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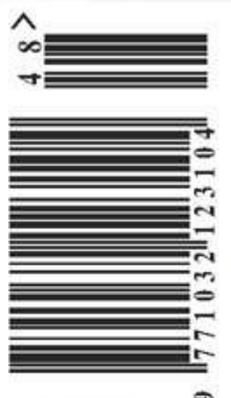


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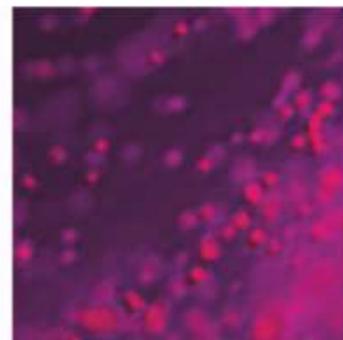
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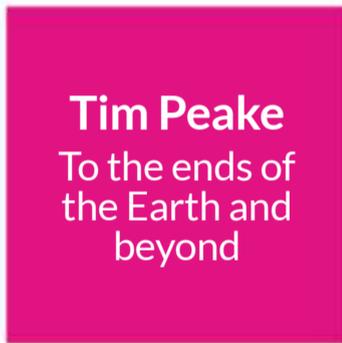
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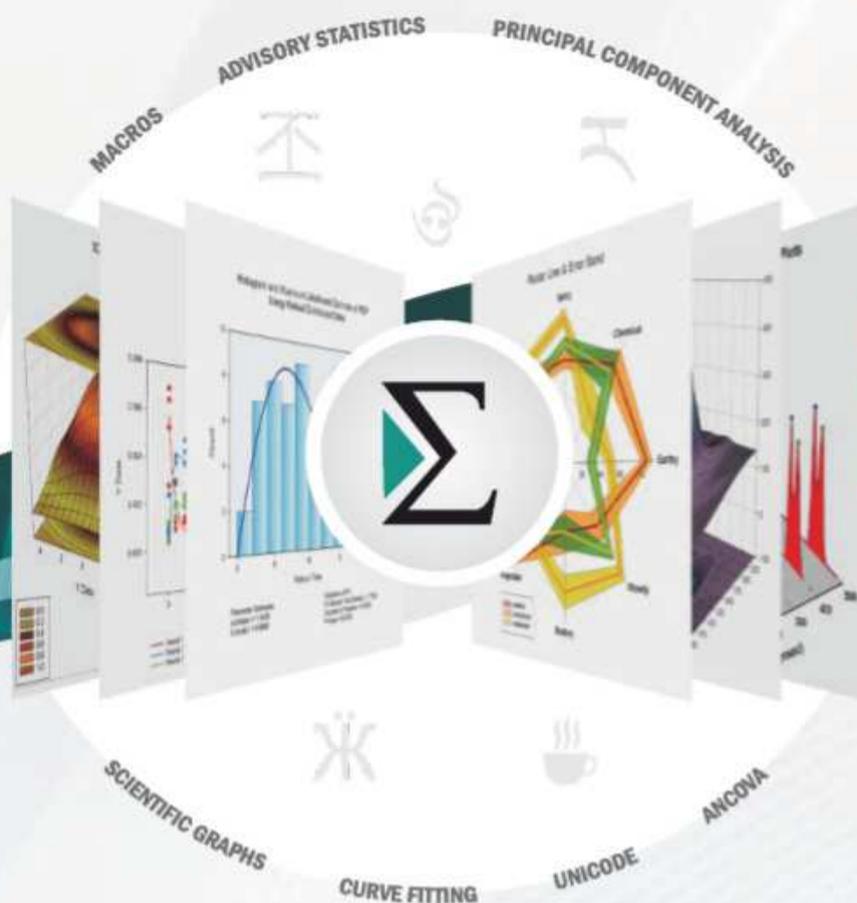
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Safety must come first

Gene-editing humans has huge potential, but caution is needed

SINCE the amazing potential of CRISPR gene editing became clear, scientists have held many summits and discussions on the subject. Indeed, the latest was getting under way in Hong Kong as *New Scientist* went to press.

The message that has emerged from all this talking is crystal clear: it is far too soon to attempt germline genome editing in humans – the process by which the genome of an individual is edited in such a way that the change is heritable.

But on Monday came the news that a team in China has – it claims – created the world's first genetically edited humans,

a pair of twin girls (see page 7). The researchers were, according to reports, trying to make individuals immune to HIV by deleting a single protein.

The experiment, as reported so far, wouldn't have been legal in Europe, Australia or Canada. (In China, there are only guidelines against it.) And many think it is unethical. There are already many other ways to prevent HIV, and we don't know if deleting this protein is effective and safe. What's more, we don't even know if the process of CRISPR gene editing is safe.

However, there is no doubt that in the future, editing our germline could be an extremely powerful

tool for improving health. So, while more needs to be done to prevent rogue experiments, we shouldn't regard our genome as sacred and inviolable, either.

We are all involuntary participants in the wildly unethical experiment called evolution. Each of us is born with around 100 new mutations. Even healthy people harbour many thousands of harmful mutations.

Germline genome editing could help change this and allow future generations to live much longer and healthier lives. We are still a long way from this point, but we won't get there at all if countries go too far and ban all research. ■

Make it a green Xmas

THE gradual drift of the festive season into November or even earlier is enough to elicit a "Bah humbug" from even the jolliest old elf. Christmas early-sliding is mostly driven by struggling shops trying to prop up sales with an end-of-year push, but it is indicative of a larger problem: the rampant consumerism that is despoiling the planet.

Put simply, most people in the West are buying too much stuff, eating too much food and then throwing too much of it in the bin. Thankfully, we have an antidote in the form of the ultimate guide for shrinking the environmental footprint of your Christmas (see page 22).

This doesn't mean celebrating in a hair shirt, but rather

minimising the impact of some of the worst festive excesses. Whether it is making your own gifts, cutting down on meat or even just reusing wrapping paper, there are loads of ways to give you a warm holiday glow inside.

Or if you must buy something, at least let it feed your mind – see our guide to the best books of the year (page 44).

And hey, at least we waited until December to break out the Christmas content. ■



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Police plan to use AI to predict crime

Serious concerns have been raised over ambitious UK policing project. **Chris Baraniuk** reports

POLICE in the UK want to predict violent crime using artificial intelligence, *New Scientist* can reveal. The idea is that individuals flagged by the system will be offered interventions, such as counselling, to avert potential criminal behaviour.

However, one of the world's leading data science institutes has expressed serious concerns about the project after seeing a redacted version of the proposals.

The system, called the National Data Analytics Solution (NDAS), uses a combination of AI and statistics to try to assess the risk of someone committing or

“Tools trained on past cases could limit police enquiries to well-trodden areas and reinforce bias”

becoming a victim of gun or knife crime, as well as the likelihood of someone falling victim to modern slavery (see “The rise of predictive policing”, right).

West Midlands Police is leading the project and has until the end of March 2019 to produce a prototype. Eight other police forces, including London's Metropolitan Police and Greater Manchester Police, are also involved. NDAS is being designed so that every police force in the UK could eventually use it.

Police funding has been cut significantly over recent years, so forces need a system that can look at all individuals already known to officers, with the aim of prioritising those who need interventions most urgently, says Iain Donnelly,

the police lead on the project.

As for exactly what will happen when such individuals are identified, that is still a matter of discussion, says Donnelly. He says the intention isn't to pre-emptively arrest anyone, but rather to provide support from local health or social workers. For example, they could offer counselling to any individual with a history of mental health issues that had been flagged by NDAS as being likely to commit a violent crime. Potential victims could be contacted by social services.

This is the first project of its kind in the world, pooling multiple data sets from a number of police forces for crime prediction, says Donnelly. In the early phases, the team gathered more than a terabyte of data from local and national police databases, including records of people being stopped and searched and logs of crimes committed. Around 5 million individuals were identifiable from the data.

THE RISE OF PREDICTIVE POLICING

Around the world, police are increasingly using data to predict crime. PredPol, developed at Santa Clara University in California, tries to identify future crime hotspots, for example. The system has been used both in the US and the UK.

The Los Angeles police has a program that assigns a risk score based on traits such as whether someone has previous convictions or is a known member of a gang. Patrols are adjusted to keep a closer eye on the “riskiest” people.



LUCY YOUNG / EVENING STANDARD / EYEVINE

Police could contact people AI predicts will be future lawbreakers

Looking at this data, the software found nearly 1400 indicators that could help predict crime, including around 30 that were particularly powerful. These included the number of crimes an individual had committed with the help of others and the number of crimes committed by people in that individual's social group.

The AI component of NDAS will use these indicators to predict which individuals known to the police may be on a trajectory of

violence similar to that observed in past cases, but who haven't yet escalated their activity. Such people will be assigned a score indicating the likelihood of future offending.

Will it work?

West Midlands Police hopes to generate its first predictions using NDAS early next year. It will work with the UK's data watchdog, the Information Commissioner's Office, to ensure the system meets privacy regulations.

However, aspects of the project have already drawn criticism. A team at the Alan Turing Institute in London saw a redacted version of the NDAS proposal last year and published their verdict this week.

In the report, the team says there are “serious ethical issues” with NDAS and questions whether it is in the public good to intervene pre-emptively when someone may not have committed a crime or be likely to do so in the future. It says that the proposal is ethically well-intentioned, but fails to recognise important issues in full, and that inaccurate prediction is a concern.

By basing predictions on past



World's first gene-edited babies announced

Alice Klein and Michael Le Page

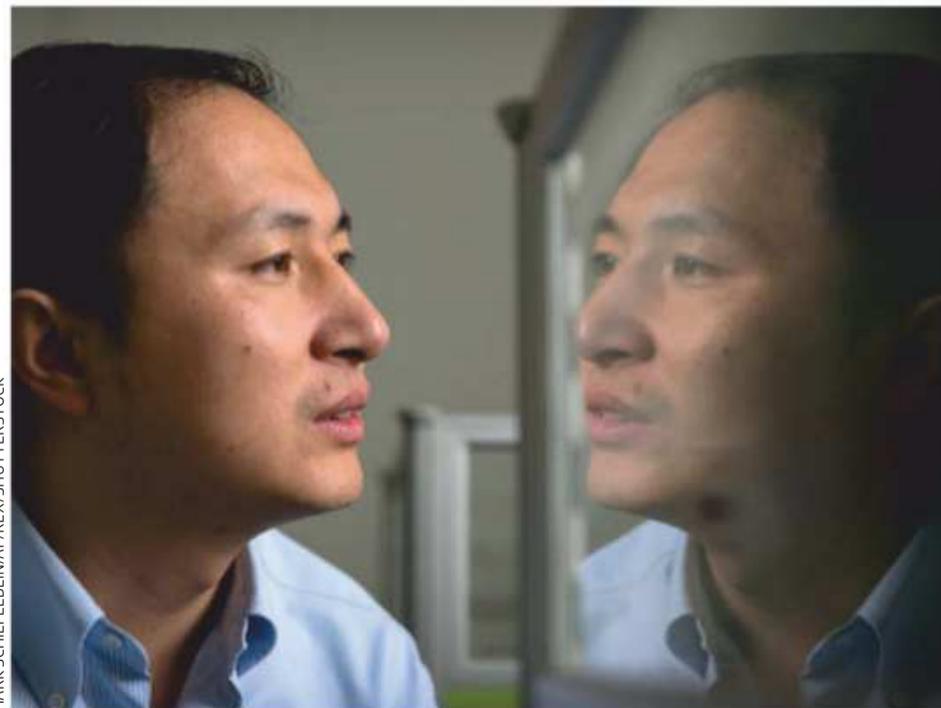
A WOMAN in China has given birth to two genetically edited girls, according to the Associated Press news agency. The aim of the experiment was to create children who are immune to HIV, but it hasn't yet been independently verified.

The experiment has been widely criticised as unethical, even by those who are in favour of using gene editing in eggs, sperm or embryos to prevent diseases in children if it can be done safely. The critics include more than 100 prominent Chinese scientists around the world, who have signed a letter condemning the experiment.

One way HIV infects cells is by binding to a protein on their surface called CCR5. The team in China, led by He Jiankui of the Southern University of Science and Technology of China in Shenzhen, says it has used the CRISPR gene-editing technique to try to disable the gene for CCR5.

But we don't yet know if it is

He Jiankui says he has altered genes in a pair of twins



MARK SCHIEFELBEIN/AP/REX/SHUTTERSTOCK

arrests, analytical tools run the risk of limiting police enquiries to well-trodden locations and can reinforce bias, says Andrew Ferguson at the University of the District of Columbia. Arrests correlate with where police are deployed and not where crime is, which tends to disproportionately affect people of colour and residents of poor areas, he says.

Martin Innes, director of the Crime and Security Research Institute at Cardiff University, UK, says he is "sceptical" that the system will reliably predict offences at an individual level. The tool will probably be more useful for generally locating communities at risk, he says.

West Midlands Police has asked Innes and his colleagues to independently evaluate the effectiveness of NDAS at a later date.

An inherent difficulty with such systems is knowing whether the predictions would have turned out to be valid had police or other services not intervened, says Sandra Wachter at the Oxford Internet Institute. "How would I know that this actually makes the right decision? That's something that is very hard to measure." ■

safe to delete both copies of the CCR5 gene in every cell of the body. "We don't know what the full effects will be," says Greg Neely at the University of Sydney, Australia.

Seven pairs of men and women reportedly took part in the experiment. All of the men were HIV-positive, and their sperm was treated to rid it of any HIV before it was injected into eggs extracted from their partners. The CRISPR gene-editing machinery was then injected into these embryos.

In total, 22 embryos were made this way. To check that the gene editing had worked, a single cell was removed from each embryo and analysed. He says that 16 embryos had been edited, 11 of which were implanted. Only one pregnancy was successfully achieved, and it produced twins.

Of these twins, one is said to have had both her copies of CCR5 disabled. That means that her body won't make the CCR5 protein, and her cells should be able to resist infection with strains of HIV that exploit CCR5 – although not all do. What's more, the baby's mother doesn't have HIV and her father's HIV is

apparently well-controlled. Simple measures should be enough to prevent the father from passing the virus to his child, with no need for gene editing. "There is no pressing need for this – it's totally inappropriate," says Neely.

According to the Associated Press, the embryo for the second twin only had one copy of CCR5 disabled. This child will still be vulnerable to all strains of HIV.

The vast majority of biologists who use CRISPR gene editing think it is too early to attempt to use it for editing human embryos because it is still far from clear if it is safe.

In several studies, human embryos have been genetically edited to see if CRISPR works in people, and then destroyed rather

"If true, this experiment exposes healthy children to the risks of gene editing for no necessary benefit"

than being implanted. The largest of these studies, done in the US, was widely reported as being successful, but in fact the findings have been questioned by many in the field and remain highly controversial.

He is understood to have conducted the work at a private hospital while on unpaid leave from the Southern University of Science and Technology of China. The Shenzhen City Medical Ethics Expert Board has said it will launch an investigation, as has China's National Health Commission.

"If true, this experiment exposes healthy children to the risks of gene editing for no real necessary benefit," ethicist Julian Savulescu at the University of Oxford told the UK's Science Media Centre.

Savulescu says that, if the science improves, it might be reasonable to try using CRISPR in embryos with lethal genetic mutations. "Gene editing for this group might be life-saving; for the [twins], it is only life risking." ■

Rats are sociable even with robots

Alice Klein

WOULD you help a trapped robot? Some rats would. The rodents can form social bonds with robots and will even rescue a robotic rat that is trapped in a cage.

Rats and other animals need to be highly attuned to social signals from others so they can identify friends to cooperate with and enemies to avoid.

To find out if this extends to non-living beings, Laleh Quinn at the University of California, San Diego, and her colleagues tested whether rats can detect social signals from robotic rats.

They housed eight adult rats with two types of robotic rat – one social and one asocial – for four days. The robot rats were quite minimalist, resembling a chunkier version of a computer mouse with wheels to move around and colourful markings.

During the experiment, the social robot rat followed the living rats around, played with the same toys, and opened cage doors to let trapped rats escape. Meanwhile,

the asocial robot simply moved forwards and backwards and side to side.

Next, the researchers trapped the robots in cages and gave the rats the opportunity to release them by pressing a lever.

Across 18 trials each, the living rats were 52 per cent more likely

on average to set the social robot free than the asocial one (*Animal Behavior and Cognition*, doi.org/cxds).

This suggests that the rats perceived the social robot as a genuine social being, says Quinn.

The rats may have bonded more with the social robot because it displayed behaviours like communal exploring and playing. This could lead to the rats better remembering having freed

Rats will help other rats that have helped them in the past

it earlier, and wanting the robot to return the favour when they get trapped, she says.

“Rats have been shown to engage in multiple forms of reciprocal help and cooperation, including what is referred to as direct reciprocity – where a rat will help another rat that has previously helped them,” says Quinn.

The readiness of the rats to befriend the social robot was surprising given its minimal design, says Janet Wiles at the University of Queensland in Australia, who helped with the research.

The robot was the same size as a regular rat but resembled a simple plastic box on wheels. “We’d assumed we’d have to give it a moving head and tail, facial features, and put a scent on it to make it smell like a real rat, but that wasn’t necessary,” says Wiles.

The finding shows how sensitive rats are to social cues, even when they come from basic robots, says Wiles. Similarly, children tend to treat robots as if they are fellow beings, even when they display only simple social signals, she says.

