seemed to make him feel alive,” writes Mlodinow. “In life as in physics, he liked to take chances.”

This rebellious streak permeated all Hawking’s activities.

“He ignored conventional wisdom... He drove his car wildly and recklessly, and his physics was also wild and unrestrained,” writes Mlodinow. Then there was Hawking’s stubbornness.

Mlodinow recounts a visit to a restaurant without a disabled toilet. In response, Hawking relieves himself outside in a bottle and instructs his carer (despite her embarrassment) to empty the bottle into the bushes near the kitchen. The chef was angry, but Hawking was angrier.

According to Mlodinow, Hawking knew his fame granted him better care than most people with ALS, so he pushed hard for accessibility in public spaces and was less than pleased when they failed people with disabilities.

These small stories all add up to a picture of a man who, despite his physical vulnerability, had an immense passion for life. And although physics played a large part in his life, it wasn’t his entire life. “Love is life,” he once told Mlodinow in response to his friend’s suggestion that physics was everything to Hawking.

There was no clearer demonstration of this than in the connections he forged, with colleagues, carers, partners and children – the latter, he tells Mlodinow, are his favourite accomplishment. That was the last time Mlodinow saw Hawking.

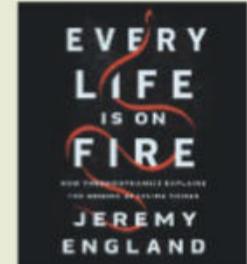
Achievement came in many forms for Hawking, who refused to be constrained in thought or deed. As Mlodinow writes: “Often we limit our chances at success by limiting the goals toward which we strive. Stephen never did that... We can get used to anything, and we can accomplish, if not anything, then at least much more than we give ourselves credit for. To grow close to Stephen was to understand this.” ■

Don't miss



Watch

Brave Blue World, a documentary airing on Netflix from 15 October, roams far and wide across six continents and the International Space Station to show the innovations that could rewrite humanity's relationship with water.



Read

Every Life is on Fire is a new book by Jeremy England, senior director of artificial intelligence and machine learning at GlaxoSmithKline. In it, he describes how the emergence of life reveals unexpected and astounding aspects of thermodynamics.



Watch

The **BFI London Film Festival** goes national for the first time, with online and cinema premieres across the UK from 7 to 18 October. Highlights include *Ammonite*, a film about palaeontologist Mary Anning, played by Kate Winslet.

Feed the world with hope

As more people face acute food insecurity, a moving play-turned-podcast reflects past and present problems, says **Bethan Ackerley**



Podcast

Seeds

No Stone Theatre

LIKE many projects, preparations for *Seeds of Hope*, the latest stage production from No Stone Theatre, were cut short by the pandemic. Inspired by Nikolai Vavilov, the Soviet agronomist who created the first global seed bank, the play has been revived as a podcast series and renamed *Seeds*.

You wouldn't notice that the audio drama has been adapted, mind, because it is a perfect fit for this medium – and is imbued with surprising new resonances.

The main plot follows four scientists in the USSR during the second world war. While Leningrad (now St Petersburg) starves as it endures one of the longest sieges in history, Irina, Dimitri, Zasha and Leonid work tirelessly to protect the 250,000 seed, root and fruit samples under their care.

Vavilov is their director, come unstuck through honesty. Asked by Joseph Stalin to develop frost-resistant crops, he tells him it would take at least 10 years. Trofim Lysenko, a purveyor of pseudoscience, assures Stalin he can produce them almost instantly. Vavilov soon disappeared.

Vavilov died in prison in 1943, possibly of hunger, the same fate that befell some scientists at his Leningrad institute. Throughout the siege, they refused to eat the samples, and many starved.

The nobility of Vavilov and his team's mission to feed the world is unquestionable. In the present day, world hunger is rising again after a decade of decline. In light

of covid-19 interrupting supply chains and nutrition schemes, the UN World Food Programme has warned that the number of people facing acute food insecurity could nearly double by the end of 2020. To highlight Vavilov's work at such a moment is incredibly moving.

Sadly, the anti-science sentiment *Seeds* explores is also very relevant. "Scientists fall in and out of favour, particularly now," warns Irina (Katy Stephens). The denialism and misinformation the researchers face have obvious equivalents today in everything from climate science to covid-19, though these parallels aren't always highlighted subtly.

But the podcast's second storyline elevates the production to great. In the modern day, a woman known as Patient (Nina Sosanya) wakes in hospital, unaware how she got there or who she is. Soon, she is searching St Petersburg for answers.

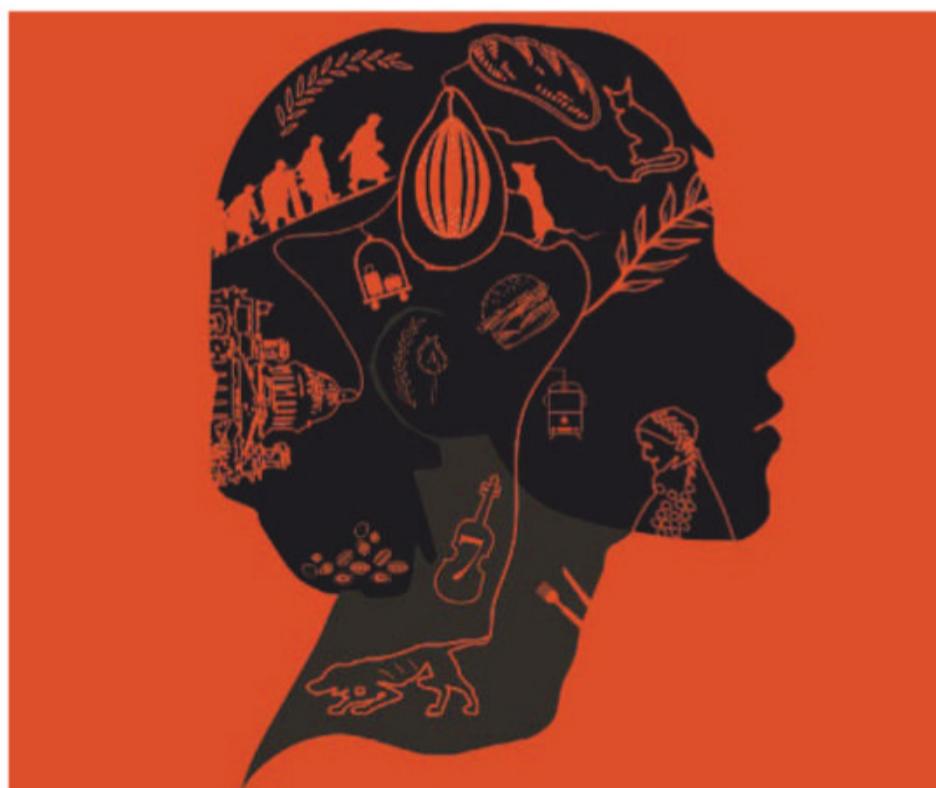
Patient shelters beneath a monument to Mikhail Lomonosov, the father of Russian science, and imagines dying in the rain. Amid the statues and squares, she feels she is being stalked by a beast on

the horizon. It is "also on a journey, like I am", she says. "Also burning and also hungry."

Care has been taken to make eerie soundscapes envelop the listener: Dimitri (Graeme Rose), for instance, is plagued by a scratching sound that will eat away at your nerves just as surely as his. Yet it is the sense that Patient is beside you, whispering thoughts of starvation in your ear, that most disconcerts.

Nick Walker's script is full of these dark imaginings, while other fragments recurring in both timelines, from Lomonosov and the city's Hotel Astoria to a series of imperilled cats, hint at revelations to come. As Patient's memory returns, the mystery of who she is and whether she relates to those four scientists begins to clear.

All in all, *Seeds* is strange and disquieting. Although I don't know how the series ends, its original title suggests that some hope, however small, will prevail. What is clear, though, is that ignorance in the face of scientific efforts to prevent suffering isn't a problem that has gone away. ■



GEMMA HATTERSLEY

Seeds is a multilayered show with the problem of feeding people at its heart

The games column

It's your call Choice is a defining feature of video games, but *Wasteland 3* takes it to extremes: play as a mime artist, say, and you will be stealthy but silent in your striped jumper and face paint. Such flexibility has a price, finds **Jacob Aron**



Jacob Aron is New Scientist's deputy news editor. He has been playing video games for 25 years, but still isn't very good at them. Follow him on Twitter @jjaron



INXILE ENTERTAINMENT



Game

Wasteland 3
inXile Entertainment
PC, PlayStation 4, Xbox One

Jacob also recommends...

Games

Fallout 3
Bethesda
PC, PlayStation 3, Xbox 360
The Fallout series was highly influenced by Wasteland, but jumped to first-person with Fallout 3, set in and around a ruined Washington DC.

XCOM: Enemy Unknown
Firaxis Games
PC, PlayStation 3, Xbox 360, Android, iOS
The turn-based combat in Wasteland 3 sees your outgunned army trying to hold off aliens. In this, it closely resembles XCOM – which is no bad thing, as it is a brilliant game.

VIDEO games offer something unique among media: choice. Putting aside choose-your-own adventure books, such as the *Fighting Fantasy* series, or films like *Black Mirror: Bandersnatch*, the chance to influence and craft a narrative is something only video games can provide. Of course, there are limits imposed by genre and software – play a first-person shooter and you won't be able to put your gun down and host a tea party – but for some games, choice is their defining feature.

In *Wasteland 3*, making those choices is a real struggle. The game is set in Colorado, some 100 years after a nuclear war, and puts you in charge of the Desert Rangers, a mercenary police force.

Your first choice is to design your squad members and, as with many such role-playing games, there is a bevy of stats, skills and hairstyles to choose from. Yet *Wasteland 3* goes further. Want to play as a mime artist? You will be stealthier in combat but unable to talk and will have to wear a striped jumper and face paint. Or perhaps you want to boost your toaster

repair skill, which lets you... repair toasters. Clearly, *Wasteland 3* doesn't take itself too seriously.

In the first hour of the game, your squad meets the Patriarch, Colorado's ruler. He sets you up with a base and asks you to hunt down and arrest his three rebellious children, who are all vying to take over his empire.

"I found a cult that worships an AI version of US president Ronald Reagan, embodied in a statue with a death ray"

This forms the backbone of the game, but there are numerous side quests. One early mission saw my team tasked with investigating noises in an apartment. I blasted down the door and was confronted by a group of clones, all vehemently insisting they were ordinary humans as they attacked.

After dispatching them using the game's satisfying and puzzle-like turn-based combat, I tracked down the man who made them, who turned out

A post-apocalyptic Colorado is full of dangerous challenges

to be a fourth-generation clone himself. Though I learned the repeated cloning was producing more and more unstable results, I was undeterred and decided to recruit him to my base. Now I can make my own clones.