“We humans seem to be fascinated by robots, and it turns out other animals are too,” says Wiles. ■



CHRIS SCUFFINS/GETTY

Misuse of nerve pain drug spikes in Australia

AUSTRALIA is the latest country to report an alarming rise in the misuse of the nerve pain drug pregabalin.

Pregabalin is a non-opioid drug that reduces pain by acting on calcium channels in the brain. It was originally developed to treat epilepsy but is now approved for treating nerve pain – the prickling, tingling sensation that can accompany conditions like diabetes and multiple sclerosis. In some countries, it is also approved for treating anxiety and muscle pain.

Anecdotal evidence suggests that doctors are turning to pregabalin for other types of pain, due to growing concerns about the harms of opioid painkillers like oxycodone and codeine, says Shalini Arunogiri at Monash University in Melbourne.

This is reflected in an increase in rates of pregabalin prescription, she says. Pregabalin is now the thirteenth bestselling drug in the US, and dispensing rates have more than doubled in Australia and more than tripled in the UK in recent years.

However, pregabalin is shaping up to be just as problematic as opioids, says Arunogiri. Her research shows that, since 2012, ambulance call-outs in the Australian state of Victoria as a

result of people misusing the drug have increased from 0.28 to 3.32 cases per 100,000 people – a trend which mirrors misuse in other parts of the country (*Medical Journal of Australia*, DOI: 10.5694/mja2.12036).

Some recreational drug users have reported taking large doses of pregabalin to experience euphoric and sedative effects, says Arunogiri. Her study found that half the people who were treated by paramedics for pregabalin misuse had a history of drug or alcohol misuse, depression,

“Pregabalin dispensing rates have more than doubled in Australia in recent years”

self-harm or suicidal thoughts.

Similar misuse patterns have been noted in other parts of the world. In England and Wales, for example, the number of deaths involving pregabalin or a related nerve-pain drug called gabapentin rose from fewer than one per year before 2009 to 137 in 2015. A recent study in four US states found that gabapentin was present in 22 per cent of people who had died of drug overdoses.

In response, the UK recently announced that it will make it illegal to possess pregabalin without a prescription from April 2019. The US Food and Drug Administration is also considering introducing tighter controls on pregabalin. Alice Klein ■

Mini placentas grown in the lab for first time

TINY human placentas grown in a dish are so close to the real thing that they can fool a pregnancy test into giving a positive result. The aim isn't to develop a full-sized placenta, but to study why some pregnancies go wrong.

Most cells used in lab studies form a flat layer when grown in a dish. This unnatural environment means they don't behave as they would when surrounded by other cells in the body. In the past few years, we have found the right cues to coax cells of several tissue types into forming complex 3D structures, creating miniature organs known as organoids.

Ashley Moffett at the University of Cambridge and her team looked at the hormones and other signalling molecules released by the placenta and uterus, and worked out by trial and error which ones are needed to grow placental organoids in the lab.

The group took samples of human placentas from early abortions and broke the tissue apart. When they added the cells to clumps of a gel-like substance to help support a 3D structure, they could grow mini placentas just half a millimetre wide. The lack of a blood supply limited further growth.

The organoids produced various placental proteins and formed into finger-like projections characteristic of the placenta's microstructure. The team also did tests to confirm that the cells were fetal in origin - as happens in pregnancy - not maternal (*Nature*, DOI: 10.1038/s41586-018-0753-3).

After several days, the organoids were making a range of hormones, including one detected by pregnancy tests, human chorionic gonadotrophin. A test kit placed in their dish showed a "pregnant" result.

Moffett says further work will help us understand why some pregnancies lead to stillbirths, small babies and pre-eclampsia - a dangerous rise in blood pressure in a pregnant woman. Clare Wilson ■



Design matters most for anti-pollution masks

CITY air is a killer. Governments are trying to cut urban pollution by encouraging the use of bikes, but this exposes people who cycle to emissions from the cars of those who don't. Are anti-pollution face masks the answer?

Fulvio Amato at the Institute of Environmental Research and Water Assessment in Barcelona, Spain, and his colleagues have tested nine commercially available masks aimed at cyclists for filtering out air pollution. The best screened out nearly half of the most harmful tiny particles that cyclists breathe in.

Air pollution has been linked to respiratory and cardiovascular disease, diabetes and cancer. It may also harm fetuses and impair cognitive function in children and adults. In 2014, the World Health Organization estimated that air pollution was a factor in 7 million premature deaths worldwide each year.

One of the nastiest things swirling around in city air is particulate matter - small particles spat out in exhaust

fumes, or tiny fragments of car tyres, brake pads or road surfaces that are shed through wear and tear. Particles less than 2.5 micrometres in diameter, known as PM2.5, can damage the lungs and even enter the bloodstream.

Amato's study is the first to test face masks designed for cyclists in an urban environment rather

"Despite the pollution, cycling around a city is still far better for your health than driving"

than the lab. The team fitted the masks to dummies and exposed them to inner-city traffic in Barcelona. To simulate the increased respiratory rate of a cyclist, the dummies sucked in air at three different speeds.

The best mask reduced the intake of PM2.5 by 48 per cent. It had a filter with three different layers that covered its entire inside surface. The mask was also a better fit to the dummy's face than the others. The worst mask only had filters over two air

Cyclists in smoggy areas may don face masks as a matter of routine

intake valves and didn't fit well (*Science of The Total Environment*, doi.org/cxdt).

If a mask doesn't fit properly it becomes ineffective, says Gary Fuller at King's College London, who wore a professionally fitted mask to protect against asbestos in a previous job. "Anyone who works in a hazardous environment knows you have to get the seal right," he says.

Even opening your mouth to breathe can affect the seal. "Any leaks and it doesn't work," says Fuller. "And if you have a beard, just forget it."

Cycling masks don't protect against harmful gases, such as nitrogen dioxide. "Chemical filters exist but they are much more expensive," says Amato.

Wearing a mask won't do you any harm. But Amato recommends simply avoiding rush-hour traffic and busy roads. If there is a cycle path by the side of the road, it makes sense to use it. "Distance from the road edge makes a great difference," he says. "Even a few metres significantly decreases exposure."

Fuller agrees. His team has helped to identify less polluted paths around London. The data went into developing an online tool called the Clean Air Route Finder, which suggests low-pollution routes between locations based on air quality readings for the day. Other apps exist for other parts of the world.

Despite the pollution, cycling around a city is still far better for your health than driving - whatever the route. You are probably exposed to less air pollution on a bike than in a car because car passengers sit directly behind other cars' exhausts, says Fuller. Several studies have also found that the benefits of physical activity more than compensate for the negative effects of pollution, he says.

Douglas Heaven ■

Martian probe set to hunt 'marsquakes'

Mika McKinnon

InSight mission control, California

THE newest robotic resident of Mars has begun its two-year mission to investigate the deep unknown. Unlike every other spacecraft that has visited Mars, NASA's InSight probe won't explore the surface. Instead, it is set to reveal the secrets within the Red Planet and make the first ever measurement of a "marsquake".

"Mars has so many missions that have been able to explore the

"InSight carries instruments that will unmask even the tiniest slosh within the molten Martian core"

exterior by orbiting or by roving around on the surface," says Elizabeth Barrett, science system engineer with the mission. "InSight is going to be that first mission that will look further into the interior."

The spacecraft touched down on 26 November in a region called Elysium Planitia, following a six-month journey from Earth and 6.5 minutes of terror – the descent involved burning heat shields and a supersonic parachute.

This landing site was chosen in the hope it would be a big, flat plain of sand. The team wanted to land somewhere with as few rocks as possible, because InSight will use its robotic arm to gently pluck instruments from the spacecraft and nestle them onto the surface.

InSight is equipped with an array of geophysics tools: a seismometer to detect movements as small as the diameter of an atom, a heat flow probe that will burrow like a mole into the depths, a radio experiment that will unmask even the tiniest slosh

within the molten Martian core.

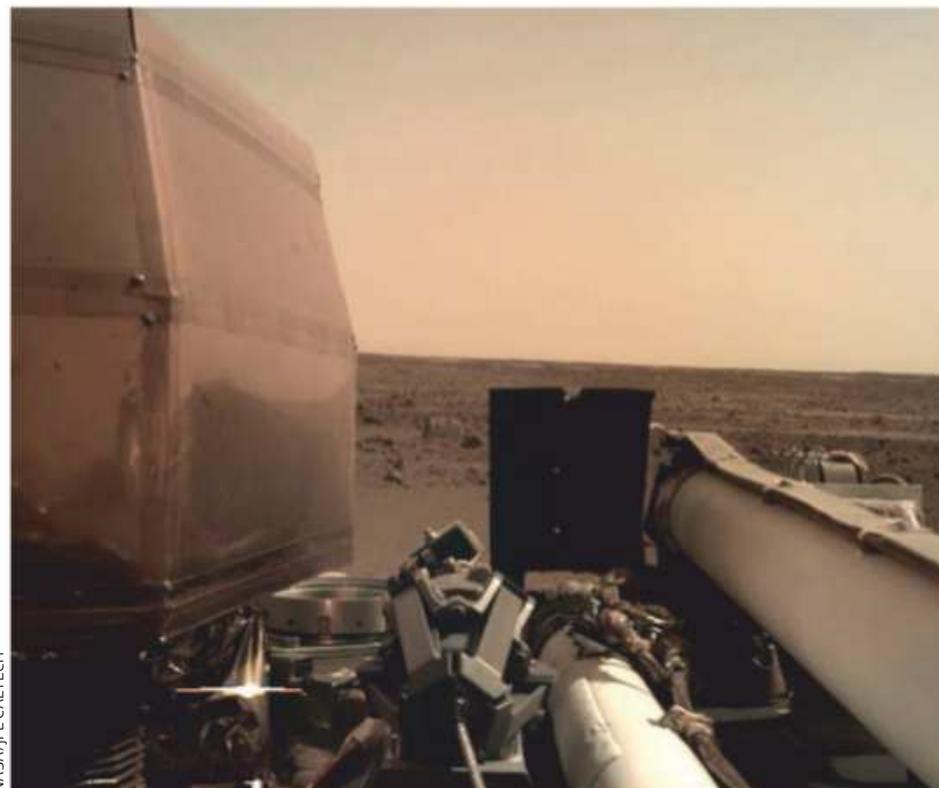
Each is geared to explore the planet's structure. Some will help determine the thickness and composition of the crust, mantle and core, and others will tell us how much heat the planet has now, allowing scientists to untangle its history of eruptions.

By studying the inside of Mars, we will have a better understanding of how rocky planets form, and the differences and similarities in how Earth and Mars came to exist.

InSight may even be able to measure the pitter-patter of meteorites as they strike the surface of Mars, by picking up seismic waves from impacting space rocks.

This isn't the first seismometer to go to Mars. Both the Viking missions in the 1970s carried seismometers, although only one of them was functional after landing. But the Viking

The view of Elysium Planitia on Mars shortly after touchdown



NASA/JPL-CALTECH



NASA/JPL-CALTECH/LOCKHEED MARTIN

seismometer was mounted on the spacecraft's deck, which caused unforeseen problems.

"Unfortunately, the deck of the spacecraft is cushioned by springs that are dampening the landing, and it's rocked by the wind as it blows past," says Barrett.

"The seismometer was very good at measuring the wind rather than any actual seismicity of Mars!" One of the scientists on the InSight mission saw it as his duty to ensure its seismometer could be placed correctly on the ground, she says.

The successful landing this week was cause for major celebration. At mission control in NASA's Jet Propulsion

InSight spreads its solar panels before a long voyage

Laboratory in California, the room was full of delighted relief, a celebratory feeling with a hint of shock that it had all happened so quickly. With each new report of incoming data and its beeps, cheers and clapping spread again. It was the perfect landing to start InSight's adventure on Mars.

Barrett says this is just the beginning. In the next few months, the lander will begin to deploy its instruments and start gathering data in earnest. She is excited for big mission milestones, like hammering the heat flow probe into the ground or recording the first marsquake on the seismometer.

InSight also broke new scientific ground with the use of a pair of cubesats – lunchbox-sized probes collectively known as Mars Cube One – to accompany the spacecraft and relay signals back to Earth. This means that, for the first time, we received real-time reports of a Mars landing limited only by the speed of light.

The small probes lack fuel or engines, so were unable to enter orbit and have already hurtled past Mars, but their successful deployment means future space missions could be similarly accompanied. InSight will now rely on existing Mars satellites, like NASA's Mars Odyssey orbiter, to send data back to Earth. ■

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Parkinson's linked to brain's autopilot

Clare Wilson

PEOPLE with Parkinson's disease are less likely to make mistakes that happen when we are "on autopilot". The surprising finding helps support a new idea about the root causes of the condition, and might lead to a test for early signs of illness.

Parkinson's is a progressive disease with core symptoms such as slowness, movement difficulties and tremors. We know that it involves the death of brain cells, especially those that make dopamine, which is involved in sending nerve signals.

In 2010, Peter Redgrave at the University of Sheffield, UK, and his colleagues went a step further, and came up with the idea that many of its core symptoms are caused by the loss of automatic movements. Whenever we first carry out a movement, it requires conscious effort. After many repetitions, we do it unthinkingly. Many everyday actions, from walking to grasping objects, are at least partly automatic.

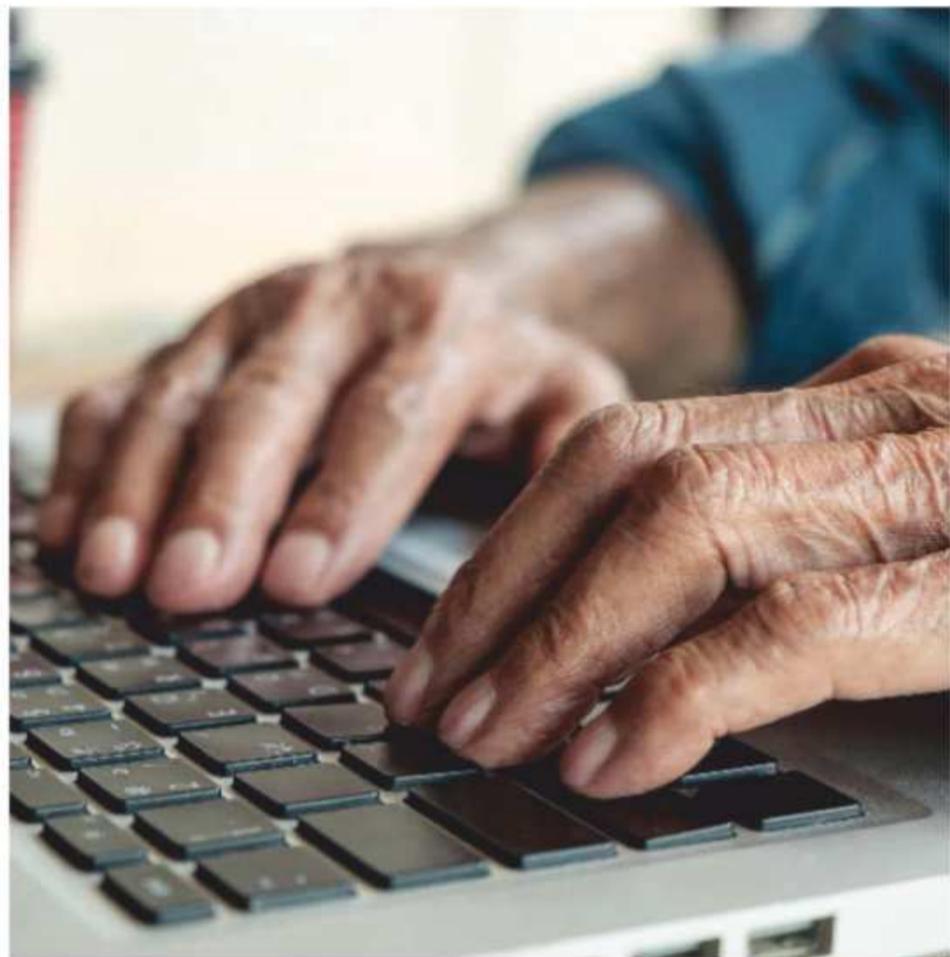
Redgrave's idea is bolstered by more recent work showing that some of the first brain cells to die

in Parkinson's are those that give automatic control. According to Redgrave, this could explain why people with the condition start walking in a shuffling way – because they are having to think about every step. His colleague Tom Stafford, also at Sheffield, came up with a way to test this.

Redgrave's premise means that people with Parkinson's are less able to function in autopilot, so should be less prone to errors that arise from this brain mode. We call these kinds of errors "action slips". An example is when we drive a certain route to work every weekday and then wrongly take that route on a Saturday trip to the gym.

Mistakes like those can't easily be measured, but action slips also happen when we type. People often automatically type "thing" instead of "think" because "ing" is a common group of letters in English, for instance. So the team designed a typing test that can distinguish between these kinds of keyboard slips and those caused by clumsiness. At its core is software that knows the most common letter combinations.

The researchers got 61 people,



NUTTAPONG PUNNA/ALAMY STOCK PHOTO

Keyboard slips are shining a light on the causes of Parkinson's disease

about half of whom had Parkinson's, to type sentences, which the software analysed. Those with the condition made more clumsy mistakes but fewer action slips than other volunteers (*PsyArXiv*, doi.org/cxch).

David Dexter of Parkinson's UK says this not only sheds light on the condition's causes, but might be the basis of a new test for those in the earliest stages of the illness.

At the moment, people tend to be diagnosed only once they have physical symptoms, but the sooner treatment starts the better. "There are quite a lot of drugs in development," says Dexter. "We need to be ready to use them by being able to spot people who have early Parkinson's."

However, the study involved people who had already been diagnosed with the condition, so further work is needed to see if the typing test can identify people before this point, says Dexter. ■

UK homes must switch to green heating system

TEN million homes in the UK must consider overhauling their heating systems by 2035 to help tackle global warming.

They will need to install hybrid heating systems, consisting of an electrical heat pump that works alongside their gas boiler. That is the finding of a report from the UK's Committee on Climate Change, the

expert body advising the government on how to meet its climate targets.

"We are talking about a large-scale roll-out," says David Joffe of the committee, who is currently installing such a set-up in his own home.

Installing these hybrid systems in a house should cut its natural gas use by 70 per cent or more. In the longer term, the gas supply system could be switched to carry hydrogen to fuel boilers and cut emissions further still. And by 2050, electrical heat pumps might entirely replace gas.

But greening heating systems won't be cheap. While the running

costs of hybrid systems should be similar to those of a gas boiler, upfront costs are higher. Joffe says his system will cost around £7000, with grants available to cover £4000 of that.

"Depending on the development of hydrogen-ready appliances and the cost premium over natural gas boilers, the government should consider mandating hydrogen-ready heating appliances by the mid-2020s," the

"Fitting a hybrid heating system should cut natural gas use in a home by at least 70 per cent"

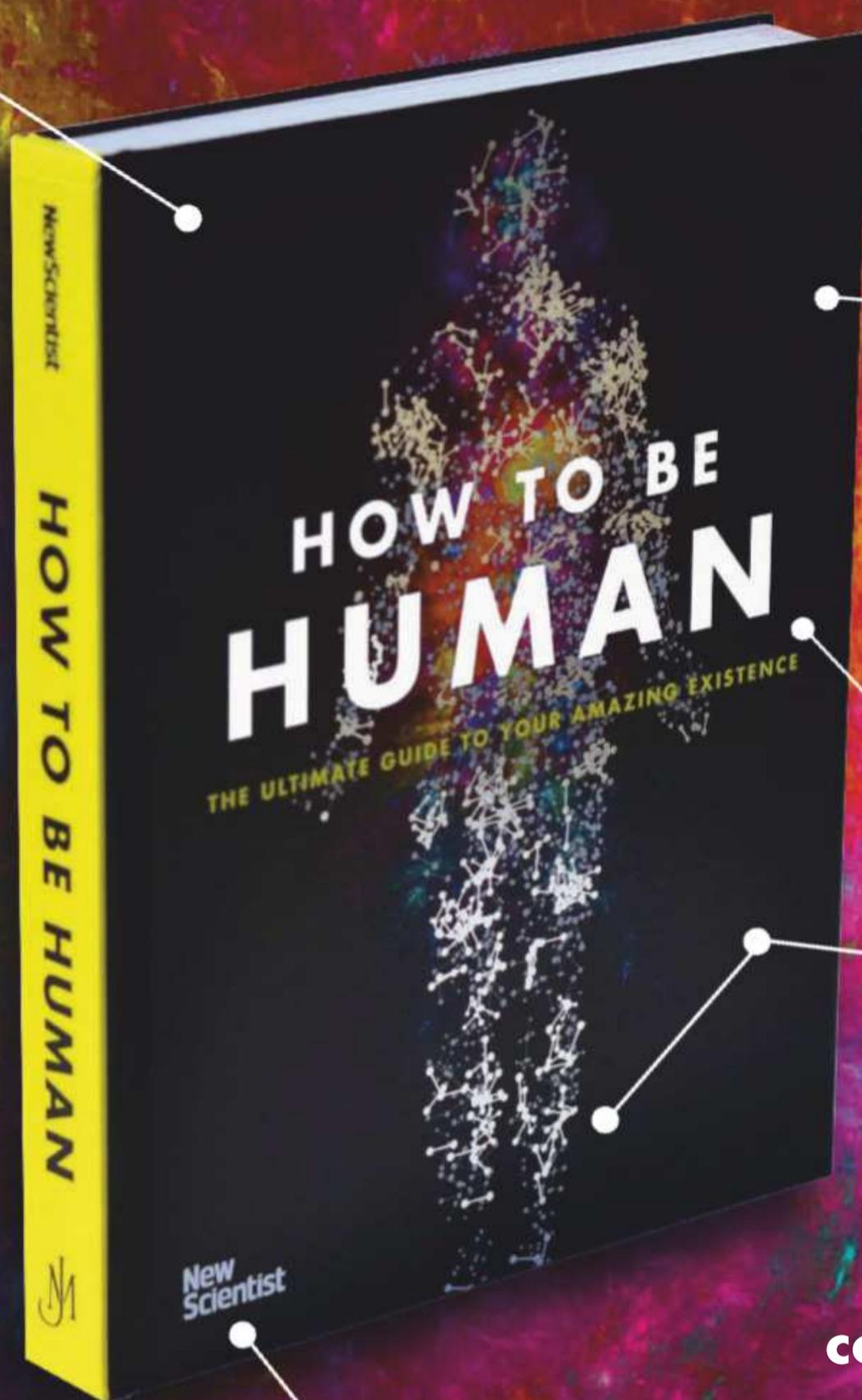
report states. It compares such a push to that requiring use of more efficient condensing gas boilers in the past.

It is clear that the world urgently needs to switch to clean, green ways of heating buildings. Three things need to be done to achieve this, says Richard Lowes at the University of Exeter in the UK, who studies energy policy. "Reduce demand with energy efficiency delivery, electrify heat with heat pumps and grow heat networks in dense urban areas."

Sweden has reduced emissions from heating buildings by 90 per cent this way. Michael Le Page ■

Humanity will need the equivalent of 2 Earths to support itself by 2030.

People lying down solve anagrams in 10% less time than people standing up.



About 6 in 100 babies (mostly boys) are born with an extra nipple.

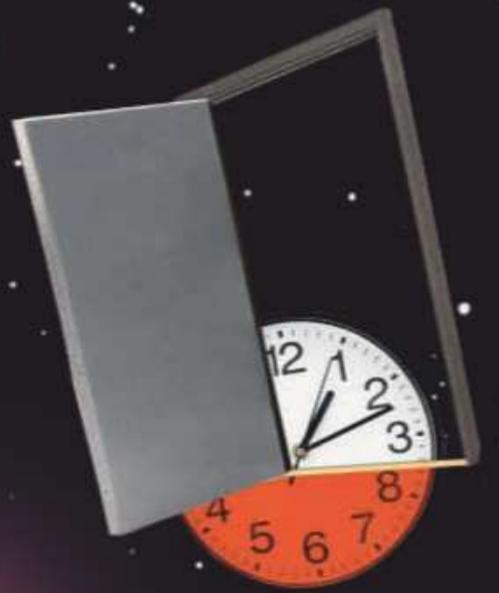
60% of us experience 'inner speech' where everyday thoughts take a back-and-forth conversational style.

We spend 50% of our lives daydreaming.

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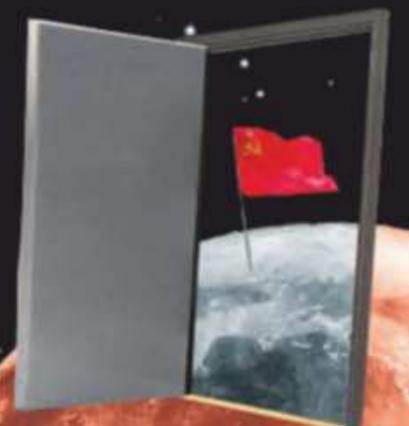
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First farmers kept wild fare on menu

Colin Barras

IT IS a familiar tale: when humans started farming, their lifestyles changed radically and forever.

People stopped foraging, and had a narrower, nutritionally poorer diet. But new evidence suggests we may need to rethink this story.

Farming arose in many places, but the “Fertile Crescent”, an area that today includes parts of Egypt, Iraq and other countries, was one of the first. Many archaeologists assume that there was a big shift in what people there ate when they became farmers 12,000 years ago. For thousands of years, they had gathered and eaten a wide range of plants, whereas the early farmers mostly grew and ate flax, barley, chickpeas and einkorn.

This assumption hadn’t been rigorously tested, say Michael Wallace and Glynis Jones at the University of Sheffield, UK. So they examined archaeological evidence from 75 sites across the Fertile Crescent, all between about 7000 and 14,000 years old.

Sifting through this for clues to

ancient diets, the team found that hunter-gatherers who lived in the area before farming may have eaten a narrower diet than we assumed.

At sites occupied by these pre-farmers, only 13 plant types – including winter wild oats, sea clubrush and plants from the cabbage family – were present in high enough amounts to suggest that they were definitely collected for food. What’s more, five of

“Abundant wild food may have enabled hunter-gatherers to experiment with farming”

these 13 – and dozens of other wild plants – still appear to have been eaten by farmers 8000 years ago, long after the farming revolution (*Vegetation History and Archaeobotany*, doi.org/cxdp).

This study shows that agricultural communities continued to eat wild plants, says Amaia Arranz Otaegui at the University of Copenhagen, Denmark. Earlier this year, her

The switch to agricultural life may have been smoother than assumed

team discovered that some of the last hunter-gatherer communities in the Fertile Crescent baked bread, a foodstuff once assumed to have been invented by farmers.

Together, these findings suggest the switch from hunter-gatherer to farmer wasn’t as drastic as we thought.

This might alter our current explanations for why everyone in the area ultimately became farmers, says Jones. It was thought that a changing environment made wild foods less abundant, forcing hunter-gatherers to begin growing crops developed by the first farmers. But it now looks like farmers continued to forage wild plants, suggesting these were still readily available.

Instead, wild resources may have been so plentiful that most hunter-gatherers across the region could afford to stop wandering, settle down and experiment with farming while still enjoying ample access to their pre-agricultural larder. Once the process began, says Jones, there might have been a region-wide coevolution of plants and people: several of the plants became crops, and all of the people became farmers. ■

Ocean meadow loss is adding to climate change

HUMAN activity has devastated a quarter of the seagrass beds along the coast of Kenya, resulting in the destruction of key habitats and contributing to climate change.

These aquatic plants grow along the shoreline in shallow ocean. They provide a home for marine animals such as turtles and fish, but also absorb carbon from the atmosphere through photosynthesis.

Mark Huxham at Edinburgh Napier University, UK, and his colleagues have used satellite images of Kenya to look in detail at seagrass coverage in East Africa, a region that has previously been poorly studied.

After comparing the current images of four sites with those from 15 and 30 years ago, the team concluded that Kenya’s seagrass meadows are shrinking by 1.6 per cent every year – equivalent to losing an area the size of 756 football fields annually. The decline shows no sign of slowing (*Biology Letters*, 10.1098/rsbl.2018.0227).

Huxham says human activities are the main drivers of the loss, especially fishing nets, boats and anchors ripping through the meadows.

What is more, carbon that would have been locked up by the seagrass at those four sites will end up in the atmosphere instead. The researchers estimated that this amounts to over 2 million tonnes of carbon, equivalent to 7 million tonnes of carbon dioxide, in the region over the past 30 years.

Globally, seagrass meadows have been vanishing at a rate of more than 7 per cent a year since 1990, which is comparable to the loss of coral reefs and tropical rainforests. However, the impact could be felt particularly hard in Kenya, because seagrass has strong links to the health of fisheries.

“Although rates of loss in Kenya are less than those in some other countries, given the high reliance of coastal people there on fisheries, we think this is a serious situation,” says Huxham. Yvaine Ye ■

Hit glandular fever virus to treat MS

Alice Klein

TRAINING the immune system to fight the Epstein-Barr virus, which causes glandular fever, leads to improvements in multiple sclerosis (MS) symptoms, a small clinical trial has concluded.

The Epstein-Barr virus has been suspected as a possible cause of MS because people who have had glandular fever – also known as infectious mononucleosis or mono – are more likely to develop the neurodegenerative condition. Multiple studies have now confirmed that almost every person with MS carries the virus and that non-carriers almost never develop the condition.

After most glandular fever episodes, the virus lies dormant in immune cells called B-cells without causing any further problems, says Rajiv Khanna at QIMR Berghofer Medical Research Institute in Australia. But evidence suggests that problems with some people's immune systems allow the virus-infected B-cells to invade their brain and spine, he says. The cells may then go rogue, attacking the protective coating around the nerves,

leading to the hallmark damage seen in MS.

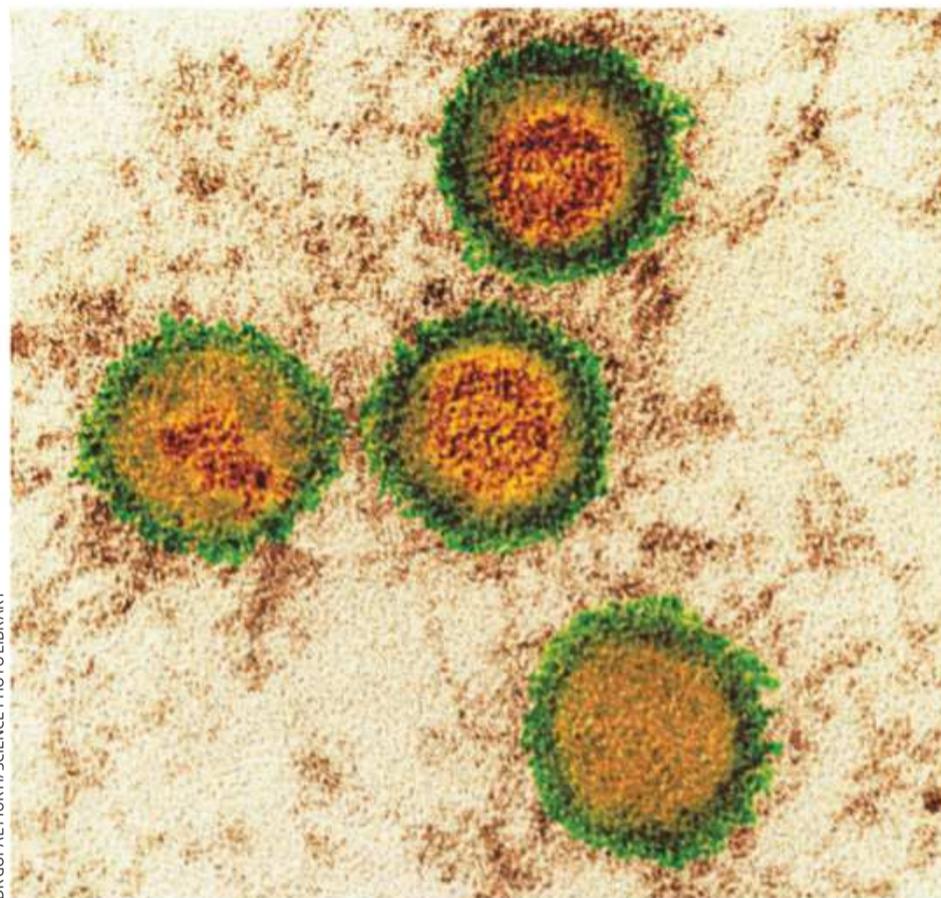
Khanna and his colleagues wondered if they could help people with MS by encouraging their immune systems to control the Epstein-Barr virus. The hope was that doing so would improve their symptoms, which

commonly include problems with vision and muscle control.

In 2013, the researchers tested this idea in a man with MS. They extracted a subset of his immune cells called T-cells, and by exposing them to Epstein-Barr virus antigens, trained them to attack the virus. They then re-injected the cells into his body.

Afterwards, the man reported feeling less tired, having fewer painful leg spasms and

Epstein-Barr viruses are found in almost everyone with MS



DR GOPAL MURTI/SCIENCE PHOTO LIBRARY

being more productive at work.

Khanna's team recently tested the same approach in 10 people with progressive MS, a form of the disease in which symptoms are constant and get steadily worse. Unlike with relapsing MS, which has symptom-free periods, there are few treatments available for the progressive type.

Seven of the people reported improvements, including increased energy and the ability to do everyday activities, as well as better concentration and mental clarity. In four people, levels of an MS-associated protein called immunoglobulin G also went down. None of the people in the study reported serious side effects (*JCI Insight*, doi.org/cxcj).

The findings strengthen the idea that the Epstein-Barr virus plays a role in MS, says Hamish Campbell at MS Research Australia. However, it remains a mystery why only a small percentage of virus carriers go on to develop the condition, he says. There may be genetic reasons why some people's immune systems are better at managing the virus than others, he says.

The clinical results are exciting so far, says Khanna, but the treatment still needs to be compared against a placebo in larger groups of people. His team is currently planning a bigger trial in Australia and the US that is due to start in the first half of 2019. ■

Shallow seabed can act as a tsunami trap

TSUNAMIS can keep pummeling the same patch of coast for days at a time if conditions are right. The finding means the initial big wave may not be the only source of danger and authorities might need to rethink their tsunami evacuation responses.

On 8 September 2017, a deadly magnitude-8.2 earthquake struck off the south coast of Mexico. The quake

caused a tsunami in the Pacific Ocean. This reached a maximum height of 3 metres when it hit land, which is modest by tsunami standards. However, it was unusually long-lived, lashing the coast for three days after the initial wave.

Long-lasting tsunamis have been seen before. Waves from the 2011 Tohoku tsunami that devastated parts of Japan were detectable across the Pacific for five days. But that tsunami was caused by a bigger earthquake and the first wave was 30 metres tall. The persistence of the smaller Mexican tsunami is surprising.