The side quests are fun, but my favourite mission was part of the main story. While tracking down one of the Patriarch's children in Denver's ruins, I found the Gippers, a cult worshipping an AI version of US president Ronald Reagan, embodied in a massive statue equipped with a death ray. Well, it's what he would have wanted.

The cultists asked me to steal a cybernetic transfer module from a commune of robots because they planned to download the Reagan AI into a human body. This sounded like a bad idea to me, but I went along with it and visited the commune, where I found a charming bunch of machines that I felt didn't deserve to be harmed.

The artificial hive mind that ran the place reviewed many of my previous decisions in the game and decided I was a friend to machines. Indeed, I ultimately chose to side with them and instead transfer the Reagan AI into the greater machine consciousness. Needless to say, the Gippers weren't happy.

This ability to choose my own path means I am getting caught up in *Wasteland 3*'s story, though it does come at a cost: the game is extremely buggy and crashes frequently. The developers are working to patch the game and fix this, but it is a testament to how much I am enjoying it that each time *Wasteland 3* judders to a halt, I am eager to boot up again and keep playing. ■

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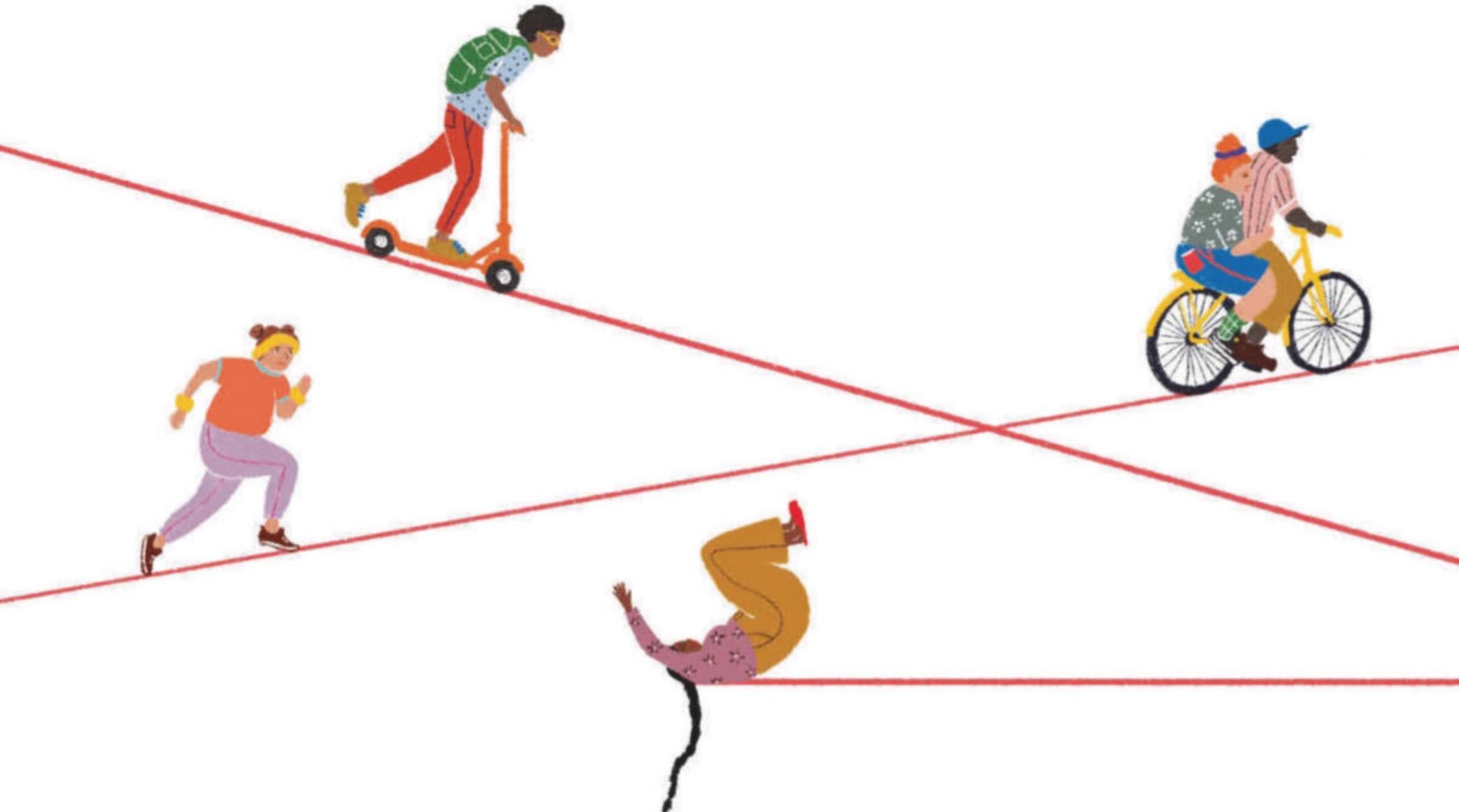
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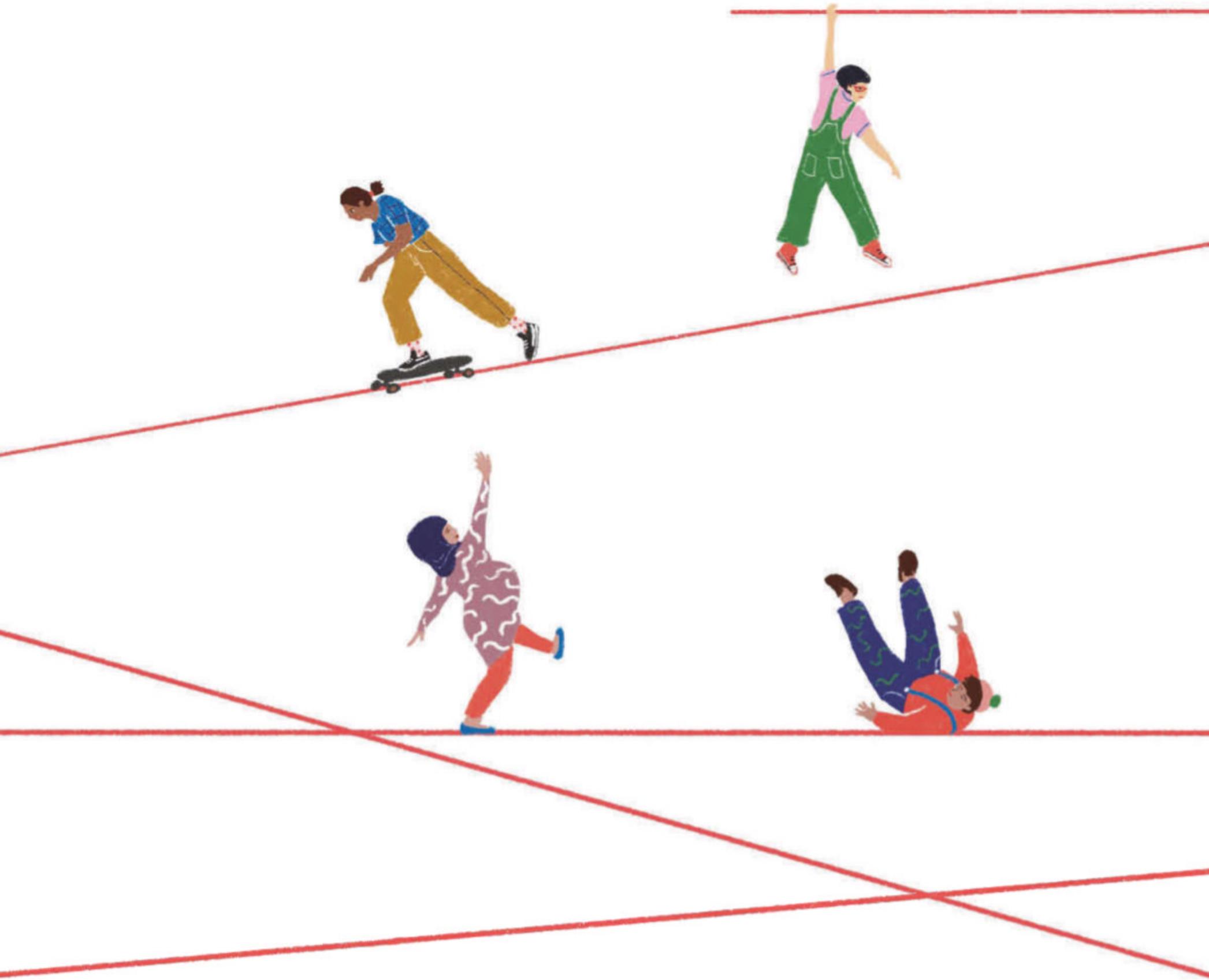
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The balancing act

We are becoming less steady on our feet, and not just in old age. That is bad news for our health, but there is plenty we can do about it, finds **Caroline Williams**



FEW things in life are as embarrassing as falling flat on your face in public. Thankfully, once we have grown out of racing around in parks and playgrounds, it doesn't happen all that often.

Don't take your grace and poise for granted, though. According to a growing body of research, our ability to balance – one of humanity's hardest-won evolutionary skills – is beginning to fade away. Around the world, falls that lead to serious injury or death are on the rise, even in the young. And most of the time, the people falling over are sober and doing nothing more complicated than standing or walking.

Globally, falls are the second biggest cause of accidental death after traffic accidents. Between 1990 and 2017, the total number of deadly falls around the world nearly doubled. Risk of losing your balance increases with

age, so you might think this simply reflects the huge number of baby boomers entering their twilight years. But recent estimates suggest the incidence of falls is rising at a rate that outstrips what would be expected from a growing, ageing population.

So what is happening? The decline in our collective stability is prompting scientists to take a closer look at the complex brain-body interactions that underpin our ability to balance, and the ways that it is tied to both cognitive and emotional processing. This system is remarkably complicated, but it turns out that the problems undermining it are relatively simple to pin down. That means there are little things we all can do to improve our balance and reduce the risk of falling.

Anyone who has unintentionally hit the deck of late can take comfort in the fact that bipedalism is far from easy – particularly the

way people do it, with our torsos balanced precariously over our legs. In fact, this is such a precarious way of getting from A to B that we are the only species on the planet that uses it as our primary mode of transport.

The human body, when standing upright, is inherently unstable, says Manoj Srinivasan at Ohio State University's Movement Lab. Our bodies are top-heavy, with a tiny base of support relative to our height. Worse, our centre of gravity sits way up at pelvis height and slightly forward of our ankles. Even without a heavy head and chest swaying around, standing up would be risky.