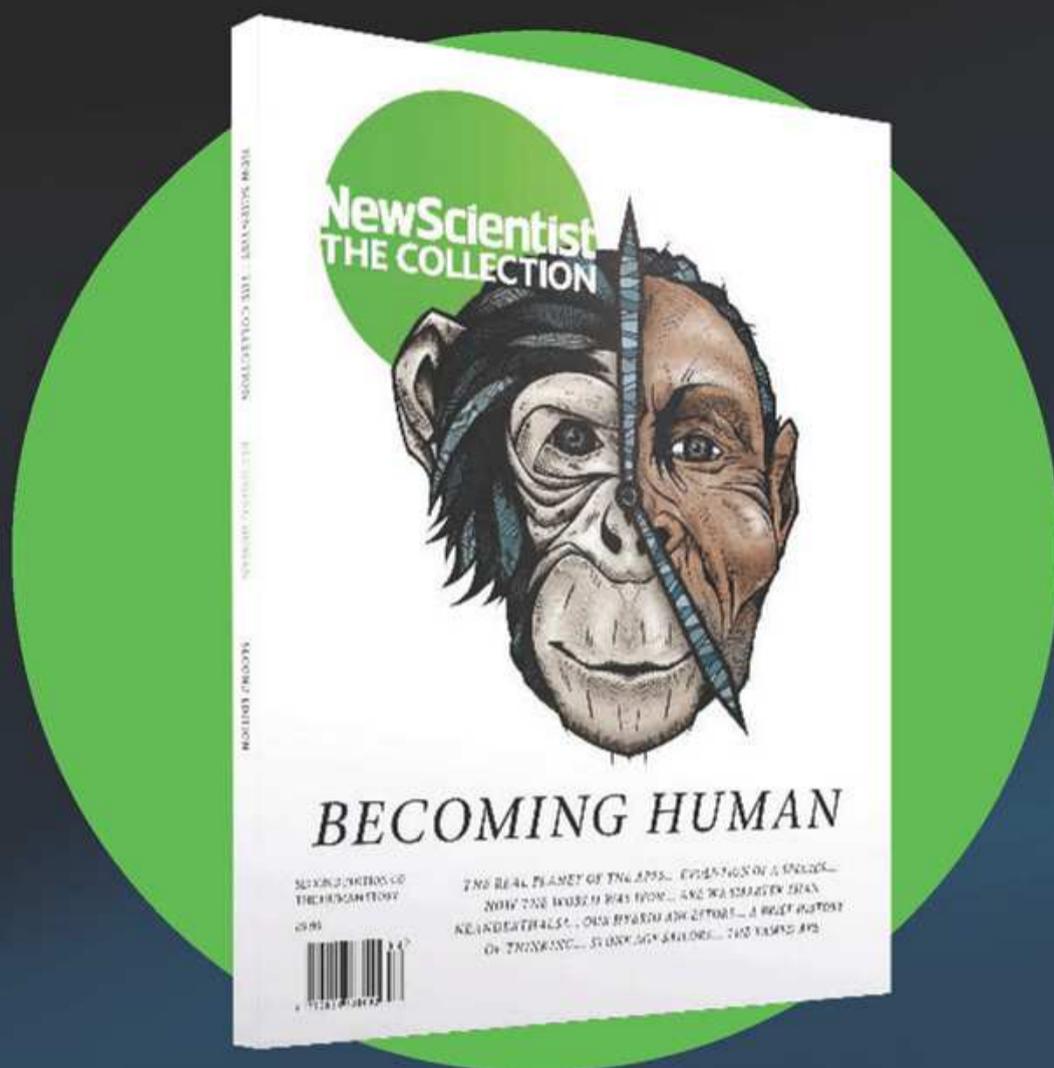
To work out why it had such staying power, Diego Melgar at the University of Oregon and Angel Ruiz-Angulo of the National Autonomous University of Mexico modelled it on a computer.

The key factor seems to be that the tsunami originated not far offshore and within the Tehuantepec continental shelf. This region of the ocean has a very flat and shallow sea floor that stretches more than 100

kilometres offshore. A tsunami here becomes trapped and "just knocks about for a long time", says Melgar. It reflects off the shore and bounces out to sea. Then when it hits the large body of deep water at the edge of the continental shelf, it reflects back towards the coast (*Geophysical Research Letters*, doi.org/gfj2q9).

If the region experienced a big tsunami, it might remain dangerous long after it first struck the coast, says Melgar. Civil authorities should bear this in mind when planning tsunami evacuation responses, he says. Michael Marshall ■

"If the region experienced a big tsunami, it might be dangerous long after it first struck the coast"



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Hens get 'Fitbits' to help them stay healthy

CHICKENS are getting backpacks to keep them in good shape. The tiny wearable electronic packs analyse the birds' behaviour, which could reveal if something is up.

The devices contain accelerometers that record movement. An algorithm uses data from the sensors to identify when and for how long the chickens perform various activities, such as preening, which give clues about health.

This could help show whether farm birds are being disturbed by parasites, such as the northern fowl mite, which feeds on chicken's blood, says Amy Murillo at the

University of California, Riverside, one of the team that developed the wearable tech.

The mite mainly affects egg-laying hens, which are kept alive much longer than those bred for meat. At the moment, farmers have to check chickens manually and individually for signs of mites. The technology could make monitoring the birds far less labour-intensive.

To train the system to analyse chicken movements, Murillo and her colleagues filmed hens wearing the backpacks, which they dubbed "Fitbits for chickens".

They then labelled the birds' behaviour accordingly, so that the system could associate various activities with movement data. Their algorithm can now automatically classify pecking, preening and dust-bathing with over 85 per cent accuracy (arxiv.org/abs/1811.03149).

Brain cells rearrange DNA in Alzheimer's

BRAIN cells are reshuffling their DNA. This may explain how Alzheimer's disease develops and inspire new treatments for it.

Most drugs to combat this type of dementia are designed to clear the build-up of clumps of beta-amyloid protein from the brain. But drug trials have disappointed.

While studying the gene that makes beta-amyloid – called *APP* – Jerold Chun at Sanford

Burnham Prebys Medical Discovery Institute in California and his colleagues found it seemed to be able to reshuffle its DNA, enabling it to take thousands of forms (*Nature*, doi.org/gfkbbh).

There were about 10 times more variants of *APP* in brain cells of people with Alzheimer's than in those without it. These forms can produce various toxic proteins in addition to beta-amyloid.

The finding may explain why Alzheimer's drugs that specifically target beta-amyloid have had little success, says Chun. "They may be missing thousands of other toxic products that are a bit different or maybe very different," he says.

His team's research suggests that the reshuffling is linked to the activity of enzymes called reverse transcriptases. Existing HIV drugs that block these enzymes may also work on Alzheimer's, says Chun.

Shine a light on skin to test for diabetes

THE way your skin reflects light can reveal your risk of getting diabetes and heart disease.

Glucose in blood can stick to proteins in skin, forming "glycated" proteins known as AGEs, which stiffen tissues. This happens with age, but can also indicate a risk of diabetes and heart disease. AGE levels can be measured in skin, because of the way they reflect fluorescent light.

Bruce Wolffenbuttel at the University of Groningen in the Netherlands and his colleagues tried AGE testing with 70,000 people who were free of diabetes and heart disease. Four years later, those with high AGE readings at the start were more likely to have developed diabetes or heart disease (*Diabetologia*, doi.org/cxb4).

The test could be used for widespread screening, but trials would have to show it does more good than harm, for example misdiagnosing healthy people.

Fathers can pass on mitochondria too

THE energy-making structures in our cells are usually inherited just from our mother. But US doctors have now found more than a dozen people in three families who inherited these mitochondria from both parents.

They seem to be very rare exceptions, probably because these families harbour mutations that disrupt the mechanism that normally prevents a father's mitochondria being passed on.

In 2002, a man was found with mitochondria from his father and mother. But with no other cases since, some doubted the finding. A team at Cincinnati Children's Hospital Medical Center now says it has identified 17 people with paternal inheritance (*PNAS*, DOI: [10.1073/pnas.1810946115](https://doi.org/10.1073/pnas.1810946115)).

Sickly ants keep their distance

WISH your coughing colleagues would stay away from the office? Unlike some humans, ants seem to understand the importance of avoiding others when infected. When foraging ants are exposed to a fungal pathogen, they reduce contact with those in the nest.

Nathalie Stroeymeyt at the University of Lausanne, Switzerland, and her colleagues have studied common black ants (*Lasius niger*) using a tracking system. Workers in these colonies are split into nurses, which work in the nest caring for the brood, and foragers, which collect food outside.

Foragers are most likely to pick up infections, but they interact less with other ants, and come into contact with those inside the nest infrequently. Stroeymeyt's team exposed some of the foragers to spores of *Metarhizium brunneum* fungus. The spores attach to an ant and, after a day or two, get into the insect and kill it.

Within a day of exposure – before becoming sick – foragers exposed to the spores changed behaviour, spending more time outside the nest and cutting contact with other workers. Foragers that weren't exposed to the pathogen also took steps to isolate themselves, and nurse ants moved eggs, larvae and pupae deeper into the nest (*Science*, doi.org/cxb2).



BUIJEN-BEELD/MINDEN PICTURES/FLPA

Revive a dying phone battery with the kiss of life

DON'T you hate it when your phone battery runs out? In the future, you might be able to give it mouth-to-mouth, thanks to a technique that harvests electricity from moisture in air.

Water droplets might seem an unlikely source of energy, but they can hold a form of static electricity called hygroelectricity, which is thought to be the source of the charge that causes lightning. This charge can be transferred from droplets to other tiny particles, such as dust.

It has previously been shown

that this energy can be harvested by structures made of graphene, a two-dimensional form of carbon. As tiny holes in these structures absorb water molecules, they become ionised, generating an electric current.

However, the structures used for this were bulky and rigid, making them impractical for small-scale electronics. To fix this, Huhu Cheng and colleagues at Tsinghua University and the Beijing Institute of Technology in China have made them out of thin films of graphene oxide that can

be rolled, stretched and folded into structures, including tubes, pyramids and balls.

To make flexible hygroelectric generators, the team used a laser to etch patterns on graphene oxide set on the surface of flexible films, which were then shaped. Spraying a mist of water droplets onto the surface of a generator, or even breathing through one rolled into a tube, produced voltages up to 1.5 volts, which is comparable to household AA or AAA batteries (*Advanced Materials*, doi.org/cxb6).

Elephantine beast walked with dinos

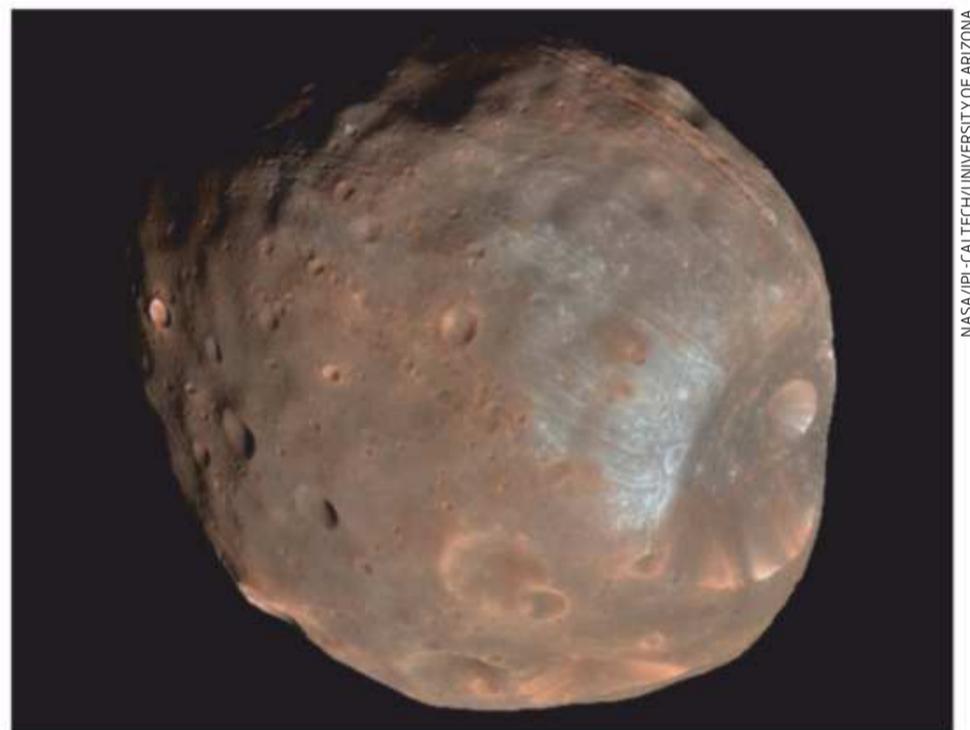
DINOSAURS weren't the only giants on Earth in the Triassic. Fossils of a bizarre, elephant-sized reptile more closely related to mammals have been found.

The creature was 5 metres long, 3 metres tall and weighed 9 tonnes. It looked like a bent-legged hippo with a beak and two tusks, according to fossil analysis by Grzegorz Niedzwiedzki at Uppsala University in Sweden and his team (*Science*, doi.org/cxb5).

During the Permian period, between about 300 and 250 million years ago, the largest herbivores were mammal-like reptiles called synapsids, some up to 3 metres long and weighing 2 tonnes. But their reign was ended in the mass extinction known as the Great Dying, after which dinosaurs came to dominate.

A few synapsids survived into the Triassic, but most were less than half a metre long. It was thought dinosaurs were the only animals to evolve into giants during the Triassic.

But about 208 million years ago at least one synapsid evolved into this new-found giant. It has been named *Lisowicia bojani* after the village of Lisowice in Poland near where it was found.



NASA/JPL-CALTECH/UNIVERSITY OF ARIZONA

Rolling stones got moon in the groove

THE huge grooves that cover Phobos, the biggest moon of Mars, may have been caused by boulders rolling across it after an asteroid impact.

Other planets and moons have similar scratches, says Kenneth Ramsley at Brown University in Rhode Island, but Phobos is covered in the marks, up to 30 kilometres long and 200 metres wide.

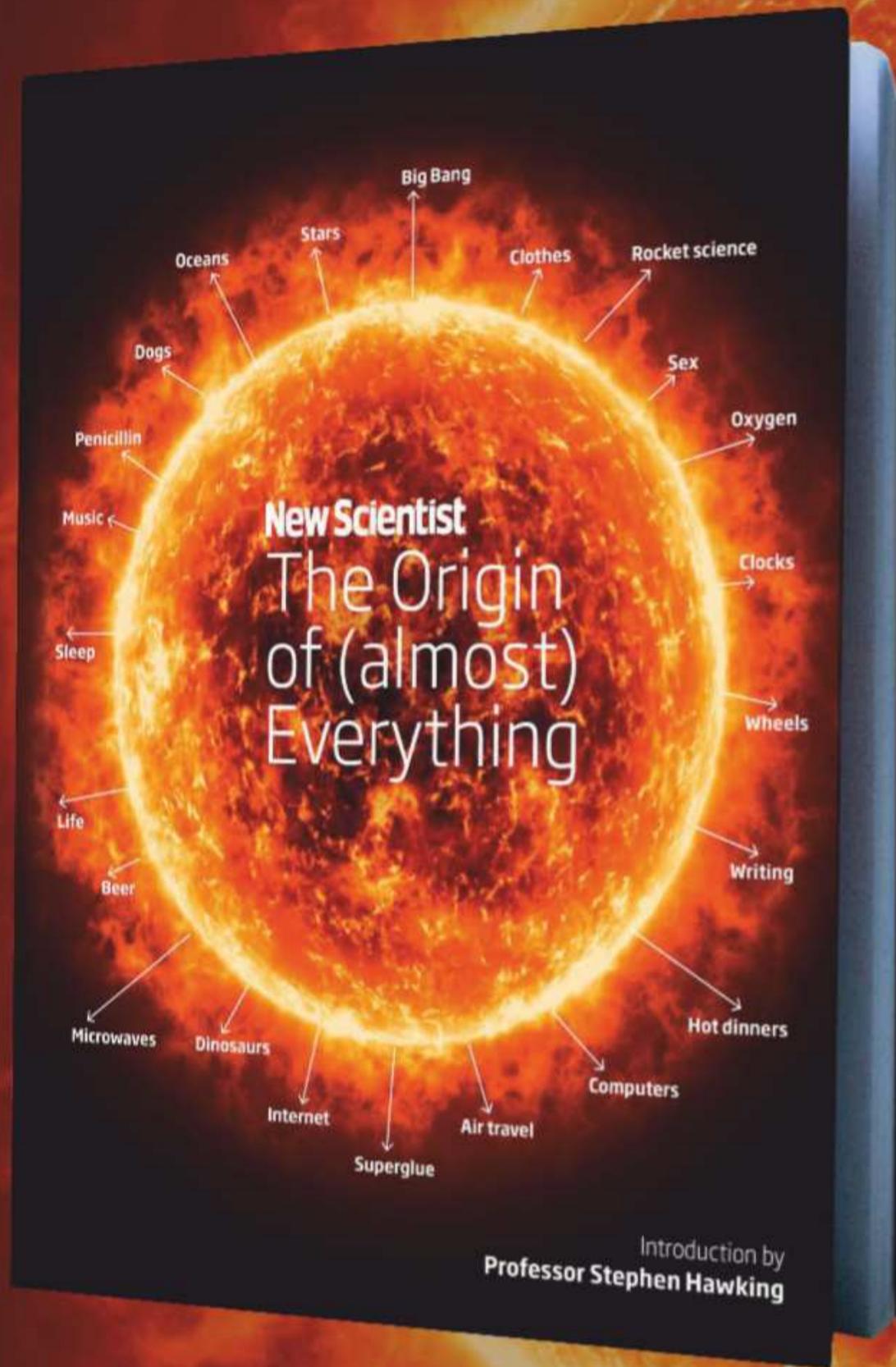
Ramsley and his colleagues simulated the Phobos-Mars system to examine whether these grooves could come from rolling stones. The pair says these would have been ejected from Stickney crater,

formed when a rock about 1 kilometre across smashed into Phobos about 150 million years ago.

The gravity of Mars would have caused some of the boulders to swiftly roll all the way around the moon, creating the lines that we see on its surface.

What about the lack of boulders on the surface now? Ramsley thinks debris from the impact got trapped in orbit around Mars and hit Phobos again, smashing up the boulders and hiding the smallest of the grooves under a layer of dust (*Planetary and Space Science*, doi.org/cxbz).

Where did we come from? How did it all begin?



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Introduction by **Professor Stephen Hawking**

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Have a green Christmas

Yuletide doesn't have to be a feast of rampant consumerism and devastating gluttony, say **Alice Klein** and **Chelsea Whyte**

IT'S the most wonderful time of the year, but it could still use some improvement. Christmas often brings a mix of joy, excitement and last-minute shopping panic, but it is also a time of reflection for many people, an opportunity to stand back and dwell on what really matters.

The past year has been a wake-up call about the state of the planet, with record-breaking heatwaves and wildfires highlighting the perils of climate change, and China's restrictions on rubbish imports spurring a global waste crisis.

Many of these problems are driven by rampant consumerism, which is on full display at Christmas time: shop shelves heaving with plastic trinkets, houses bedazzled with energy-sapping lights and bins clogged with piles of uneaten food.

If you celebrate Christmas, these woes don't mean you should give up and become the family Grinch. But there are ways of approaching festive traditions in a more environmentally friendly and socially responsible manner. We take a look at some of the most common ones so that you can have a guilt-free Christmas and bore your relatives with your new-found virtuosity.

Oh, Christmas tree...

There's nothing like the smell of a real Christmas tree permeating your home, but every year brings a pang of guilt about chopping down forests for temporary decorations. Are artificial trees the greener option?

Perhaps not. Fake trees are made from non-renewable plastics and

usually shipped long distances. To work out which is better for the environment, Canadian consulting firm Ellipsos calculated the environmental footprints of real and fake Christmas trees over their entire life cycles from production to disposal.

The firm concluded that you would have to reuse an artificial tree 20 times for it to become more eco-friendly than freshly cut trees, mainly because of the chemicals used during manufacturing and shipping

"Artificial trees must be reused 20 times to become more eco-friendly than freshly cut trees"

emissions. And even the fanciest fake tree is going to be pretty sorry-looking by Christmas 2038.

Cutting down natural Christmas trees isn't actually so bad, says Peter Kanowski at the Australian National University, because they are purposely farmed and grown each year. They also help to mitigate climate change by sucking carbon dioxide out of the air, he says.

To make your real tree even greener, Kanowski recommends sourcing it from the closest farm possible to reduce transport emissions, or even growing your own and keeping it in a pot in your garden year-round.

Once the festive season draws to a close, it is best not to chuck your tree in landfill where it will release methane – a potent greenhouse gas – as it rots. Most councils offer to collect your tree and turn it into mulch, which is then returned to the soil to nourish new life. It is a Christmas miracle.

Get stuffed

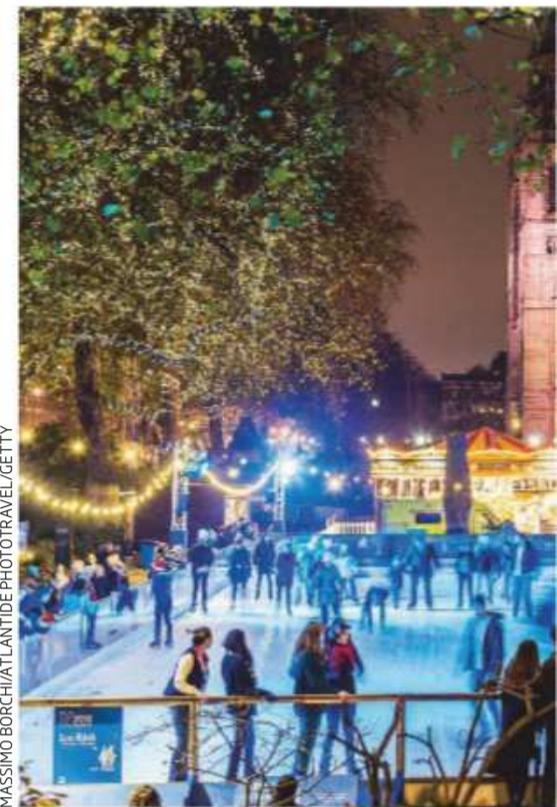
One of the best parts of Christmas is the food. Celebrations often call for tables overflowing with glistening pies, a succulent ham and a turkey fresh out of the oven. But the ghost at the feast is the huge environmental impact of such gluttony. Thankfully, making your holiday meal a little more Earth-friendly isn't too difficult.

"Reducing the amount of red meat and dairy you serve will go a long way to improving your environmental footprint," says Raychel Santo at Johns Hopkins University in Maryland.

"A lot of times when people remove meats, they add a lot of dairy and that has a high greenhouse gas footprint as well. Keep dairy as a garnish instead of a main component of the dish, and shift towards root vegetables or dishes with lentils or beans," she says.

Of course, a vegan meal is the ultimate ethical Christmas dinner, if you think you can pull it off. Santo says that as a society we need to shift towards eating less meat to lower our impact on climate change, but says that if you are going to eat meat in general, the times to do it are special occasions. So, if you can't stand the idea of Christmas dinner without the turkey – or even just less of it – consider making up for it by cutting out meat from your dinners one night a week in the months following the holidays.

Another way to ease your greenhouse gas contributions from food is to prevent waste. "It's much more important to prevent food waste than to compost it afterwards. That's



MASSIMO BORCHI/ATLANTIDE PHOTOTRAVEL/GETTY

Giving experiences like ice skating as gifts and cutting down on food waste will both keep your Christmas green - but a few fairy lights are OK

the second resort," says Santo. Make room in your freezer before the holiday, work out creative ways to eat up leftovers, and plan just how many cocktail sausages you really need for a festive party.

All this stuff adds up, but it is nothing compared with the greenhouse gas emissions we create as we travel to our holiday parties. "I'd be worrying less about serving meat and dairy at this one meal versus did we fly or carpool with a lot of family members, or find a way to take a train or bus," says Santo. Again, make your ethical holiday efforts part of your larger life, and think about



TETRA IMAGES/PLAINPICTURE

PLAINPICTURE/WESTENDIG/ROBIN PAGE

“There are far worse sins than lying to a child about Santa Claus. But when this is one puzzle piece in a culture that regularly oppresses children, we need to worry about that one piece,” says H. Peter Steeves, an ethicist at DePaul University in Chicago.

The modern vision of Santa as surveillance is all around us during Christmas. It’s right there in the song: “You’d better watch out, you’d better not cry... Santa Claus is coming to town”. Turning Father Christmas into a threat to monitor your child’s behaviour is troubling, says Steeves. It turns a wondrous story of make-believe into an almost-all-powerful kind of babysitter to get children to stop whining or go to bed on time. “That’s horrible. St Nick deserves better,” he says.

An extension of the ever-watchful threat is the Elf on the Shelf, a figurine that some parents place in their house that is said to be reporting to the North Pole like some kind of

festive CCTV – Steeves likens it to a panopticon.

This doesn’t mean that the myth of Santa Claus has to be set aside to enjoy an ethical Christmas. The magic and mystery is a great thing, but the ways we use this story may need to reflect more of the joy and wonder of the holiday.

Festive knitwear

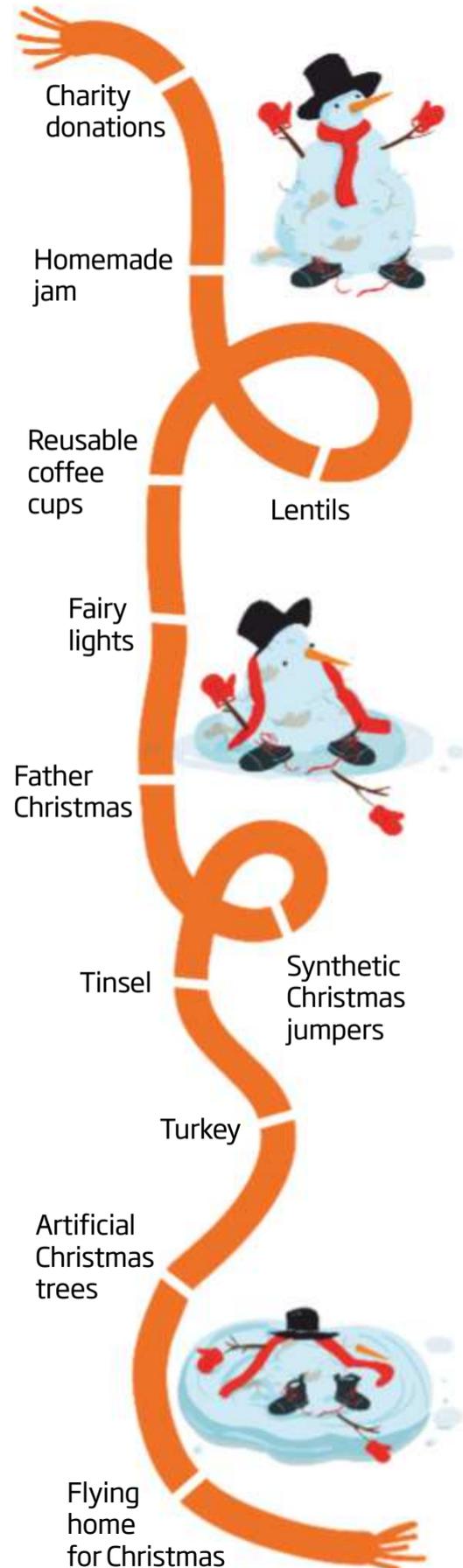
Donning the most garish Christmas jumper you can find has become a somewhat ironic holiday tradition. You can even use the fad as an excuse to raise money for charity, for example, by participating in Save the Children UK’s Christmas Jumper Day.

However, when selecting your tacky knitwear – complete with googly reindeer eyes and flashing lights – it is worth thinking about where it came from and where it will end up, says Sandra Capponi,

BE A CHRISTMAS NUMBER ONE

Are you a Christmas angel, or will you be getting a lump of carbon-belching coal in your stocking? See how your holiday plans rank on *New Scientist’s* list of what’s naughty and nice

NICE



NAUGHTY

offsetting any Christmas travel by biking to work at other times of the year, if that’s feasible.

Santa’s surveillance

For children, some of the magic of Christmas comes from believing in Santa Claus. The flying reindeer, the toy factory at the North Pole, the wish-fulfilment.

But is it ethical to lie to kids about the existence of a large, jolly man who brings presents, or could the lie at the heart of the Father Christmas myth be psychologically damaging?

ILLUSTRATION BY JOSIE FORD

co-founder of ethical fashion guide Good On You. Many stores sell super-cheap, mass-produced jumpers shipped from overseas factories with poor working conditions, she says. They also

“People in the UK throw away 108 million rolls of wrapping paper each year”

tend to be made from synthetic fabrics that don't break down in landfill and can leach harmful microfibres into waterways.

If you want to feel warm and fuzzy about your jumper selection, you could opt for a hand-knitted woollen version instead, says Capponi. Wool is biodegradable and you can find suppliers that have good animal welfare practices and make minimal use of pesticides, she says. Plus, it doesn't count as sweatshop labour if you make a family member knit it for you.

For vegans who are against wearing sheep's wool, Capponi recommends buying synthetic Christmas jumpers from second-hand stores, re-wearing them on consecutive Christmases rather than discarding them after one wear, and washing them as little as possible to minimise microfibre leaching.

Bright Christmas

Twinkly fairy lights can give even the dingiest apartment a festive feel, but can you really justify the carbon emissions?

Fortunately, yes – most modern fairy lights use LED light bulbs, which consume 90 per cent less electricity than incandescents. They also last for 100,000 hours, which beats the 3000-hour life expectancy of incandescent bulbs.

A standard string of fairy lights with 100 LED bulbs uses just 2 watts, which is one-fiftieth the energy consumption rate of a standard fridge. Even if you drape your house in 1000 LED lights and

switch them on for 5 hours every night in December, you will only chew through about 3000 watt-hours – less than half the power it takes to oven-roast a turkey.

To be as energy-efficient as possible, you can buy LED Christmas lights that operate on a timer, or if you live in a sunny climate like Australia, use solar-powered lights. Switching them to static rather than flashing mode also uses less power.

Finally, once your LED lights finally conk out, several lighting manufacturers and waste management companies now offer to recycle them.

What's inside?

Wrapping paper is festive and makes a gift feel special, and a Christmas card is a lovely way to let someone know you are thinking of them – at least until they get chucked into the bin. A 2017 survey estimated that people in the UK throw away 108 million rolls of wrapping paper each year. But these paper products are often not recyclable

because they can be made with plastics and glitter.

“Most wrapping paper is coated or has foil which would be detrimental for recycling. And all the sparkles on cards would be bad for recycling,” says Nina Goodrich, the director of the Sustainable Packaging Coalition in Charlottesville, Virginia.

“I would suggest saving good paper to use again and using bags that can be used multiple times,” she says. Instead of using plastic-coated ribbons, consider reusing fabric ribbons each year or simply adorning your boxes with a fresh-cut spring of holly or hearty herbs like rosemary.

As with foiled wrapping papers, tinsel is not recyclable. And neither are plastic-coated garlands. But that doesn't mean your tree needn't look festive. You can dress its branches with fabric or paper decorations, or even make some with your family around the holidays. And there is always the classic string-of-popcorn garland, which is fun to

Think of the polar bears when you are decorating your tree this year

make while snuggled up watching a Christmas movie. For your doors or mantle, take a cue from the old classic and deck them out with boughs of holly.

Thoughts that count

If you want to ooze self-righteousness and make your relatives feel guilty about buying you yet another piece of plastic junk, why not declare yourself an ethical gift-giver this Christmas?

Ethical presents are those that don't harm the environment during their production, don't require energy-intensive transport and don't generate lots of waste or rely on sweatshop labour, says Arunima Malik at the University of Sydney in Australia.

Examples include antiques, plants, homemade jams in recycled jars, hand-knitted scarves from your local markets, non-material experiences like cooking classes or tickets to shows, or charity donations made on the gift recipient's behalf, says Malik. The obvious no-nos are flimsy, throwaway plastic goods shipped from overseas, she says.

Not only does ethical gift-giving make you feel like a superior human being, it can also be easy on the wallet. Whip up a dozen homemade jams on the cheap, and if anyone complains about your stinginess, you can tell them you're just trying to save the planet.

Another option is to buy presents that foster green habits, says Malik. Home compost bins or reusable coffee cups or water bottles, for example, may encourage your relatives to reduce their waste over the long term, she says.