When in good health, we manage it by using a vast brain-body network which integrates information from our muscles, eyes and the vestibular system of the inner ear. It then engages muscles of the legs and core to make necessary adjustments to ➤

The link to mental health

Anxiety, depression, schizophrenia and other mental health disorders have been shown to affect balance in a way that influences both standing posture and gait.

Ron Feldman at Tel Aviv University in Israel says there are many potential reasons why. People with depression tend to have a more stooped posture with significantly slower movements. This increases the risk that, if they stumble, any righting movements will happen too slowly. For people with schizophrenia, symptoms of mental distress are often accompanied by a swaying posture, which has been linked to problems with integrating visual information with other components of balance. For those with anxiety, fear of falling can, paradoxically, affect posture in such a way as to make a fall more likely.

Yet this new understanding hasn't translated into new methods of diagnosis or treatment so far. "The physical elements are usually not addressed in mental disorders," says Feldman. That may be a missed opportunity, he says, because the relationship between balance and mental health might go both ways; work to improve your balance could benefit your mental health too.

posture. While the core muscles often get the credit for keeping balance, it is the leg muscles that do most of the work. "If we turned off all our muscles in our legs when we were standing, we would fall," says Srinivasan.

Integrating constantly changing information coming from the muscles, joints, senses and the environment is a massive computational challenge, and neuroscientists don't fully understand how the brain accomplishes it. They have identified a few key players, however. Perhaps the most important is the cerebellum, the small, bulbous region at the bottom of the brain that contains more neurons than all other brain areas combined. Evolutionary studies have shown that it rapidly increased in size as our ancestors began walking on two feet (see "On your feet!", page 37).

It is thought that our ability to rapidly react to different situations is thanks to the brain making predictions based on previous experience. Some neuroscientists have suggested that these predictions happen in the cerebellum. The area is linked with other brain regions including the motor cortex, which directs movement, in closed loops that shoot information back and forth. The cerebellum acts as a kind of super-fast processing outpost that supports all other operations, says cognitive neuroscientist Jessica Bernard at Texas A&M University. "You send stuff back there to process it more efficiently and it also brings information forward and helps you refine your behaviour."

Having a wobble

We have long known that the cerebellum plays a part in movement control. More recently, research has shown it has a role in fine-tuning our thoughts and emotions too. This could explain why some mental health conditions also commonly feature poor balance (see "The link to mental health", left). It could also explain studies in which people who are asked to do a cognitively demanding task don't balance as well at the same time, and those trying to balance do worse in cognitive tasks. It turns out that it might be quite apt when people invoke the

Our ability to balance is built up through trial and error – starting with our first steps

language of balance when describing feelings, such as feeling emotionally "stable" or "having a wobble".

Walking seems effortless to most people, so Srinivasan was surprised by what he found when he looked a little closer. He and his colleague Yang Wang, also at Ohio State University, attached reflective markers to the hips, ankles and feet of volunteers and used an infrared camera to track their movements while they walked on a treadmill. They found that, even on a stable surface, walking is basically a refined version of a drunken stagger or a stumble after an unexpected nudge. "Imagine you are walking along and you get pushed to the right. Naturally you would stick your right leg rightwards and apply a leftward force," says Srinivasan.

It turns out that every step, even on the smoothest surface, is a process of re-righting ourselves as our upper bodies lurch from side to side. Usually, we don't look as if we are staggering thanks to the way that the





MOMO PRODUCTIONS/GETTY IMAGES

"WALKING IS
BASICALLY A
REFINED VERSION
OF A DRUNKEN
STAGGER"

cerebellum, senses and muscles work together to make micro-corrections mid-stride. Srinivasan's studies revealed that this is largely because the brain keeps tabs on the position of the pelvis and adjusts the leg position accordingly. Srinivasan says we step, not towards where we want to go, but "in the direction of where we are falling".

Because the body's balance-control system is made up of so many interconnected parts, it can be challenged in many different ways. Uneven ground, a problem with the vestibular system, weaker muscles or greater speed can make it more difficult to keep upright and can turn a wobble into a fall. Pregnancy, illness and injuries – particularly to the legs – are among the things that can affect the inputs into the system enough to make a fall more likely. Inflammation, which is linked to obesity, stress, injury and infection, has also been shown to change balance enough to affect the way we walk, potentially increasing the risk of falls.

On your feet!

Early humans, we always thought, first struggled onto two feet after a long period of gorilla-like knuckle-walking. But a newer hypothesis suggests that our move to bipedalism began much earlier, at a time when our ancestors were still living in the trees.

According to this line of thought, about 15 million years ago, our tree-dwelling ancestors began to spend more time standing up, at first holding onto branches with their hands and gradually balancing independently. One study found that even lightly touching a moving branch with the fingertips provides enough sensory feedback to the brain to stay balanced. If this is true, then learning to balance is an integral part of what made humans what we are today.

When people's balance is tested by asking them to stand on one leg with eyes open or closed, it reveals that the ability to maintain our equilibrium begins to decline as early as our 20s or 30s. By midlife, there is an increase in the likelihood of serious falls. That seems to be getting worse. One analysis has found that fatal falls for people in the US aged between 45 and 64 jumped by 44 per cent between 1999 and 2007. This increase has researchers scrambling to figure out which aspects of this complex system are getting out of sync.

The first problem, says Dawn Skelton at Glasgow Caledonian University, UK, is that children aren't moving enough. Our stability is built up by trial and error as we learn to walk, gradually refining a toddle into effortless striding and running. The more this system is challenged in childhood and early adulthood, the more reserve we have to draw on in later life. Too much sitting, cuts in school sport and shorter break times mean ➤

How to restore your balance

Want to boost your balance? First, test it out. If you can't stand on one leg with your eyes closed for at least 30 seconds, says Dawn Skelton at Glasgow Caledonian University, UK, you should start balance training as a priority.

Standing on one leg is a good measure of balance skills because it taxes the balance system as a whole. The eyes-closed version of the test is particularly revealing because it takes vision out of the equation, showing how your muscles and the vestibular system of your inner ear alone cope with the challenge of staying upright.

"If you stand up and close your eyes, you will feel that the wobble happens in your ankles and feet," says Skelton. She suggests practising rocking forward and back between the heels and toes and also foot strengthening exercises, such as picking up a marble or pen between your toes. It is surprising how many people can't manipulate their toes,

she says. Going barefoot indoors and wearing minimal shoes can also help keep the feet fit and strong, she says.

Skelton doesn't rate pilates or slow-moving kinds of yoga as ways to improve balance. They are great for core strength and can also build up leg muscles in a way that improves standing balance, she says. But because they mostly involve assuming still postures fairly slowly, they don't tax the body's ability to combine sensory information from the eyes with internal sensations coming from the vestibular system of the inner ear. "Eyes open, head moving: that's what trains your vestibular system," says Skelton.

Hit the trail

This means that gym bunnies who train inside on static bikes and treadmills aren't doing their balance skills any favours. In contrast, road cycling and mountain biking involve balancing while looking around for

cars or trees, looking straight ahead on a static bike doesn't. Similarly, running outside involves dodging pedestrians and negotiating uneven ground. Running while staring at a screen at the gym, less so. The need to resist gravity also has to be a factor in any balance-training exercise, adds Skelton. That is why swimming isn't especially good for balance, despite the fact that you need to turn your head.

If you want to start simple and be sure that what you are doing will benefit your balance and reduce your risk of falls, the UK's National Health Service recommends practising walking sideways, crossing your feet as you do so, or standing on one leg with or without your eyes shut. Hold onto a wall for support until you are sure you won't fall. For the more acrobatic, practising standing and moving on a wobbleboard, doing slalom walks on stable and uneven surfaces and balancing on beams or logs can take things to another level.

Stationary exercises do less to challenge and improve your balance than getting out for a hike or bike ride



that young adults are hitting their 20s with a wobblier stance than they should, says Skelton. From there it is all downhill. These same factors mean the muscles we need for balance are weaker than they should be. According to one recent study, 10-year-old children in England in 2014 were 20 per cent weaker than their counterparts in 1994.

Through midlife, sedentary lifestyles become even more common, leading to a drop in strength that can make falls more likely. The trend towards sitting for longer probably accounts for some of the rise in falls in younger adults too. According to one recent study, millennials – those who reached adulthood around the turn of the century – are significantly weaker than adults of the mid-1980s. A general lack of fitness hammers in the final nail: when we do less physical activity, the balance system is left unchallenged, getting less effective by the day.

All of this adds up to a perfect storm of falling younger. “I commonly see people in their mid-40s that have worse balance than 70 or 80-year-olds,” says Skelton. Research on falls used to focus on people aged 65 and up; studies now report on falls in 50-year-olds.

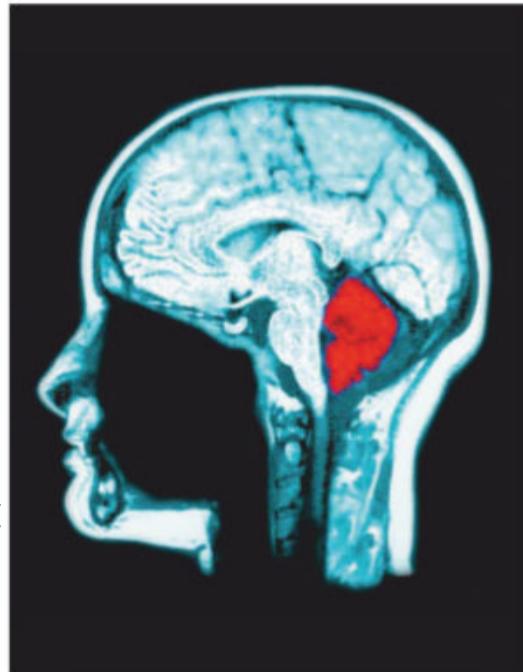
Walk the line

Age-related declines in brain function really start to show at about the age of 50, says Bernard, and the cerebellum is one of the first regions to go, particularly in women. We don’t know exactly how or why this happens, but we do know that oestrogen has a protective effect on the brain and declining levels of the hormone during the menopause might be part of the answer.

Fortunately, there are steps we can take to slow or even reverse this decline (see “How to restore your balance”, page 38). Balance training, which can be as simple as standing on one leg, sitting on a balance ball or practising walking heel-to-toe along a line on the floor, has been shown to bring improvements in young people, older adults and in those with balance issues resulting from illnesses such as Parkinson’s disease.

As if to underline the “use it or lose it” nature of balance, the more work you

CULTURA CREATIVE (RF) / ALAMY



The cerebellum (in red) increased in size in the brains of our ancestors as they began to walk upright

“YOUNG ADULTS
ARE HITTING THEIR
20S WITH A
WOBBLIER STANCE
THAN IN THE PAST”

do on your balance, the greater the improvement. The dose required for older people is around double that for the under 40s. One study found that, to see a noticeable improvement in their balance, older people needed to do 36 to 40 training sessions of at least 35 minutes, whereas people under the age of 40 needed only 16 to 19 sessions of 15 minutes. What’s more, balance and strength training can help reduce the fear of falling, which encourages further exercise, setting up a virtuous circle of improvement.