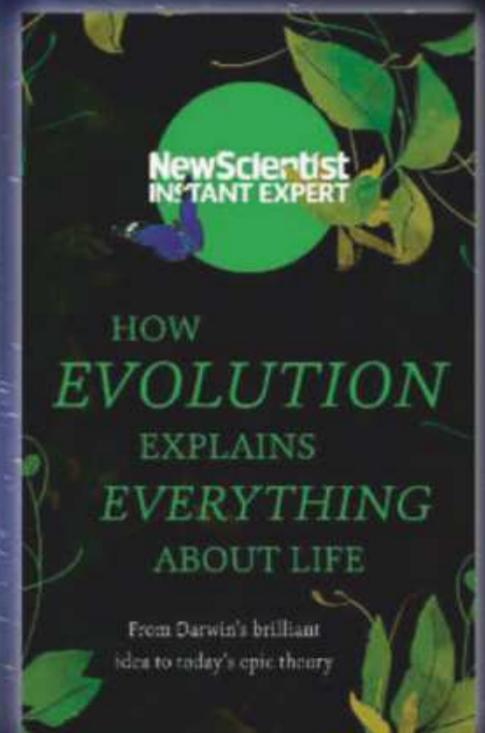
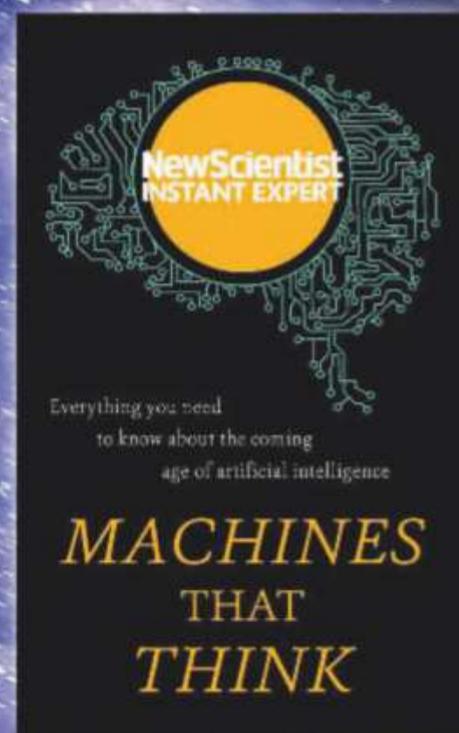
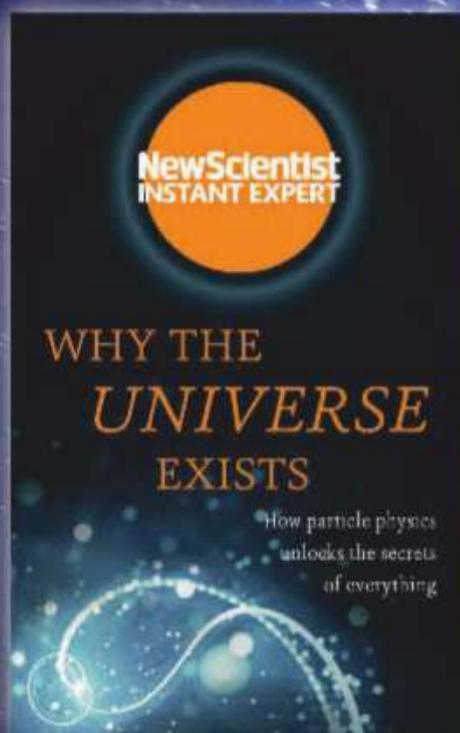
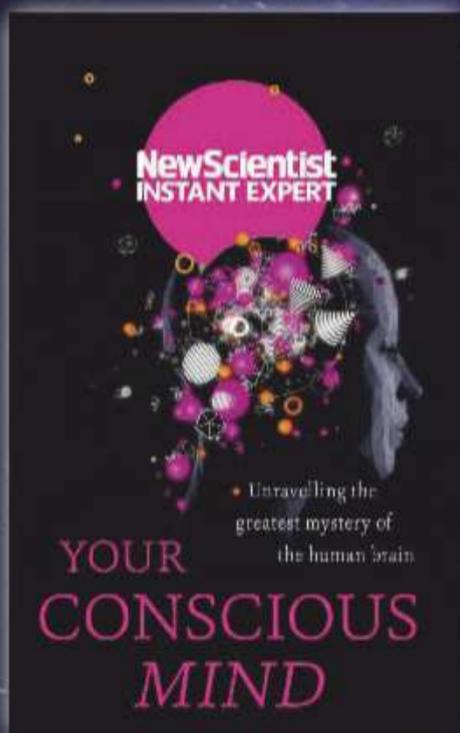
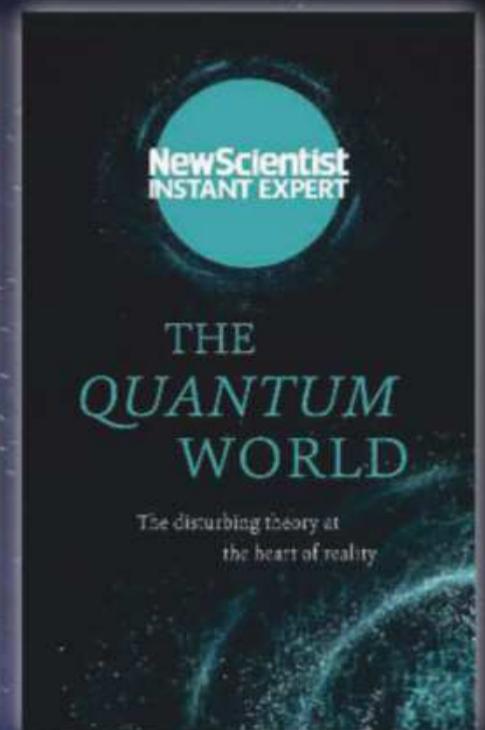
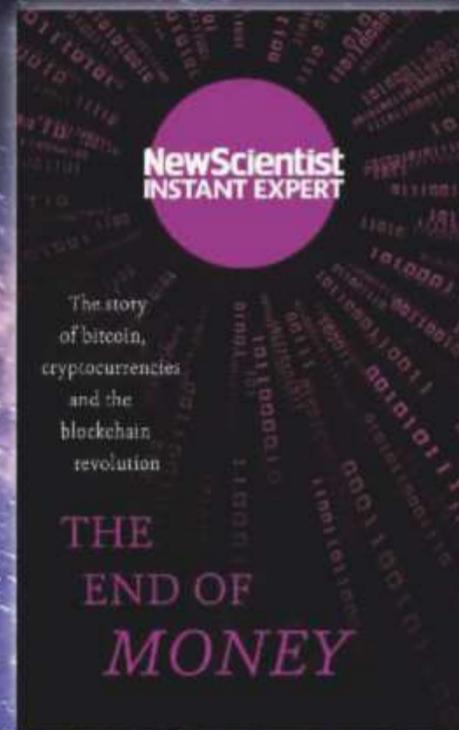
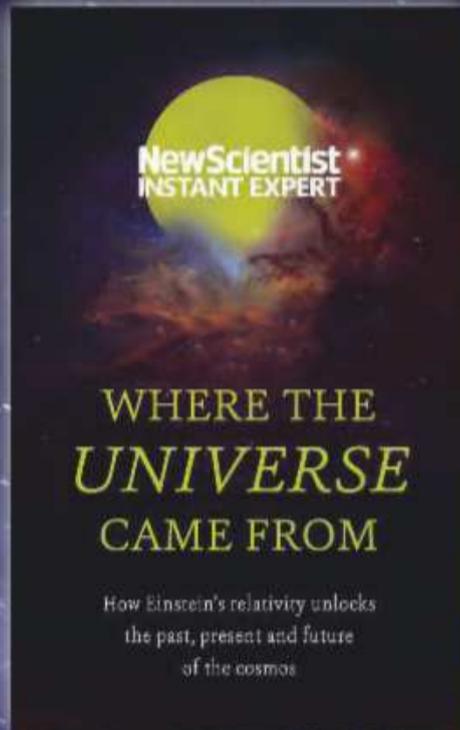
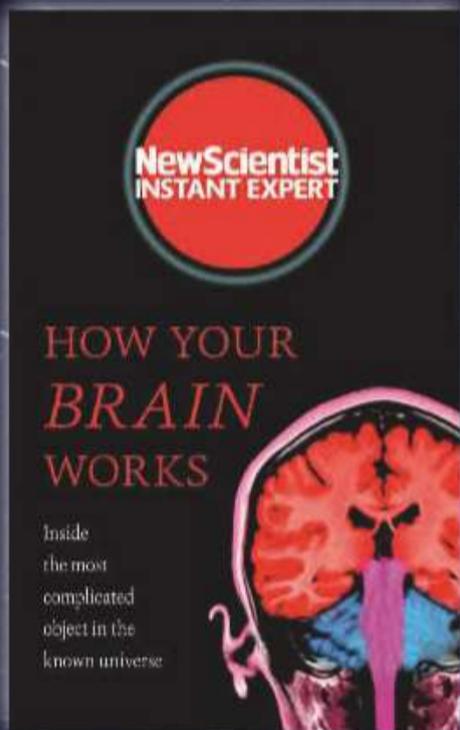
Of course, if you can't bring yourself to buy everyone bins for Christmas, you may want to consider a *New Scientist* subscription to get your loved ones thinking green all year round. Visit newscientist.com/gift for more information. ■



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Robots without borders

The US is mulling controls on its AI technology, but this restrictive approach may do more harm than good, says **Mark Riedl**

LAST week, regulators in the US announced plans to review export controls across a wide range of emerging technologies. The list includes artificial intelligence and machine learning, as well as technologies that would make substantial use of AI and machine learning, such as robotics and brain-computer interfaces, and supporting technologies. This may result in the US becoming the first nation to explicitly control the spread of AI technologies.

Law-makers are responsible for balancing economic prosperity and growth against public safety threats. Companies such as Google, Apple, Uber and Salesforce have invested heavily in products and services that use AI and machine learning, granting the US a competitive advantage.

But there is a growing concern about intellectual property theft by foreign countries, which



corrodes the competitive advantage of these companies. Export controls would make it harder for foreign agents to obtain and reverse engineer US AI and machine-learning products. In addition, these technologies have military applications, such as the design of autonomous weapons and cybersecurity tools.

Preventing the spread of the mathematics underlying AI is impossible. There are broad categories of well-known AI algorithms, including reinforcement learning and recurrent neural networks. The maths is taught in universities and discussed by researchers in scientific literature. It is extremely unlikely that there is a broad class of algorithms that we do not yet know about, kept under wraps by a company or government.

While there might not be any

JOSIE FORD

Costing the Earth

The flexible cost of carbon emissions reveals an economic charade, says **Kevin Anderson**

IN 2016, the administration of US president Barack Obama estimated that each tonne of carbon dioxide released into the atmosphere caused about \$50 of damage. In August, the Trump administration revised that to \$1, revealing the charade that has supported decades of inaction on climate change.

Few people would agree that a price could be put on our planet, but that is the idea behind this “social cost of carbon”. Such hubris is the preserve of a select group in industrialised countries, who put a dollar value on the devastation that a strengthened hurricane wreaks on distant communities, pricing the

people killed, the homes and neighbourhoods destroyed.

Added to this is a guess of the cost to our children of living with exacerbated floods and droughts, human migration, the loss of pollinating insects, dieback of forests, sea level rise and so on.

Yet an important property of the social cost of carbon is that it can never be so high as to raise fundamental questions of today’s dominant economic model.

The massaging of costs to an

“What we lack is not spurious financialisation, but the courage to deliver on our commitments”

acceptable level is achieved by two main ruses. First, the effect on poor people is underplayed by valuing such impacts against the low economic “worth” of those enduring them. Second, the effects on future generations are “discounted”, that is, considered less damaging than if those impacts occurred today.

Such cost-optimising models have dominated the agenda on how we can mitigate climate change for more than two decades, during which emissions have risen rapidly.

The 1.5 to 2°C commitments enshrined in the Paris Agreement provide a guide on how much

secret algorithms, there are engineering secrets. The process of creating a product or service from an algorithm requires a multitude of design choices that don't change the algorithm itself, such as programming language, how data checks are applied and how data is moved from computer memory to processor.

There are also secret data sets that don't change the algorithm, but affect the accuracy of its outputs. These software and hardware details can be critical to the commercial success of a product or service. There is a valid argument that these engineering details should be protected, and they already are by national and international rules on intellectual property and trade secrets.

If implemented poorly, export control of AI and machine-learning technologies could result in government control of AI research, which would have a chilling effect on the work done, and a detrimental impact on US economic competitiveness. To protect this industry, we must have clarity about what is to be controlled, and why existing rules and laws are insufficient. ■

Mark Riedl is professor of computing science at the Georgia Institute of Technology in Atlanta

carbon we can emit. This has been informed by science.

What we lack is not spurious financialisation of deeply human and ecological values, but the courage and integrity to put in place the measures necessary to deliver on our commitments.

A price on carbon may be one tool for bringing about rapid decarbonisation in our society, but such a figure can never reflect the true cost of the escalating damage to ecosystems, or the misery caused by our emissions. ■

Kevin Anderson is professor of energy and climate at the University of Manchester, UK

ANALYSIS Brexit depression



KRISTIAN BUUS/IN PICTURES VIA GETTY IMAGES

No proof Brexit vote was a major downer

Clare Wilson

THE UK's decision to leave the European Union has caused a fair few headaches, not least for prime minister Theresa May. But did the referendum make the country more depressed? The number of people taking antidepressants rose after the UK's vote for Brexit in 2016, according to numerous headlines last week.

Supposedly, economic uncertainty around Brexit sent people to their doctors to cope with the stress. This appealing narrative was covered by newspapers in the UK and elsewhere, from India to the US; the world is fascinated by Britain's political turmoil. Which makes it all the more disturbing that the neat story is probably wrong.

It stems from a study that looked at prescribing data for England in July 2016 – the month after the Brexit vote – and for all months before back to 2011. But the figures are not clear-cut. Antidepressant prescribing has been steadily rising in most Western countries for many years now, and the UK is no exception. Sure enough, in July 2016, antidepressant doses were slightly up on July the previous year

(*Journal of Epidemiology and Community Health*, doi.org/cw98).

But in the five years before then, use of these medicines had also been rising, in fact at a higher rate. So if anything, the number of people seeking antidepressants the month after the referendum was lower than expected, given those trends.

So how did study authors Sotiris Vantoros of King's College London and his colleagues reach the opposite conclusion? They compared the monthly antidepressant figures with prescribing rates for two other common medicines, a treatment for gout and iron tablets for anaemia.

“Supposedly, uncertainty around Brexit sent people to their doctors to cope with the stress”

Use of these medicines had also been increasing over the previous five years, but in July 2016, they both had a downturn. The authors reasoned that whatever factors made the other two medicines fall should also have made antidepressants fall by the same amount. But antidepressants didn't fall

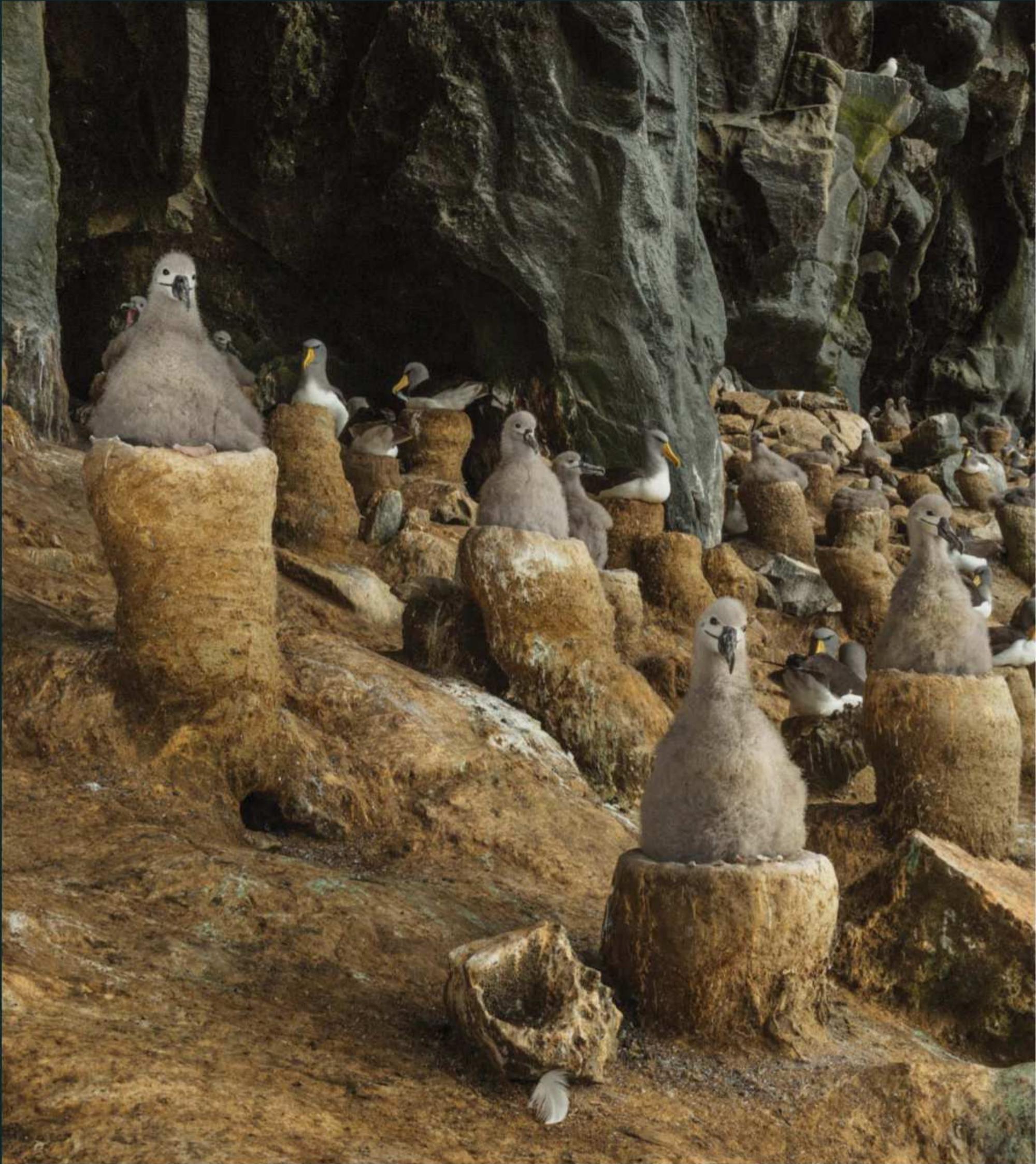
as much as they “should have”, according to this premise, so the most likely explanation is Brexit, they said.

For a start, this means that headlines about Brexit triggering a rise in antidepressant use – a “spike” according to the *Huffington Post* – are plain wrong. They can't solely be blamed on journalists overhyping the findings, though. The title of the journal's own press release stated that the referendum is “linked to [a] rise in antidepressant prescribing”. Vantoros says he had no control over the title.

Press release aside, the whole premise of deducing a cause of antidepressant use from prescribing trends in two other drugs is questionable. It seems unlikely that the collection of factors that affect the use of anaemia and gout medicines are the same as those influencing antidepressant use.

The conclusion that the referendum made people depressed also seems to contradict recent figures from the UK's Office for National Statistics that show a rise in national happiness in England in the months following Brexit, as the authors acknowledge in their paper.