As well as physically training the balance system, there is intriguing evidence that engaging in cognitive challenges might help. This may work by engaging parts of the brain responsible for motor function and other complex tasks that are linked to the cerebellum, and by reducing the cost of thinking while walking.

The cerebellum operates on the same use-it-or-lose-it basis as the rest of the brain, so the most important thing is to give it something to do. In one study, people who did 100 days of cognitive training over a six-month period had less shrinkage of the cerebellum than those who didn’t. “Using your resources can be beneficial in terms of maintaining function,” says Bernard.

If physical and cognitive training are good in isolation, doing both at the same time is even better. Tai chi, which involves focused attention and a series of fluid physical movements, has been shown to not only improve balance, but also boost cognitive skills and reduce the fear of falling, the number one risk factor for falls.

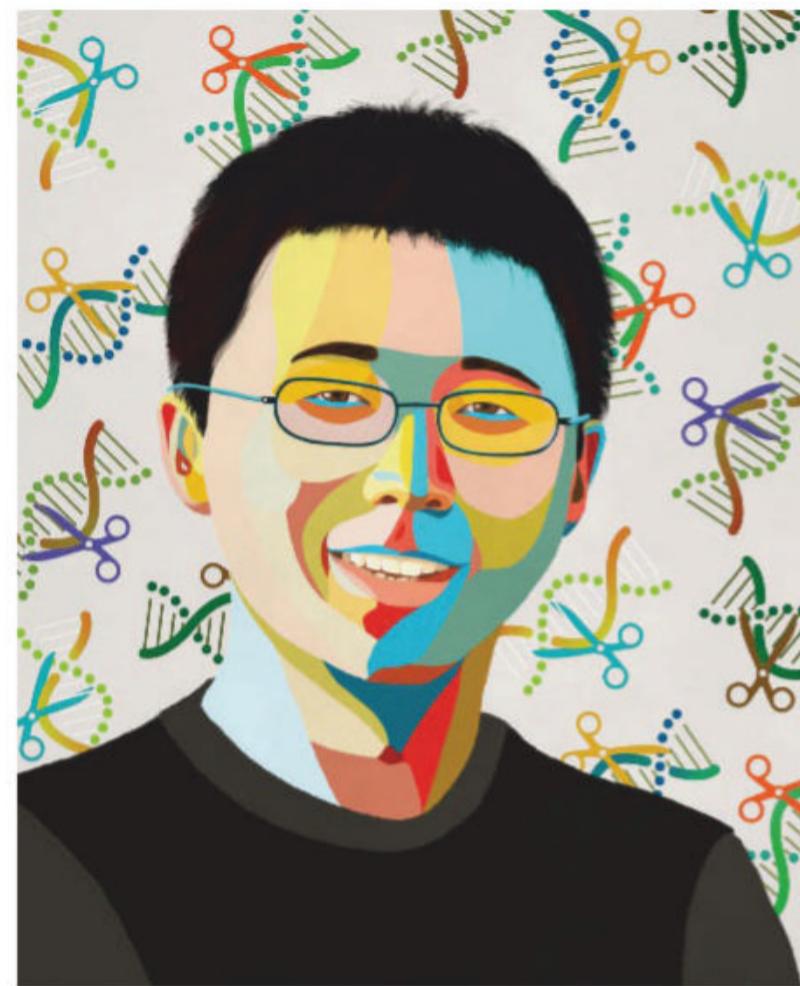
The good news, says Skelton, is that there is no need to enrol in any specific balance-related programme. “If you want to stop the rot, you don’t have to go and do a structured exercise programme,” she says. “Just any activity that challenges you to stay upright.” Whatever your age and ability, the time to start is now. ■



Caroline Williams is a consultant for New Scientist. Her book *Move: The new science of body movement and how it can set your mind free* will be published in 2021

“My parents told me I should make myself useful and not waste time”

Feng Zhang is one of the pioneers of gene editing. He tells Jessica Hamzelou how we can use it not just to battle disease, but also against hunger and even climate change



IT IS no exaggeration to call Feng Zhang one of the most groundbreaking scientists working today. In his 20s and 30s, he helped develop two revolutionary technologies. The first, known as optogenetics, involves inserting genes into brain cells to allow them to be switched on and off by shining a light on to them. This technique has helped us understand how the brain works and is being explored as a potential treatment for some neurological conditions.

The second, CRISPR, is a gene-editing technology that promises to correct a near-limitless list of human diseases. These days, Zhang has a dual appointment at the McGovern Institute for Brain Research and the Broad Institute, both in Massachusetts, and is often spoken of as a future Nobel laureate.

Powerful tools can be used in different ways, however, and when it comes to CRISPR, there have already been some worrying developments. Two years ago, biophysicist He Jiankui was widely criticised – and eventually handed a prison sentence –

for using CRISPR to gene edit human embryos. Many researchers, including Zhang, feel his actions were an ethical overstep.

Meanwhile, Zhang is party to an ongoing dispute over who should own the patent for CRISPR. Other scientists were first to publish details of the technology, but he was quickest to show it works in human cells.

New Scientist caught up with Zhang to discuss those controversies and to get the low-down on the future of CRISPR. These days, Zhang is optimistic that the technology may help us in the battle against covid-19 and that it may have applications that go far beyond medicine.

Jessica Hamzelou: What are the most promising applications of CRISPR in the works today?

Feng Zhang: One of the tantalising possibilities is to use it to correct DNA sequences so that we can restore genes and treat disease. I co-founded Editas Medicine with several other colleagues and, earlier this year, the company began human trials using CRISPR to treat a rare, inherited eye disease called Leber congenital amaurosis.

A harmless virus carrying the CRISPR tools is injected into the eye, where it modifies cells to restore normal function of a faulty gene.

Another company called CRISPR Therapeutics has been using the system to treat people who have beta thalassaemia, a disorder in which the blood has low levels of haemoglobin. They found that one patient responded very well and no longer needs blood transfusions.

Because you can use CRISPR to target many genes at once in human cells, scientists have been using it to carry out screens to find genes that are involved in specific disease processes. Then we can potentially edit those genes too.

So CRISPR is already showing promising results. How does it make you feel when you see that?

It is really exciting to be part of building something that can have a huge impact on people's lives, but it also makes me realise that there is a lot more that we need to do. Seeing these promising early results really motivates me to want to do more.



SIMON FRASER/SCIENCE PHOTO LIBRARY

What needs to be done before these become approved treatments?

We need to make CRISPR work more efficiently and precisely. One risk is that it will not only make edits that you want, but, by random chance, it also edits something else. We have started on this by engineering new versions of the system that are much more specific. We also need to develop the tools so that they can make many more types of changes in the genome and influence how genes work in different ways.

We are also working on new ways to deliver the CRISPR enzymes. We have developed a protein from *Staphylococcus aureus* bacteria, which is much smaller than the first CRISPR system we reported. The more compact the package is, the easier it should be to get it inside cells where it can do its work. We have already found that this system can edit genes efficiently in mice.

Are there any conditions that you are particularly interested in?

I have had an interest in mental illness and psychiatric conditions since I was a college student. People around me have been affected by these illnesses. CRISPR is already being used to better understand how they affect the brain and how we might develop more effective treatments.

But all diseases are important. Each affects people in different ways, biologically, but also emotionally. In terms of negatively affecting their lives, it's the same – it is a toll on people's quality of life. This is why I have focused on developing the technology for gene editing as a broadly applicable platform.

You are involved in a patent dispute over CRISPR. Does it matter who owns the rights to the technology, as long as it is being used for good?

It is important that this technology is developed safely and responsibly, and shared in a way that everyone can benefit from. The patent holder has the privilege and obligation to ensure that the technology is made accessible. The Broad Institute will continue to do this.

What do you think the next breakthroughs are going to be?

We will continue to see a lot of exciting applications in therapeutics. Cell therapy, where clinicians take cells out of a patient, repair them, and put them back, has a lot of potential. Integrating CRISPR with other technologies, like stem cells, could be especially powerful. These approaches could be used in everything from blood diseases all the way to liver, muscle and brain diseases in future.

One possible way to do this is to use stem cells to derive microglial cells, which are brain cells that respond to infections and damage. These cells could be engineered to restore or introduce genes. You could then transplant them into patients so that they can take residence in the brain and treat conditions. In the long run, we might treat neurodegenerative diseases in this way.

Have there been any uses of this technology that have worried you?

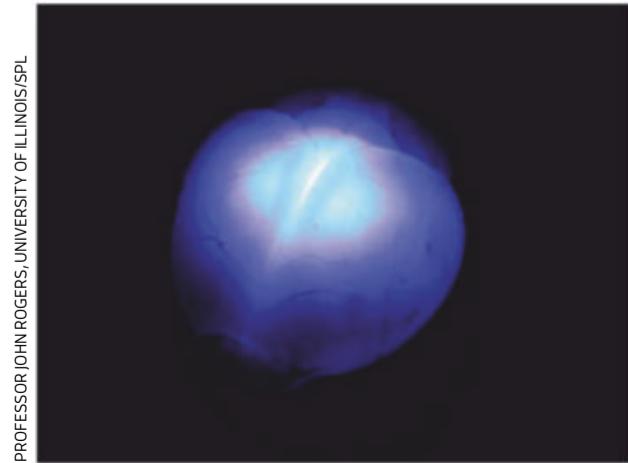
Absolutely. One of the things I was very concerned about was the use of CRISPR in editing human embryos. Less than two years ago, scientists described using CRISPR to edit two human embryos and then using them to create two genetically modified babies. I think it crossed many ethical bounds.

There has been lots of talk about how to regulate the technology, both before and after that incident. How should we do that?

I have been involved in a number of discussions about this, but the world is complicated. There isn't a single type of ethics or culture or governing system. This means we have to reach agreements through international collaborations. People must come to an understanding of the potential impacts of these technologies before we get a consensus on using them.

The technology is still nascent and there is much about its performance and safety that we don't fully grasp. To jump ahead and begin to apply this to a modified human embryo could have unintended consequences. On top of that, we don't understand the biological

"We've all seen enough dystopian science fiction to know that genetic enhancement would be terrible for humanity"



PROFESSOR JOHN ROGERS, UNIVERSITY OF ILLINOIS/SPL



Gene-edited seedlings (left) might suck in extra carbon dioxide. Optogenetics enables us to switch on specific parts of a mouse brain using light (below left)

mechanism that causes a lot of things that we want to treat. So, even if the technology was perfect, we wouldn't know what edits to make to the genome. This is why we can't yet use CRISPR to treat conditions like Alzheimer's or cancer.

There are also tangled issues surrounding consent. Who has the right to consent to the use of this? How will availability of these technologies affect the human race going forward? When people think of changing the genome, they often think of genetic enhancement. We've all seen enough dystopian science fiction to know that a society like that would be terrible for humanity.

What do you think gene-editing technologies will look like in 10 years?

We will probably begin to see the technology applied to diseases that affect a large number of people, like cancer or even brain conditions. I suspect gene editing will be used beyond medicine, for example in agriculture, to create more drought-resistant and higher-yielding crops to help fight global hunger. We might also see CRISPR used in

biological computing or as part of the response to climate change.

How could the technology help with climate change?

Some scientists are working out how to use CRISPR to engineer plants so that they can sequester more carbon. Others are looking at ways to engineer fast-growing cells like cyanobacteria to get them to take in and store carbon faster. These are some starting ideas to tackle climate issues. I am sure people will use their creativity to come up with more.

We can't afford to ignore the climate, but we also have a pandemic to deal with. Can CRISPR help with that?

My team has spent a lot of time developing CRISPR-based diagnostics. One of the critical things for helping us fight the covid-19 pandemic is the ability to test more people, more rapidly and in more places in the community. So we have been working on something we called the STOPcovid reaction. The main advantage of a CRISPR-based test is that it doesn't require sophisticated laboratory equipment – you just need a water

bath at 60°C. You put your sample vial into the water bath and then, within an hour, you can dip in a test strip and get a result.

How soon will it be ready?

Another company I helped found, called Sherlock Biosciences, has been developing similar CRISPR-based technology for detecting coronaviruses. In May, this received emergency use authorisation from the US Food and Drug Administration. So now people in clinical labs in the US can begin to use that technology for detecting coronavirus, which should help expand our testing capacity.

My lab has also distributed STOPcovid test kits around the world. One of our collaborators in Thailand got approval from the Thai government to use it in his hospital and will be screening surgery patients for coronavirus, so that they can better triage and isolate people who test positive for the virus.

You were also involved in the invention of optogenetics, another groundbreaking discovery. What is your secret to spotting the next innovation?

I am always curious about the way things work – or don't work in the way they should. I have those questions in mind whenever I think or read about something. I always cross-check with the scientific problems I am interested in and see whether I can create a new connection.

The other thing I do is look at nature, which has done way more than we can imagine. CRISPR proteins are examples of things that nature has created through billions of years of evolution that have amazing applicability.

Also, when I was growing up, my parents always told me that I should make myself useful and not waste time. That probably has something to do with it. ■



Jessica Hamzelou is a reporter for New Scientist. Follow her @JessHamzelou

Covid-19's AI revolution

Automation was already taking over jobs, but the coronavirus pandemic is hugely accelerating the trend.

Should we be worried, asks **Sandy Ong**

ON AN upper floor, something stirs in the semi-darkness of a closed shopping centre. It stops in front of a clothing store, bathing the window display in searing light. No alarm bells sound, no security guards rush forth. The Sunburst UV Bot, with its 1000 watts' worth of UVC light capable of "tearing apart strands of virus DNA", comes here every night, as well as to a few other malls and hospitals in Singapore. It is doing something that human workers would have done before the covid-19 pandemic: cleaning.

Similar scenes are occurring across the world. In Texan hospitals, Moxi delivers medications, lab samples and supplies. P Guard enforces lockdown curfews on Tunisian streets. James the telepresence bot helps residents at Belgian care homes stay connected. Other robots scrub supermarket floors, deliver meals to people in quarantine and even help walk the dog. Meanwhile, non-embodied artificial intelligences are assisting in everything from contact tracing and cracking the coronavirus's genetic code to the logistics and customer fulfilment of an increasingly online commercial world.

This trend towards automation and roboticisation isn't new – but covid-19 is vastly accelerating it. "What this pandemic has done is make people extremely aware of hygiene and the need to distance",

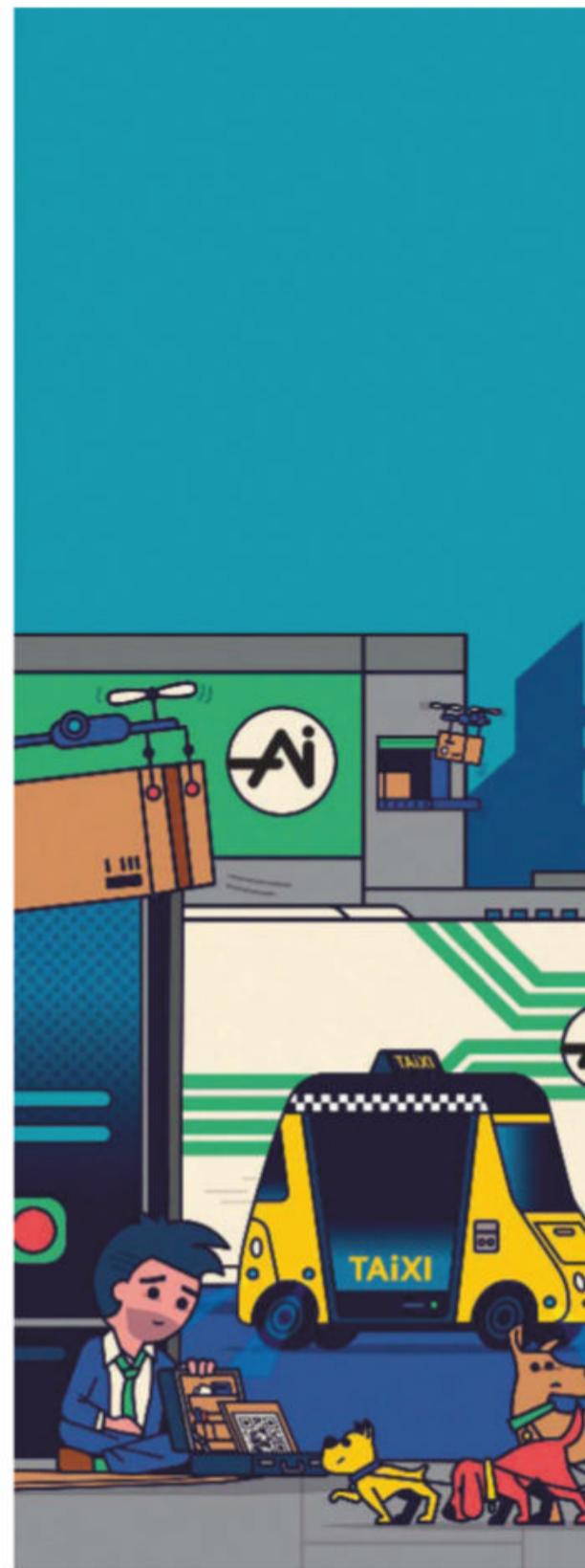
says Richard Pak at Clemson University in South Carolina. "In these times, robots and automation definitely provide a safety benefit."

And perhaps also a huge problem. Unemployment has shot up as coronavirus has hit the global economy. What happens if we emerge from the covid-19 recession to find that jobs have permanently gone – with no plan B to keep us gainfully employed?

The rise of robotics and AI has often been described as part of a "fourth industrial revolution", following on from the three similar step changes over the past three centuries powered by coal and steam, by oil and electricity and by digital computing (see "Four industrial revolutions", page 46).

Many cheer the promise of self-driving vehicles, virtual assistants and other labour-saving innovations. It is hard to argue with technologies that can give us a customised massage, recommend something good on Netflix or allow us to pay for groceries with the tap of a phone. During the covid-19 pandemic, such technologies have helped reduce public health risks by enabling many people to work from home, safeguarding productivity while allowing businesses to stay afloat.

Even before the pandemic, however, many people were worried about the potential long-term jobs fallout of the





SPENCER WILSON

"What happens if we emerge from the covid-19 recession to find that jobs have permanently gone – and there is no plan B to keep us gainfully employed?"

Four industrial revolutions

trend towards automation. One analysis by consulting firm McKinsey & Company in 2017 suggested that automation could displace up to 800 million jobs worldwide by 2030. Back in 2013, Carl Frey and Michael Osborne at the University of Oxford rather piquantly used a machine-learning algorithm to assess how easily different jobs could be automated. The study concluded that machines will be able to do 47 per cent of all US jobs in the coming two decades – a figure that remains relatively constant today, says Frey. “In the UK, the estimates are at 35 per cent.”

Getting serious

Faced with employees under lockdown and the need for strict social distancing measures in the workplace, many companies have been putting a rocket under those trends, either by looking at greater automation for the first time or by accelerating and extending existing plans.

“There’s so much room for automation now,” says Derik Pridmore, CEO of Osaro, a company in San Francisco that develops AI systems for warehouse robots. “If companies were thinking about it before, they’re now doing something. If they were doing something, they’re now actually deploying it. Everyone is moving up a phase in their seriousness about automation.” In March, a survey by auditing firm Ernst & Young of around 2900 executives in 46 countries found that more than three-quarters were taking measures to either change or re-evaluate the speed of their automation processes.

Concrete steps include the likes of Amazon, Walmart and other big retailers deploying more robots to haul and pack goods in their warehouses, and YouTube and Twitter using more machines for content moderation. Chatbot use has also swelled: in March, PayPal was using such software to handle a record 65 per cent of its message-based customer enquiries. IBM reported seeing a 40 per cent jump in demand from February to April for its Watson Assistant software that firms such as US retailer Macy’s and car manufacturer Chevrolet use to handle online calls.

The advent of AI and advanced robotics is part of a suite of changes that some see as a fourth industrial revolution akin to the three that developed economies have already passed through.

First industrial revolution:

COAL AND STEAM

- Kicked off in about 1760
- Characterised by the steam engine and the first factories
- Key inventions include steamships and railways, mechanisation widespread
- Transformed societies from agrarian to industrial

Second industrial revolution:

OIL AND ELECTRICITY

- 1860s onwards
- Characterised by mass production and the assembly line, as well as new industries such as oil, electricity and steel
- Key inventions include the lightbulb, telephone, radio, cars and aeroplanes
- Increasing rural to urban migration

Third industrial revolution:

COMPUTING

- 1960s onwards
- Characterised by electronics, automation, digitisation and widespread use of IT systems
- Key inventions include semiconductors, personal computers, the internet, email and e-commerce
- Shift from physical to online worlds

Fourth industrial revolution:

CONNECTED TECHNOLOGIES

- Starting now
- Characterised by artificial intelligence, robots, big data, smart technology and biotechnology
- Key inventions include DNA sequencing and CRISPR technology, nanotechnology, blockchain, virtual reality, the internet of things, cloud computing, quantum computing, autonomous vehicles and 3D printing
- Continued shift from physical to online worlds

Pridmore says his firm has “seen a big pickup in interest from basically every region, in every application and sector” since the pandemic hit. His clients include a grocery chain in Australia that found demand had doubled as more people began cooking at home, rather than eating out. Osaro helped automate the firm’s order-fulfilment and shelf-restocking processes to cope with the increased demand.