Perhaps Brexit did cause more people to visit a doctor the next month with stress. Perhaps something else was responsible. Or perhaps it is all just statistical noise with no real effect that needs explaining. But this study is overhyped, questionable and proves nothing, and the headlines mangled the science. Now that is depressing. ■





Sit and wait

THESE giant baby birds aren't potty-training, but waiting to grow strong enough to travel. They bide their time on towering nests meant to keep them safe.

The Chatham albatross (*Thalassarche eremita*) is one of the rarest and least known albatross species, with only around 5000 breeding pairs left in the world.

The birds spend most of the year living on the ocean, but as the breeding season begins each August, juveniles and adults return to Te Tara Koi Koia, a small, steep and rocky islet in the Chatham Islands, 800 kilometres east of New Zealand.

The albatrosses use soil, bird faeces and plants to build these stool-like nests, some a metre high, to protect offspring from the weather and sea.

Once the eggs are laid, they take more than two months to hatch. The grey, fluffy chicks that emerge then need another four to five months to become strong enough to fly with their parents.

With such a small population and a single breeding site, conservationists fear these birds will go extinct soon. Rising sea levels caused by climate change are making it harder to find a nesting site that won't get washed away.

To try to address this, a new breeding site has been established for these albatrosses. By moving chicks at an early age to a different island that is at less risk of flooding, conservation workers hope they will choose to return to this safer breeding location. Yvaine Ye



Photographer

Thomas Peschak

National Geographic Creative



The truth about supplements

Popping a pill to boost your diet feels like a no-brainer, but supplements often don't work - and could even do you harm. **Linda Geddes** investigates

FOR some people, they are an insurance policy against a less-than-perfect diet. Others take them because they can't – or won't – eat certain foods. Whatever the reasons, popping vitamin and mineral supplements can feel like a virtuous shortcut to a healthy life.

But in recent months, serious doubts have been raised over whether they are actually any good for us. Take omega-3. For many people, these golden capsules are a way to get the essential fatty acids we are told our bodies need without having to consume oily fish. Yet recent studies indicate that – unlike eating fish – taking omega-3 or fish oil supplements does nothing to reduce your risk of heart disease, stroke or early death.

It is a similar story for other nutritional supplements, including multivitamins: the results from a slew of studies on their impact on our health has been underwhelming. In some cases, taking high doses of certain nutrients may even be harmful.

We are also waking up to the importance of the interactions between the different foods we eat and how these influence the uptake of

the nutrients they contain. It turns out it's not what we eat, it's how we eat it.

So are supplements just a waste of money? And if not, which are the ones we should be taking – and how?

It is only in the past century that we have begun to identify and recognise the importance of the various health-sustaining nutrients found in our food.

The word vitamin, derived from “vital amine”, was coined by the Polish chemist Casimir Funk in 1913, following observations that compounds called amines in rice husks could protect chickens from beriberi. This serious condition, which also affects humans, can result in nerve damage or heart failure. We now know that beriberi is caused by a deficiency in vitamin B1, also known as thiamine. Nutritional deficiencies like this were common at the time, but their causes were poorly understood. It wasn't until 1926 that vitamin B1, for example, was identified.

The following two decades saw many more vitamins discovered and a growing understanding of how their deficiencies caused common illnesses. This led to the

formulation of dietary strategies that cured ailments such as scurvy, rickets and pernicious anaemia, caused by deficiencies in vitamin C, D and B12, respectively. The onset of the second world war prompted the publication of recommended daily allowances for various food groups, vitamins and minerals in many countries. Some nations also began fortifying certain foods with nutrients, such as adding iron to flour and vitamin D to margarine.

However, as well as making populations healthier, this reductionist approach to nutrients has fuelled the growth of what is now a multibillion-dollar supplements industry. This not only focuses on correcting nutritional deficiencies, but also seeks to sell vitamins and minerals to the worried well. In the UK alone, consumers spend £420 million on supplements each year, with multivitamin tablets the most popular, followed by fish oil.

On a superficial level, the evidence seems to suggest all this is a good idea. Epidemiological studies, which look at the incidence of disease in specific groups or populations, show that people who eat a lot of fish, or plenty of ➤



Omega-3, or fish oil, supplements were thought to help protect our heart health, but a recent study found they have little effect

vegetables, whole grains and olive oil, have lower rates of illnesses such as heart disease and dementia. Many of us have swallowed the notion that a handful of the super-nutrients found in these foods, packaged up into neat once-a-day capsules, can provide the same benefits without the perceived hassle and expense of preparing healthy meals.

The problem is that these benefits aren't necessarily found when the supplements themselves are tested. Randomised controlled trials (RCTs) are used to examine whether and how a type of food or a supplement works. In these studies, people are randomly assigned to take either a component of that diet, such as omega-3 fatty acids, or a placebo. And here the results have been mixed. Some RCTs uncover a benefit; others find none at all. "Industry has been attracted to the silver bullets of micronutrients because they are very cheap and easy to formulate into tablets," says Andrew Prentice, head of the MRC international nutrition group at the London School of Hygiene and Tropical Medicine. "If it had all worked that would have been fine, but the trouble is that it hasn't. We need to understand why – and what to do about it."

Perhaps the biggest recent blow was a large study published in June by the highly regarded Cochrane Collaboration. The meta-analysis – a statistical approach that combines the data from multiple RCTs to try to get a more precise estimate of an effect – looked at 79 studies to assess the long-term impact of omega-3 fatty acids or fish oil supplements on cardiovascular health. It concluded that they

have little or no effect on our risk of heart disease, stroke or early death. Other recent meta-analyses support this finding, and have reached similarly disappointing conclusions for the effects of vitamins A, B, C, D and E on various aspects of our health.

Yet some researchers question the relevance of meta-analyses to nutrition research. Unlike drug or surgery trials, where you have a standard intervention and a fairly homogeneous group in which it is being tested, nutrition research is much messier.

KNOW YOUR VITAMINS

Vitamins can be separated into water-soluble and fat-soluble varieties. The water-soluble kind, such as vitamin C, are absorbed from what you eat until you reach a saturation point, after which any excess is urinated out. However, you can't store them, so if you stopped consuming these vitamins your levels would quickly fall.

Fat-soluble vitamins, however, can be stored in the body, particularly the liver. But you can have too much of a good thing, with the risk of certain stores reaching toxic levels. While most multivitamins limit the amounts of fat-soluble vitamins they contain, if people take multiple supplements at once they might unknowingly be having too much.

With a supplement like omega-3 fatty acids, you are pooling together widely disparate studies. They may involve different doses, formulations or even types of the nutrient. Finding an appropriate placebo is also fraught with difficulty. "If I do a study with a vitamin E supplement, I have been exposed to vitamin E in utero, throughout my entire life and for the duration of the study – so there is no such thing as a placebo control," says Jeffrey Blumberg, who studies antioxidants at Tufts University in Boston.

Nor do RCTs of supplements often record what else participants are eating, or measure background levels of the nutrient in their bodies. This is important, because supplementing someone who already has adequate levels of a vitamin or mineral is very different to giving it to someone who is deficient in it.

And whereas drug companies will invest large sums of money in high-quality studies because of the regulatory hurdles they must jump to get their drugs approved, there is less incentive for supplement companies to do so. Supplements are generally regulated in the same way as food, rather than medicines. They must be safe for consumption and correctly labelled, but they don't have to prove that they improve health. "The studies tend to be smaller. They tend to be of a shorter duration," says Simon Dyall at the University of Roehampton in London. "But nutritional supplements are not drugs, so you're unlikely to see an effect on people's health after taking them for 10 weeks, or even four or five months. You're looking at a minimum of a year, and supplement companies are less likely to fund those kinds of studies."

Meta-analyses often try to account for some of this variability, but the basic problem remains, says Dyall. Still, randomised controlled trials are the best approach we have tried so far. Where does that leave us?

Most nutrition researchers agree that for people who find it harder to eat a balanced diet, either because of allergies or lifestyle choices such as being vegetarian or vegan, taking supplements may be a good insurance policy. There are also other groups in the population who should consider them (see "Who should be taking what?", right).

However, on the issue of whether healthy and well-nourished individuals should take food supplements, expert opinion is divided. "I think we have to be aware that, especially at high doses, dietary supplements may not be entirely free of risk," says JoAnn Manson, an epidemiologist at the Harvard T.H. Chan

WHO SHOULD BE TAKING WHAT?

Although there is no substitute for healthy eating, some groups of people are more likely to be deficient in certain nutrients. Here, supplements may play a useful role



PREGNANT WOMEN

Pregnant women, or those considering becoming pregnant, should consider taking folic acid. This has been estimated to more than halve the risk of neural tube defects like spina bifida, caused when the spine and spinal cord don't develop properly in the uterus. Some foods, such as certain cereals and possibly soon bread flour in the UK, are fortified with folic acid.



INFANTS

The American Academy of Pediatrics recommends that exclusively or partially breastfed infants receive supplemental vitamin D, which is only present at very low levels in breast milk.

"We don't know how much vitamin D was present in the breast milk of our ancestors, but we do know now that it is limited, at least in general, in high-latitude countries," says JoAnn Manson at the Harvard T.H. Chan

School of Public Health in Boston, who recently reviewed the evidence for nutritional supplements in various population groups.

Healthy children with a well-balanced diet don't need multivitamin or multimineral supplements, she says. However, there is some evidence that omega-3 fatty acids can reduce the symptoms of attention deficit hyperactivity disorder in children with behavioural and learning difficulties.



ADULTS OVER 50

As we age, we begin to produce less stomach acid, which can impede our ability to absorb certain nutrients from our diet.

One of these is vitamin B12, used to make red blood cells, nerves and DNA. People over the age of 50 are therefore often deficient in this nutrient, and should either consider getting more of it from supplements or fortified foods, including some breakfast cereals.

Bones also weaken as we age, and vitamin D and calcium are needed to strengthen them. Vitamin D is

made in the skin from sunlight, but during the winter at high latitudes, supplements may help - although it is uncertain whether they reduce the rate of fractures.

A recent meta-analysis concluded that calcium supplements do reduce the risk of fractures and loss of bone mass density among postmenopausal women and men aged 65 years and over. But they also increase the risk of kidney stones (see main story).

If you have a health problem, you should speak to your doctor before taking supplements.

School of Public Health in Boston. Too much beta-carotene, for instance, seems to increase the risk of lung cancer in smokers, while excessive vitamin E has been linked to a greater risk of haemorrhagic stroke, and possibly prostate cancer.

Manson recently published guidance for clinicians on what to tell their patients about nutritional supplements. Her conclusion: "Routine micronutrient supplementation of the general population is not recommended."

Prentice agrees. "My view is very strongly that people shouldn't take supplements unless there is a specific indication - and in a country like Britain, most people don't need supplements."

Hidden hunger

Yet Blumberg at Tufts University argues that a country's wealth is a poor indicator of people's nutritional status: you can have plenty to eat, but still be malnourished. "Sixty-six per cent of Americans are overweight or obese - and the reason is because they are eating energy-dense, nutrient-poor foods," says Blumberg.

This "hidden hunger" doesn't only affect people who are overweight or obese. In a joint publication, the US departments of agriculture, and health and human services identified vitamins A, C, D and E, together with choline, calcium, iron, magnesium, potassium and fibre, as "under-consumed" by many people in the US. Those taking a daily multivitamin have intakes that are much closer to the recommended daily allowances, according to work by Blumberg.

"We know that people in the UK, the US and around the globe are not eating the way they should," says Blumberg, who led the study. "We should try to change that, but I think it is also a prudent and reasonable thing to tell you to take a multivitamin."

Blumberg, who acts as a consultant for several supplement companies, points to the Physicians' Health Study II - one of the largest randomised trials of supplements conducted so far, led by researchers at Brigham and Women's Hospital in Boston. It tracked the health of more than 14,000 men in the US aged over 50 for more than a decade and concluded that those taking a daily multivitamin had a modest but significant 8 per cent fall in the incidence of all cancers.

Further studies are ongoing to see if its results can be replicated, and if the findings also apply to women. "As an ageing, older man, I am happy to take modest benefits in any of my physiological systems," says Blumberg. ➤

Eating a mixture of foods brings a host of benefits that supplements won't provide



OKSANAKIANG/GETTY

For those with a poor diet, then, topping up with supplements can bring them closer to the recommended daily dose. But that doesn't always translate into the health benefits you might expect. For one thing, foods contain much more than the nutrients you would find in a typical supplement. This may be another reason why the results from trials of supplements don't match observational studies of populations who eat large quantities of foods containing those nutrients.

Not in a pill

"One of the main things that is deficient in the UK diet is fibre, and you don't get fibre from a pill," says Richard Hoffman at the University of Hertfordshire, UK.

Then there are phytochemicals, compounds found in plants, such as carotenoids and flavonoids, that are thought to work in the body to minimise damage to cells caused by free radicals, unstable and highly reactive molecules released by normal body processes. "These would certainly be missing if you are eating a diet of processed foods supplemented with a multivitamin pill," says Hoffman.

The balance of these nutrients also seems to matter. For instance, the body uses omega-3 oils from oily fish to make substances that dampen inflammation. But closely related omega-6 fatty acids, found in meat, make molecules that promote inflammation. This may be one reason why eating too much red meat is bad for us, and why populations that consume a lot of fish seem to be healthier.

But it isn't only important to eat an overall balanced diet – eating a mixture of foods at each meal also matters. "How much food you eat, when you eat it and the combination of foods you eat it with can have a huge impact," says Julian McClements at the University of Massachusetts.

In an as-yet-unpublished study, McClements and his colleagues gave people fresh fruit and vegetables to eat either on their own or in combination with emulsions containing various fats or spices, or both. Far more of the nutrients entered the bloodstream when the fruit and vegetables were consumed with an emulsion. When emulsions were combined, the impact was higher still. "It suggests that we can design foods to increase the amount of beneficial nutrients absorbed by the body," says McClements. But it also has implications for the design of clinical trials to test nutritional supplements. "If you don't control for this 'food-matrix' effect, then people could eat the same amount of, say, carotenoids, and one person might absorb a lot, while another would absorb very little," he says.

Outside of the lab, a good example of this effect is olive oil. It increases the amount of a carotenoid called lycopene that we absorb when we eat tomatoes, because carotenoids must be dissolved in fat to be transported

into the blood. A similar principle applies to the fat-soluble vitamins A, D, E and K.

Such findings are important for supplement-takers, says Blumberg. "If you don't take a supplement with food then many of those nutrients are going to be less than optimally absorbed," he says.

In some situations, these effects could even undermine your health. For instance, calcium supplements have been linked to an increased risk of kidney stones, whereas dietary calcium seems to reduce people's risk.

Clearly, we still have a lot to learn about how different foods interact. As we discover more, it may be possible to boost the nutritional value of the foods we eat, as well as design better supplements.

Food, then, is the best source for the nutrients we need. But for those who aren't able to get all their nutrition from what they eat, there are some simple things you can do to ensure you get the most out of a supplement: always take it with food, including a little fat, and follow the instructions on the container to avoid overdosing on certain nutrients. And ask your doctor about any supplements you are taking, as some vitamins have been shown to interfere with drugs, such as the blood-thinning medication warfarin, and lab tests.

Most of all, don't assume that taking nutritional supplements can compensate for eating an otherwise unhealthy diet. There are thousands of active ingredients in foods – some of which we are only starting to become aware of. They taste a lot better, too. ■

Linda Geddes is a freelance writer based in Bristol, UK

"The combination of food you eat and when you eat it can have a huge impact"

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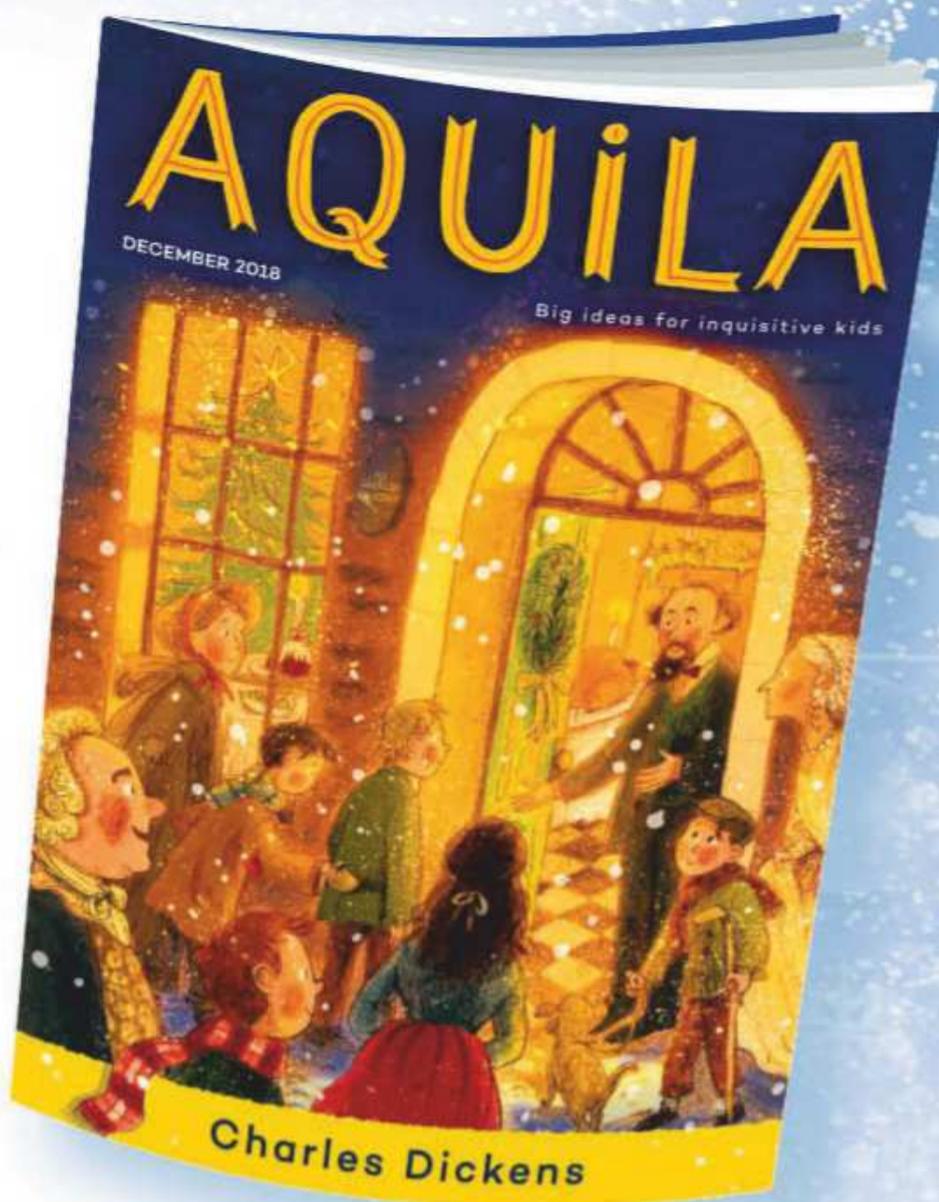


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Into the dark

Dark matter particles secretly crossing to the regular world could open portals to the universe's hidden realm, finds Daniel Cossins

WE KNOW it is out there. It makes up the bulk of matter in the universe and sculpts its grandest features with a hidden gravitational hand. And yet, despite a long campaign to expose it, the mysterious cosmic architect known as dark matter continues to evade detection.