Chris Duddridge, managing director at UiPath, whose AI platforms help automate call centres in the UK, India and other countries, echoes this sentiment. “The pandemic was indeed an accelerator for the adoption of automation,” he says. Software robots have been instrumental in helping his firm’s clients deal with the “huge backlogs and unprecedented volumes of requests” during the crisis, he says.

Anxiety about automation seems to be increasing in lockstep. As part of a recent survey conducted by the Center for the Governance of Change at IE University in Segovia, Spain, almost 2900 people from 11 countries were asked whether their governments should limit automation by law in order to save jobs and prevent technological unemployment. In January, 42 per cent of respondents in Spain and 27 per cent in China – two countries that bore the initial brunt of the pandemic – said “yes”. Three months later, as covid-19 worsened, those figures jumped to 55 and 54 per cent, respectively.

Part of that is generalised economic worry. “If you look historically, what you often see is that automation anxiety tends to be particularly prevalent during economic downturns,” says Frey. “Losing one’s job when there is an abundance of others is not that bad, but if you lose your job in an economic downturn, chances are that you’re going to struggle to find another.”

Perhaps the most infamous example, highlighted by Frey in his 2019 book *The Technology Trap*, were the Luddites, who smashed stocking frames, mechanised looms and other trappings of the first industrial revolution in the UK. The unrest was especially bad after the Napoleonic wars



Above: Automation in an Amazon warehouse in Peterborough, UK. **Below:** A Sunspot UV Bot patrols a shopping mall in Singapore

ended in 1815, when Europe slumped into a depression, weavers saw their wages cut by a third and food prices skyrocketed because of new tariffs imposed on foreign grain.

Today, the sheer number of sectors affected is compounding such fears. Automation-related upheaval already posed a big threat to warehouse and factory workers, but many others in white collar jobs may find themselves out of work too. Those include financial analysts and radiographers whose jobs involve a lot of routine analysis of specific forms of data. Many of those jobs can now be performed just as competently, if not more so, by an AI. “This is one of the first times in history where a mix of blue and white collar jobs are affected,” says roboticist

Ayanna Howard at the Georgia Institute of Technology in Atlanta.

Whoever is affected, the trend tends to be a one-way street. “When automation is here, it’s here to stay,” says futurist Ravin Jesuthasan. “In the economics of robotics, once you’ve made the upfront investment, whether it’s in hard dollars or soft dollars of retraining the workforce and getting behaviour change from customers, it’s much easier to perpetuate.”

It isn’t all doom and gloom, says Frey. “The only thing that is worse than automation is no automation.” The world has been on a long-term path of technology doing more work for us for good reason, he says – it has enabled higher productivity, lowered costs, greater scalability, safer environments, more flexible working and improved connectivity, to name just a few things. “If you look back over the past 200 years, there’s no question that people are better off today, in large part because of automation,” says Frey.

Others say we shouldn’t overstate the scale or speed of this new transition, even as covid-19 gives new reasons to drive it forward. Automation doesn’t come cheap: firms need to have the funds to install new machinery and software, as well as time to reconfigure workplaces and retrain workers to use ➤



CHRIS J RATCLIFFE/AFP VIA GETTY IMAGES



THOMAS LOHNES/GETTY IMAGES

Care home residents in Frankfurt, Germany, meet a prospective robot carer

them. “Automation only happens when the technology is ready to be implemented,” says John Etchemendy at the Stanford Institute for Human-Centred Artificial Intelligence in California. “If the technology is not yet there, is not yet ready to take over the task, then the pandemic is not going to accelerate that.”

“Our fear is often based on our science-fictional notion of robots replacing us,” says roboticist Kate Darling at the Massachusetts Institute of Technology. To be convinced that we are “on the cusp of massive robot job-takeovers” would be to overestimate what robots and AI are capable of, she says. “Covid-19 may accelerate some investment, but we’re looking at a longer time period than most people think.”

Many tasks are still too delicate or complex to be automated, such as assembling a smartphone, cleaning elevator buttons or delivering the post. Others, such as confirming a medical diagnosis, still require human insight and interpretation, even if AIs can do some of the legwork. Then there are undertakings that simply cannot do without the warmth of a human touch. Most of the world is a long way from accepting robot therapists or nurses, for example.

With this wave of innovation, as with previous ones, the jobs most ripe for automation are those that are repetitive and dull. Few people have ever begged for one more spreadsheet to fill or one more

box to pack, after all. Here, technology can remove tedium and free up people to do more meaningful work. More often than not, they end up working in partnership with machines – algorithms can trawl through countless transactions or medical images and flag up suspicious ones for a person to review, for example.

Work redefined

Economist James Bessen at Boston University in Massachusetts agrees with that assessment. What we are likely to see isn’t fewer jobs overall, but different ones. “There’s no evidence that AI will lead to massive unemployment, but there will be increased churn,” he says. “Automation can actually lead to new jobs.” Already, we are seeing an increase in demand for the likes of drone operators, data scientists, cryptographers, digital marketing specialists, video tech support and virtual event organisers. In the future, says Howard, we are going to need robot mechanics and customer service officers capable of handling people “so they aren’t mad at a robot anymore”.

That will require new training. “Jobs will be redefined,” says Howard. Many experts suggest a sure-fire way to cushion against the economic effects of automation in the post-coronavirus era: invest in education, and specifically re-education. “At the heart

of it is ensuring that anyone can engage with upskilling and reskilling in bite-sized chunks,” says Jesuthasan, “as opposed to this fixation on a three or four-year degree where you’re somehow expected to be relevant for 30 years after. I think the world has moved on very rapidly from that legacy model.”

This needs workers to adopt an open mindset to learning, but governments and firms must step in and help too by offering subsidised adult education courses, retraining programmes and other types of learning to help people make the necessary transitions. All this should be part of any post-covid-19 recovery scheme. “Otherwise, left purely to market forces, you’re going to find lots and lots of people left behind,” says Jesuthasan.

There are other challenges we will have to face as the trend towards automation accelerates. One major issue is that AI has a tendency to inherit and amplify biases that exist in the data used to train it – for example, against minority ethnicity or lower-income groups. Then there are questions about how to frame laws around the responsible use of machines with ever-increasing autonomy, and the possibility of a growing social divide between those who can afford technology and those who can’t.

Finding solutions requires having the headspace to think these things through, and that is difficult in the middle of a global pandemic. “We’re still in a very reactive mode,” says Howard. “To think about what comes next requires you to pause, and right now we’re not in that state of luxury to be able to pause.”

Get things right, though, and we can embrace the opportunities afforded by new tech, rather than being hampered by fear. As the threat of covid-19 persists, devices like the virus-killing Sunburst UV Bot may be redefining certain jobs, but they are also making it safer for us to get on with others. ■



Sandy Ong is a freelance technology journalist based in Singapore. She tweets @sandyong_yx



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The back pages

Puzzles

Which chairs should be swapped around in a bizarre bistro? **p52**

Almost the last word

What makes people short-sighted or long-sighted? **p54**

Tom Gauld for

New Scientist

A cartoonist's take on rejection **p55**

Feedback

Deadly digit ratios and a condom caper: the week in weird **p56**

Twisteddoodles

for *New Scientist*

Genies or research scientists? **p56**

Science of cooking

Get a shroom

Mushrooms are high in protein, nearly impossible to overcook and the main ingredient for the original ketchup, writes **Sam Wong**



Sam Wong is social media editor and self-appointed chief gourmand at *New Scientist*. Follow him @samwong1

ALTHOUGH mushrooms come in many shapes and sizes, the most commonly eaten types in Europe are one species, *Agaricus bisporus*. We know them as button mushrooms and chestnut mushrooms when they are young and portobello mushrooms when they are fully grown.

Most of the organism is made up of an underground network of thin fibres called hyphae. The part we eat is the fruiting body, which emerges above the soil and releases spores into the air. The more highly prized types of mushroom, such as chanterelles, morels and porcini, grow in symbiosis with trees, so they are harder to cultivate and are usually harvested from the wild. Many mushrooms produce poisons to protect themselves from being eaten by animals. As such, foraging for them isn't recommended without expert knowledge.

Mushrooms are 80 to 90 per cent water. Their cell walls contain chitin, a quite different polymer to the cellulose of plant cell walls, which accounts for their strange texture. Chitin is remarkably heat-stable, which is why it is practically impossible to overcook mushrooms – they remain firm yet tender even after prolonged cooking.

They are also higher in protein than most plant foods and contain more glutamate, the chemical responsible for the savoury umami taste. The distinctive aroma of mushrooms comes partly from octenol, an alcohol



RUDISILL/GETTY IMAGES

molecule with eight carbon atoms. It is made by enzymes when the tissue is damaged, which happens most in the gills (the ribs beneath the cap). This is why closed cup mushrooms are less flavoursome than types such as portobello.

Although ketchup is today associated with tomatoes, it first became popular in Britain and the US as a mushroom-based sauce in the 18th century. In historical recipes, the mixture is strained to produce a thin liquid akin to soy sauce that packs a similar umami punch. I prefer to puree the mixture, making a thick sauce more like the ketchup we are familiar with.

Slice the fresh mushrooms or break them up by hand. In a large bowl, mix them with the sea salt, squeezing and bruising them with

your hands. Cover and leave for 24 hours. Soak the dried porcini mushrooms in 200 millilitres of hot water for 30 minutes. Sauté the onion with a pinch of bicarbonate of soda so it softens and browns more quickly.

Once starting to brown, add the garlic and cook for 2 minutes. Then add the fresh and rehydrated mushrooms along with any liquid in the bowls, being careful to leave any grit behind. Add the spices and simmer for 45 minutes, adding water if it starts to become dry.

Blend the mixture with the vinegar, sugar and olive oil until smooth. Taste and add more salt, sugar or vinegar as needed. ■

What you need for mushroom ketchup

- 400g fresh mushrooms of different types**
- 1tbsp sea salt flakes**
- 20g dried porcini mushrooms**
- 1 onion, finely chopped**
- Pinch of bicarbonate of soda**
- 3 cloves garlic, finely chopped**
- Pinch of allspice**
- Pinch of nutmeg**
- Black pepper**
- 100ml cider vinegar**
- 2tbsp brown sugar**
- 2tbsp olive oil**

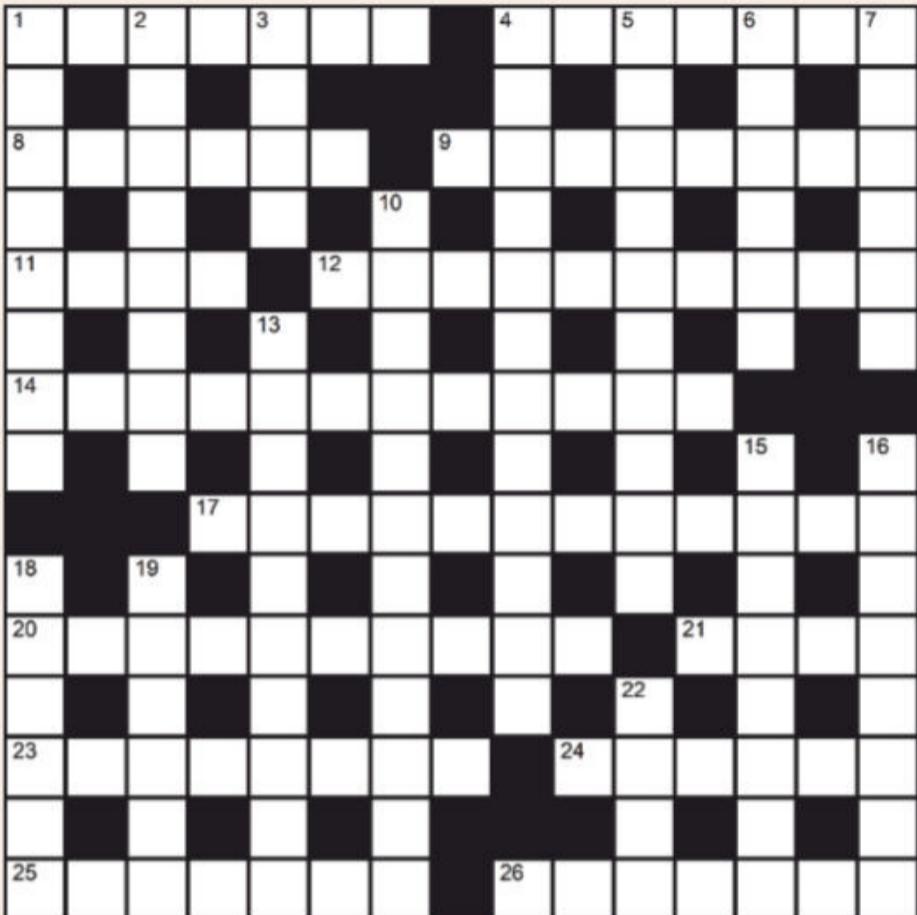
Science of cooking will appear every four weeks

Next week

Stargazing at home

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

Quick crossword #68 Set by Richard Smyth



ACROSS

- 1** Genus of flowering plants named after Renaissance botanist Leonhart Fuchs (7)
- 4** Device; automaton (7)
- 8** Wild ass (6)
- 9** Screw insert also called an anchor (8)
- 11** Therefore (4)
- 12** Repeated event; return of medical symptoms (10)
- 14** Vessels that supply the heart (7,5)
- 17** Invisible (12)
- 20** Designs; plans (10)
- 21** Marvel mutant superheroes (1-3)
- 23** City dweller (8)
- 24** Highland cryptid (informally) (6)
- 25** Brackish zone between river and sea (7)
- 26** Protective ring inserted into a hole in fabric or sheet metal (7)

DOWN

- 1** Italian city, home to the Museo Galileo (8)
- 2** Whistling pink aliens created by Firmin and Postgate (8)
- 3** Stalk; stipe (4)
- 4** Dimensions; quantitative data (12)
- 5** Infuse or treat with Cl (10)
- 6** Of an engine, to run while disconnected (6)
- 7** Young bird in the genus *Aquila*, perhaps (6)
- 10** The study of chemical processes in the geology of earth (12)
- 13** Bamboo-eating mammal, *Ailuropoda melanoleuca* (5,5)
- 15** Fourth stomach component in a ruminant (8)
- 16** Devise again (8)
- 18** Of an angle, greater than 90 degrees (6)
- 19** Insect-eating marsupial of Western Australia (6)
- 22** O(4)

Scribble zone

Answers and the next cryptic crossword next week

Quick quiz #72

- 1** What is the nearest star system to our sun?
- 2** In what year did the first untethered, crewed flight of a hot air balloon take place?
- 3** In 2019, the first Denisovan remains other than those found in Denisova cave in Siberia were confirmed. Where were they discovered?
- 4** When Charles David Keeling first began measuring atmospheric carbon dioxide in 1958, what were the levels of this gas in parts per million?

- 5** What name is given to the random movement of particles suspended in a liquid or gas?

Answers on page 55

Puzzle

Set by Christian Lawson-Perfect #80 Vive la Différence

The eccentric manager of Bistro Vive la Différence has a bizarre method of offering discounts to his customers.

Each seat has a number and each customer gets a discount (in euros) equal to the difference between the numbers of the seats either side of them. For example, a guest seated between seats 6 and 1 would get a discount of €5 on their meal.

Seven friends have booked a meal, and arrive to find chairs numbered 1 to 7 in order around their table. They figure that with the seats arranged like this, they can get a combined discount of €20. But they reckon they can do better. They want to maximise their discount, but only have time to swap two chairs before the waiter comes to take their order. Which chairs should they swap?

Answers next week



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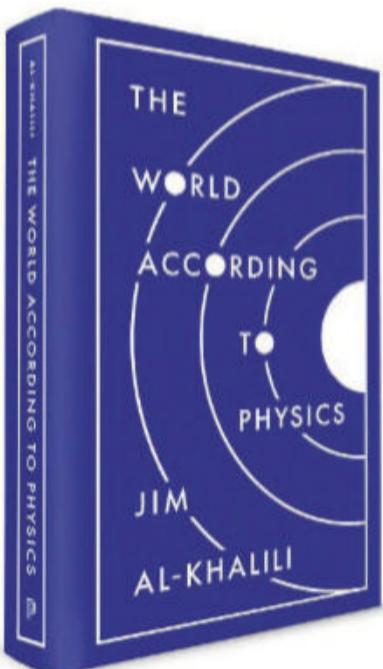


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Different views

What exactly occurs in the eyes to make some people short-sighted and others long-sighted?

Joe Oldaker

Nuneaton, Warwickshire, UK

Short-sightedness (myopia) and long-sightedness (hyperopia) are usually due to a mismatch between the length of the eye, from front to back, and the combined power of the cornea – the transparent surface layer at the front of the eye – and the eye's crystalline lens to converge rays of incoming light.

Light rays entering the eye are bent by the cornea and lens to converge at a focal point, which should be on the retina at the back of the eye to make a sharp image. In myopia, rays from far-off objects focus in front of the retina and the image is blurred. In hyperopia, nearby objects focus behind the retina, with a similar result.

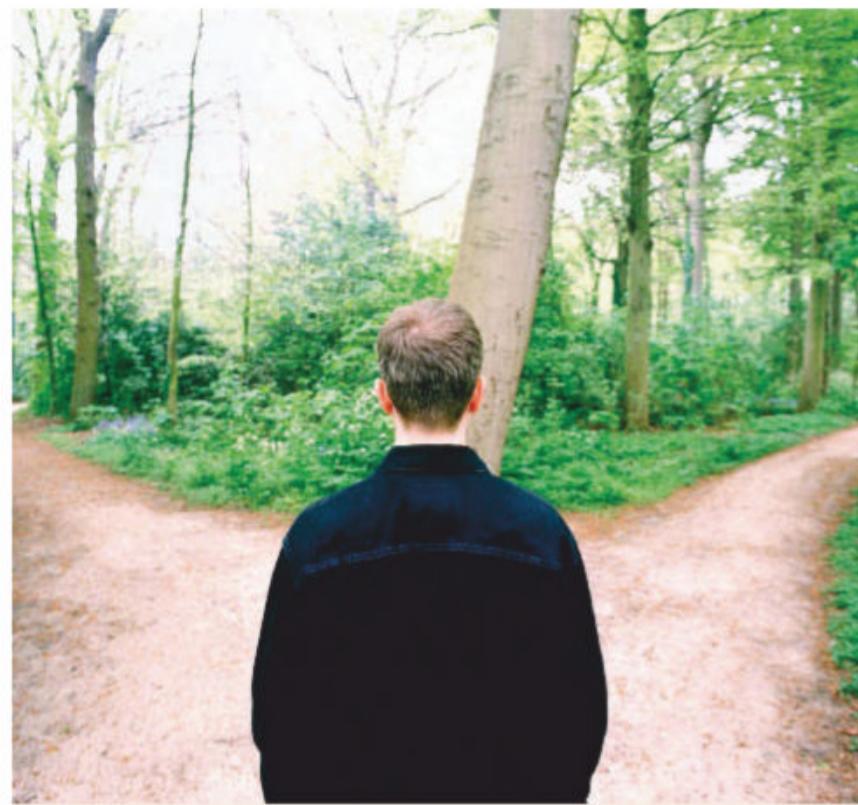
The excessive convergence of rays in myopia and the reduced convergence in hyperopia can be

“Chicks raised in red light grow up to have longer eyeballs and become short-sighted”

corrected by appropriate lenses worn in front of the eye. Laser surgery to reshape the cornea is also used, mainly for myopia.

An additional complication is that the lens in the eye is flexible, and can, via muscular control, change shape to add convergence power. This is automatic when looking at things that are near, such as words in a magazine, so they can be seen clearly. This effect can mask some long-sightedness.

In later life, the eye lens becomes less flexible and this ability fades, so reading glasses are needed to see close objects sharply. However, people with myopia have extra convergence built in and so can often do without the reading glasses most of us need with age.



DAVID SACKS/GETTY IMAGES

Knowing whether to go left or right may not be so easy for everyone

light is usually redder, it is possible that our eyes have adapted accordingly and short-sightedness is the consequence. Getting children playing outside, where they are exposed to more blue light, may reduce their risk of becoming short-sighted. Alternatively, we could make indoor lighting mimic daylight.

Small torque

How do food packaging companies decide how tight to make the lids of jars? Has this increased over time or am I just getting older? (continued)

Roger Miles

St Albans, Hertfordshire, UK

The previous discussion about lid tightness fails to describe the root cause of the intractability of airtight jar lids. It isn't possible to make an airtight seal between a thin metal lid and the rim of a glass jar on their own. To obtain one, a soft material is needed between the two parts.

This is achieved by a thin layer of plastic around the inside edge of the screw lid. Unfortunately, the very quality that makes the material work as a seal means that the friction between seal and glass is high. Hence, if the seal is doing its job, the lid will be difficult to turn.

The conflict of requirements has been addressed by the glass jar industry, with the manufacture of a new type of lid. This is made in two parts; a lid comprising a disc, with the seal bonded to the periphery, and the lid rim, with its thread that engages with the jar thread. It is designed so that the disc is held captive by the lid rim, but is free to rotate within it.

Crucially, the sliding friction between the two lid components is far less than that between the seal and jar rim. Problem solved. This more complex type of lid construction is no doubt more

This week's new questions

Right, wrong Why do some people struggle to tell left from right? *Peter Jacobsen, Davis, California, US*

Sniffy dilemma Is it better to sniff or blow one's nose to clear non-infectious secretions? *Clive McGavin, Horrabridge, Devon, UK*

Mike Follows,

Sutton Coldfield, West Midlands, UK

Lifestyle rather than genetics seems to account for the increased prevalence of myopia seen in recent times.

This idea came to prominence with a study published in 1975, entitled “Inuit myopia: an environmentally induced ‘epidemic?’”, that compared the eyesight of younger and older Inuit people. It showed that about 31 per cent of those below 30 years of age were myopic compared with about 4 per cent of their parents. The younger generation had spent much more time in school.

Many subsequent studies have shown that time spent outdoors makes it less likely that people become short-sighted. This could be due to sunlight-induced

production of vitamin D, which stimulates production of the signalling molecule dopamine, and so influences the development of the eyeball.

Another even more convincing study, led by Chi Luu at Melbourne University in Australia, suggests that the colour of light is the key. The cornea does the lion's share of the focusing while the lens does the fine-tuning.

Like glass, the cornea refracts red light less than blue light, so red light comes to a focus further behind the cornea. The team found that chicks raised in red light grow up to have longer eyeballs and become short-sighted, while those raised in blue light have shorter eyeballs.

Given that we now tend to spend more time indoors, where

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expensive to make, but the resulting reduction in exasperation across the human race is well worth it.

Sylvia Potter

Godalming, Surrey, UK

If a jar has a metal seal, the simplest solution to a stuck lid is to hold it for a few minutes under a very hot tap. This heats the metal, thus expanding it slightly, and also warms the contents, which may reduce any pressure differences.

Mark O'Shea

York, UK

Further to the recent answers concerning tight lids on glass jars, anyone who has worked in the packaging industry will know how easy it is to damage the seal on glass bottles or jars.

Opening a very tight lid doesn't require the help of the strongest person in the household. Tapping the edge of the lid against a firm surface is sufficient to break the seal and release the vacuum. The lid will then be easy to open.

This illustrates why the food

"Coffee made by the cold-brew method lacks some of the acids that give regular coffee its distinctive bitterness"

safety button on lids was put there in the first place. An apparently undamaged jar could let in air if subjected to rough handling in the distribution chain. This could result in the contents spoiling.

Anthony Woodward

Portland, Oregon, US

Grip strength does decrease with age. This is measured by squeezing a handheld device called a dynamometer. Many studies in different countries around the world show declining grip strength from the age of 30 or 40.

Editor's note: You can find out more about the decline of strength with age, and how to fight this decline, in our recent feature on strength training (18 April, p 34)

Cold brew

People often say that to brew the best coffee you must start with cold water. Are they right?

Theo Megarry

Brisbane, Australia

Coffee becomes more bitter when exposed to high temperatures. As such, starting the brewing process from a lower temperature means the coffee is less likely to have a burnt taste.

The cold-brew method requires a coarser grind than regular coffee. The technique means certain acids that give hot-brewed coffee its distinct bitterness remain mostly unextracted from the grounds, resulting in sweeter, if slightly weaker, coffee. Whether or not cold-brew coffee is "better" depends on what kind of coffee will better suit the drinker. The cold-brew method can take up to 12 hours to produce a single cup, meaning it is significantly less convenient than other methods. Some drinkers prefer a stronger, quicker coffee as a pick-me-up. ■

Answers

Quick quiz #72

Answer

1 The triple star system Alpha Centauri, made up of Toliman, Rigil Kentaurus and Proxima Centauri

2 1783

3 Tibet

4 316 parts per million

5 Brownian motion, or pedesis

Cryptic crossword

#41 Answers

ACROSS **1** Tutu, **3** Pandemic, **9** Polymer, **10** Siren, **11** Singularity, **13** Rhodes, **15** Albedo, **17** Cryosurgery, **20** Yeast, **21** Swear to, **22** Sediment, **23** Stay

DOWN **1** Tapestry, **2** Talon, **4** Atrial, **5** Distilleries, **6** Marry me, **7** Cant, **8** Immune system, **12** Roly-poly, **14** Orchard, **16** Asks in, **18** Egret, **19** Dyes

#79 Marathon relay

Solution

Whoever hands over the torch with 4 miles to go can be certain to have it for the final mile.

To guarantee that they will have the torch at this point, that runner should hand over the torch at 8 miles to go... and before that, at 12, 16, 20 and 24 miles to go.

So Rimsky should take the torch first, run 2.2 miles and hand it over with 24 miles still to go, guaranteeing he will have it for the final mile.

Meat jerky

Rifling through our extensive piling system, we come across the tumescent category "questions we wish we'd never asked". We recently mentioned a researcher whose duty it was to paint eyes on the buttocks of cows to deter predators (5 September).

Unwisely, we solicited similar stories of unglamorous tasks performed in the service of science. You have not failed us.

A common theme seems to run through the correspondence. Graeme Coles writes from New Zealand of three months inducing cows to urinate by "moderately vigorous sub-vulval massage". He doesn't specify why, yet "the splashes when success was achieved were bad enough, but when the cow behind you decided to defecate, the glamour quotient declined dramatically", he writes.

Rosalinda Hardman of Portsmouth, UK, paints an only slightly more refined picture of unintended public horror and revulsion as she checked the intimate areas of an unnamed museum's bronze statuary for corrosion during opening hours.

Pride of place, however, goes to Frank Smith and Andrew Taubman, both of Australia, in differing ways. They write in independently, in eye-watering detail, of services rendered down under in the field of porcine fertility studies. We shall spare readers all the details, but feel ourselves very much the wiser, if also in some way very much older, for having read them in their full extension.

We are left thinking that you have all made an eloquent case for the robots to take over, as discussed on page 44. More bad jobs, if we can stomach them, next week.

Facepalm

If nothing else, the coronavirus crisis has had makers of sanitising gels rubbing their hands.

We observe this as we examine our fingers more closely than normal for coded warnings. The reason is an envelope shoved

Twisteddoodles for New Scientist



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under Feedback's door by an anonymous well-wisher, or possibly trouble-maker. Inside is a paper from journal *Early Human Development* entitled "Understanding COVID-19: A hypothesis regarding digit ratio (2D:4D), ACE 1/D polymorphism, oxygen metabolism and national case fatality rates".

Ah, digit ratios. The central idea is one propounded with enthusiasm over the decades by a co-author of the paper, John T. Manning, and to which we feel duty-bound to prepend the adjective "controversial".

It says the ratio between the lengths of a person's index and ring fingers is determined by prenatal exposure to various sex hormones, and thereby indicates everything from personality to susceptibility to heart disease to sexual orientation. That last one

is all the more controversial not least because the researchers can't agree in what way.

To this list, we must now putatively add likelihood to die from covid-19, if you are a man. We had previously ascribed the UK's scandalously high covid-19 death rate to what the old military 7 Ps adage says proper planning and preparation prevents.

But we now see that the average UK male right index finger is 98.5 per cent the length of the average UK male right ring finger. Contrast this with Germany, with an average male digit ratio of just 98.3 per cent – and deaths per 100 confirmed covid-19 cases less than a third of the UK's back on 3 July, and it becomes easy to put your finger on what is going on.

Before we don our tin-foil face mask and head for the hills, however, we are arrested by small

details of the study. Why, for instance, did Belgium's apparently stubby index fingers – mirroring in form, we can only presume, that nation's delicious frites – not save them from one of the world's worst covid-19 case fatality rates?

Feedback is a great fan of correlation, especially in those statistically rare instances in which it indicates causation. Yet, even leaving aside the varying competence of countries' responses to covid-19, and differences in testing regimes and reporting criteria, we humbly submit that anyone seeing any correlation between national covid-19 case fatality ratios and anything else whatsoever is possibly more than a little in hock to, how shall we say, wishful thinking.

Over-recycling

A public wildcard entry in the undesirable job stakes: police in Vietnam announce the confiscation of an estimated 345,000 used condoms from a gang that had been cleaning them and selling them as new in the southern province of Binh Duong. Criminal or with a deep desire to reduce the planet's reliance on single-use plastics?

A colleague claims to remember a time when everyone had reusable prophylactics they washed and hung out t'back. Feedback recalls something similar only with teabags on the line, but a 2018 tweet from the US Centers for Disease Control and Prevention urging people not to wash or reuse condoms suggests that we have led a sheltered life.

Too hot to handle

Finally, some more public health advice: John Gibbs's new thermos flask warns that it shouldn't be used with hot liquids, because these "may cause burns or scald user". Feedback agrees that you can't be too careful, but would welcome statistical analysis of how digit ratio influences the danger of serious injury. ■

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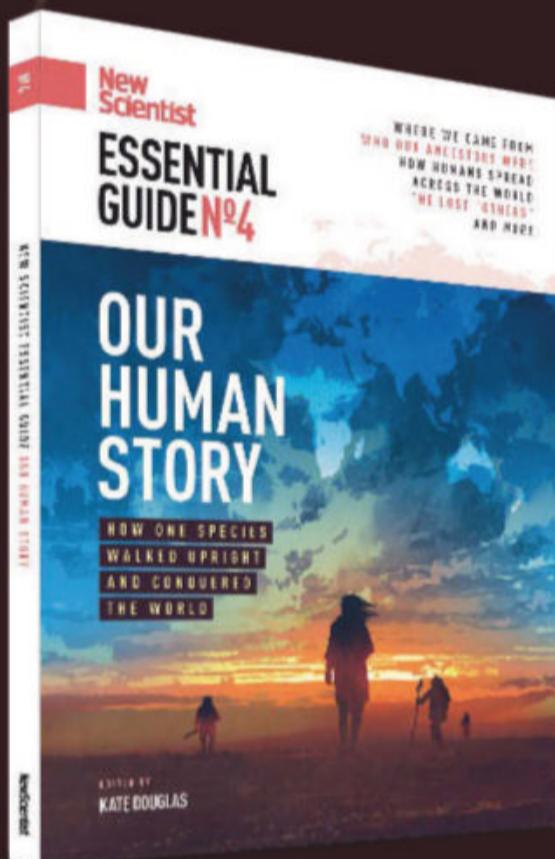
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