Myriad dark-matter hunters have spent decades trying to trap their prime suspect. They may yet prevail. But their struggle has led a new wave of hunters to try a different approach. Rather than tailoring their search for a single candidate, they are embracing the possibility that dark matter consists of a panoply of particles and forces – an entire dark sector operating in parallel to our own.

This hidden realm would be accessible by only the faintest lines of communication: particles capable of carrying messages from the dark side to the world of familiar matter. Now the plan is to track those go-betweens as they pass messages through these dark portals, wiretapping them to learn about the universe on the other side. “This is a shift in the way we think about the problem,” says Jonathan Feng, a theorist at the University of California, Irvine. “It has reinvigorated the search.”

All we know about dark matter comes from the way stars in the outer reaches of galaxies move faster than expected, given the amount of visible mass present. So fast, in fact, that

the galaxies we see should have long since been torn apart. For some physicists, this is reason enough to believe that Einstein's laws of gravity are wrong. Others insist that some invisible form of matter must be lurking behind the scenes, holding the universe together.

Pitiful WIMPs

For decades, the prime suspect has been the weakly interacting massive particle, or WIMP. This hypothetical heavy particle is attractive thanks to a remarkable coincidence dubbed the WIMP miracle: when physicists calculate how many of them would have survived from the early universe to the present day, they get exactly the amount of dark matter we need to explain our observations. The other thing in their favour is that WIMP-like particles emerged naturally from supersymmetry – a mathematically elegant theory designed to smooth over wrinkles in the standard model, our best picture of particles and their interactions.

All told, WIMPs looked to be such hot suspects that it was merely a matter of smoking them out. In a boon to experimentalists, theory predicted that WIMPs would, in addition to the pull of gravity, feel the weak nuclear force, which is beefier but only works across tiny distances.

This makes them capable of interacting with regular matter in experiments, and sparked a worldwide race to find them.

And yet there is no sign of them. Nor are there indications of any of the heavy partners of known particles that supersymmetry predicts. They might yet show up, of course, but our most promising candidate is running out of places to hide just as its theoretical underpinnings are looking shaky – and that scenario has pushed scores of younger dark-matter hunters in an intriguing new direction.

What Feng and others propose is that dark matter might consist not of any one particle but of an entire catalogue, all interacting with each other through a dark force that nothing in the regular universe can feel. The components of this dark sector might even form their own atoms and molecules, opening a whole new world of dark chemistry.

That might seem outlandish, but there are good reasons to consider the possibility. After all, the stuff we consider ordinary comprises a veritable selection box of particles, so no great leap of logic is needed to assume that the same holds true for dark matter. What's more, strange observations in recent years have hinted at the existence of dark forces – an indication that dark matter may be more complex than the WIMP-hunters believe.

The first observation is that dark matter appears to be spread more evenly within



TISHK BARZANJI

“The portals are mathematical - you can’t drive a spacecraft through them”



JNAF

galaxies than the WIMP models predict – something that can be explained if dark matter particles exert a repulsive force on one another, pushing themselves apart. Particle experiments on Earth have thrown up similarly suggestive anomalies, most recently in 2016 when researchers at a nuclear physics lab in Hungary noticed a beryllium atom decaying in a way that could be explained only by invoking a new force of nature.

Claiming a dark sector exists is all well and good, but deciding how to populate it is a different story altogether. “We could guess a potentially infinite range of dark sectors,” says Brian Shuve at Harvey Mudd College in California. Fortunately, we don’t have to. What Feng, Shuve and others have realised is that the search can be guided by hard data rather than theoretical guesswork. If the dark sector is capable of exchanging messages with the regular universe, then those rare points of contact turn into portals that can shed light on the world on the other side.

To be clear, we aren’t talking about something you could drive a spacecraft through. “What we call portals are mathematical doorways,” says Gordan Krnjaic at the Fermi National Accelerator Laboratory (Fermilab) near Chicago. These doorways allow

for particles capable of feeling the dark force to interact with particles of regular matter. The most promising type of portal would be a direct metamorphosis – a dark sector particle transforming into one in the standard model. Fortunately, the invisibility of the dark sector allows us to dramatically narrow down where such portals can arise. The dark constituents must be chargeless, and as such particles cannot transform into charged ones, any go-betweens must be neutral particles.

Dark messengers

The three standard model particles that stand the best chance of interacting with such a dark mediator are photons, via the so-called vector portal; Higgs bosons, via the scalar portal; and neutrinos, via the neutrino portal. “If new particles exist, these portals are our best chance of creating and detecting them,” says David Curtin, a theorist at the University of Toronto. All we have to do now is watch their every move.

It could take a while, but the stake-out has already begun. The most promising of the three is perhaps the vector portal, in which processes designed to produce ordinary photons would occasionally spit out a dark

The hunt is on at the Jefferson National Accelerator Facility

photon, their shadowy alter ego. Like a regular photon, such a particle would be extremely gregarious: it would interact with anything that has electrical charge. The strength of those interactions would also be reasonably large, meaning there are lots of places to look for it and that we stand a good chance of seeing it if it is there.

Moreover, the “dark photon” doesn’t necessarily have to be perfectly analogous to the regular photon. It is just a proxy for all manner of vector bosons – the class of particles to which photons belong – that could form part of the dark sector. “It is one of a long list of possibilities,” says Natalia Toro at Stanford University in California.

Toro performs experiments at the Jefferson National Accelerator Facility in Virginia that has been attempting to flush out dark photons for a few years. They fire a high-intensity beam of electrons at fixed targets to generate photons in the hope that, very occasionally, they will produce a dark photon too – identifiable by its telltale decay. Others, including Shuve, have looked for evidence of dark photons by revisiting decade-old data

from the BaBar experiment at the SLAC accelerator in California, which smashed electrons and their antimatter counterparts together until 2008.

Although both efforts have come up empty-handed so far, the search has stepped up a gear. The more intense your beam, the more photons you produce, and the greater your chances of making a dark one. Those are the odds that several new higher-intensity experiments are hoping to exploit, including the Heavy Photon Search at the Jefferson Lab and Dark Light at the SLAC accelerator. As of last month, there is also the PADME experiment outside Rome. “It’s a very lively area,” says Toro. “But the truth is that we’re really just getting started.”

That much was clear in March 2017, when the entire field came together at the behest of the US Department of Energy, which is eager to find out how to get the biggest bang for its buck in pursuit of dark matter. There was no shortage of proposals for experiments aimed at rooting out dark photons. Among the most ambitious pitches, however, was one touting a new detector at the Large Hadron Collider near Geneva, Switzerland. Instead of using the photon as a bridge between the two worlds, Curtin and his team wanted to use a different portal, and spy on the Higgs.

The Higgs boson and its associated energy field are famous for giving other fundamental particles their masses. In a dark sector populated by massive particles, it makes sense to think of them getting their mass from a dark equivalent. Curtin says the best way to properly explore the Higgs portal is to produce lots of Higgs bosons – and the only place we can do that is at our most powerful atom smasher. Indeed, Curtin reckons the LHC might have been producing dark Higgses all along. But whereas the regular Higgs falls apart before it can escape our detectors, the dark Higgs’ tendency to avoid interactions means it might be long-lived enough to get away scot-free.

We already know such long-lived particles exist, so there is no reason to think new particles from the dark sector won’t also travel a great distance before they decay. The long-lived particles we find might be the dark Higgs or another kind of particle from the dark sector that interacts with the dark Higgs, says Curtin. “The only way to know is to find the long-lived particles and study their properties.”

That might seem a quixotic task. After all, in theory, these particles could decay anywhere. But cosmological observations place a limit on

how long they can last – roughly 0.1 seconds – so the trick is to cover a sufficiently large area around the LHC to catch them, regardless of the direction they travel from the point of collision. That is precisely why Curtin and his colleagues have proposed a new detector at the LHC to catch them. They call it MATHUSLA, after Methuselah, the biblical character who lived to the ripe old age of 969.

It would essentially amount to a huge barn above the beam line, with detectors hanging from the ceiling to track any particles that make it this far. With a cost of about \$50 million, MATHUSLA wouldn’t be cheap. But Curtin says it could be ready by 2026, when the LHC will be producing at least 10 times more Higgs bosons than it does now. “This is our best chance to see long-lived particles, including the dark Higgs,” says Curtin.

MATHUSLA might also shed light on the third dark portal, provided by the neutrinos. As the smallest, lightest and least sociable of the known particles, neutrinos may seem uninteresting. In reality, though, they are bursting with mysteries. Not only are the three types of neutrinos somehow capable of transforming into one another at will, a process that is still not completely understood, but their masses are incredibly light for no good reason.



“It’s possible the LHC has been producing dark Higgs bosons all along”

To explain these mysteries, physicists have invented a heavier fourth “sterile” neutrino that would be even harder to spot than the other three. Such a particle has all the hallmarks of a dark matter mediator, one capable of travelling through the neutrino portal to transform into regular matter.

The trouble is that, unlike the photon and the Higgs, neutrinos can only feel forces, not carry them. That means yet another particle would be needed to allow particles of dark matter to interact with the sterile neutrino. “That makes things more complicated,” says Miguel Escudero at the University of Valencia, Spain, and probably explains why the neutrino portal has largely gone under the radar.

Keeping watch

Only in the past couple of years have people like Escudero begun to explore scenarios in which the dark sector talks to us through sterile neutrinos. The models they have come up with are promising, but depend on the confirmed discovery of a sterile neutrino. Several experiments are currently on the hunt, and hints of one coming from an experiment called miniBooNE at Fermilab grabbed headlines earlier this year. But for Escudero, it is premature to even suspect it could be the emissary to the shadow world we seek.

If we ever do start reliably producing such things, however, they will bring exciting new leads in our long quest to identify dark matter. “If the dark photon we identify decays invisibly, for example, meaning it decays to dark matter, that would tell us that the dark matter is lighter than the dark photon,” says Feng. “Suddenly, we would know that dark matter is lighter than something. That would rule out 99.9 per cent of our theories.”

It is impossible to say which, if any, of the portals will reveal the dark sector. In fact, to ask the question is to miss the point, says Flip Tanedo at the University of California, Riverside: “The reason we’re squeamish to say ‘here are the best candidates’ is because we no longer think that way.”

His generation is not driven by the same sense of certainty as previous generations, gripped as they were by supersymmetry fever and the rush to find WIMPs. “We’re a bit humbler,” says Tanedo. “We focus more on the experiments we can do to find something that will guide us.” ■

Daniel Cossins is a feature writer at *New Scientist*



The missing city on the plains

Following in the footsteps of an ill-fated conquistador, archaeologists may have unearthed one of America's biggest pre-Columbian settlements. Daniel Cossins reports

IN JUNE 1601, Juan de Oñate, conquistador and governor of the fledgling colony of New Mexico, marched eastwards in search of Quivira, a fabled land of gold thought to lie near an undiscovered coast. He found no treasure and no ocean. But according to Spanish records, Oñate's expedition did turn up an intriguing discovery – one whose true significance is only just coming to light.

In testimonies given on their return, Oñate's soldiers described their journey across what are now the US states of Texas, Oklahoma and Kansas. They spoke of "grasses so high that in many places they hid a horse", Apache horse riders hunting vast herds of "monstrous" bison, and friendly encounters with a tribe they called the Escanxaques. Then the Spanish recounted how they were led to a settlement

of people they called the Rayados so large that it would have taken two days to walk across it. They called it Etzanoa and reckoned it was home to some 20,000 people.

Scholars have long been sceptical about Etzanoa. Conquistadors were notorious for embroidering their tales to impress the Spanish authorities, and many believe that the people of the Great Plains lived in small, scattered settlements – not sprawling proto-cities.

Now, fresh translations of the soldiers' testimonies have led one archaeologist to claim he has found Etzanoa. If true, and if it really was as extensive as Oñate reported, it wouldn't only shake up our picture of how the people of the Great Plains lived before Europeans arrived. It would also remind us

that the remains of large and socially complex settlements can hide in plain sight.

Modern attempts to find Etzanoa have relied on an enigmatic map drawn by a man called Miguel. He is thought to have been from Quivira, but captured by the Escanxaques as a boy. He was taken prisoner by Oñate's men as they returned from Etzanoa in 1601, during a day-long skirmish with the Escanxaques, who had turned on them. He was later taken to Mexico City, where he gave testimony and sketched the landscape.

The first attempt to find the place depicted in the "Miguel map" came in 1982, but it led nowhere. Four years later, Susan Vehik, an anthropologist at the University of Oklahoma, published a breakthrough. She realised that the portion of the map that dealt with the



JIM RICHARDSON / GETTY

Great Plains depicts north to the left, rather than the top, and from that figured out that the settlement that Oñate's expedition reached was either along the Walnut river in southern Kansas or possibly at Beaver creek near the border between Oklahoma and Kansas. "With the information available to this point, it is not really possible to separate [them] as possible points of destination," Vehik wrote.

Since then, fresh leads have come to light. In 2013, a group of historians and linguists led by Jerry Craddock at the University of California, Berkeley, published new translations of documents associated with Oñate's expedition: the official account, written by one of the friars who travelled, and testimonies from five soldiers questioned

in Mexico City in 1602. They also posted a full-colour scan of the original Miguel map, including corrections to the names of some of the settlements.

That was enough to pique the interest of Donald Blakeslee, an archaeologist at Wichita State University in Kansas. Blakeslee had previously been involved with an attempt to retrace the route of Francisco Vázquez de Coronado, who led the first Spanish expedition to the Great Plains in the 1540s. As such, he has a keen appreciation for the

"Modern attempts to find Etzanoa have relied on an enigmatic map"

pitfalls of using historical accounts to find archaeological sites. "You have to tread carefully," he says. But the new translations convinced him to follow in the footsteps of Oñate. "I was so impressed," says Blakeslee. "Earlier versions were a bit murky, but this was all so vivid. I thought, 'wow, I can almost picture these places'."

Before long, Blakeslee was out in the fields and woods around the confluence of the Arkansas and Walnut rivers, not far from Arkansas City in southern Kansas, comparing the map and landmarks described in the documents with the lie of the land as it is today.

His explorations brought him to one of the two swathes of land that Vehik had identified 20 years earlier. Scattered archaeological

A Wichita group
building a lodge in 1904

The Mississippian metropolis

In southern Illinois, just beyond the urban sprawl of East St Louis, the flat plains give rise to a big grassy knoll that marks the centre of North America's first city.

Cahokia, as it is known, began in the 9th century as a small collection of villages inhabited by the Mississippian people. At its peak, 200 years later, it was home to as many as 20,000 people - and it was quite a sight. A 30-metre-high terraced structure hewn from the clay-heavy soil overlooked a grand plaza, outside which people lived in thatched huts scattered across the landscape.

Analysis of bones and teeth from the site suggest that people came to Cahokia from far afield. What brought them there? Some archaeologists think it was down to politics and economics: a powerful leader created a new form of governance and people flocked in to take advantage of the urban life it made possible. Others argue that the city's emergence was the result of a religious revival, perhaps inspired by a star that went supernova in 1054 and lit up the night sky for almost a month. Either way, it didn't last long. Cahokia seems to have been abandoned by the middle of the 14th century.

The fact that it existed at all shows that Native Americans didn't always live nomadic lives, scattered across the plains in small groups. But it was an outlier - the only known example of urban living in North America before the Europeans arrived. Hence why people are excited by the recent discovery of what seems to be a similarly sized settlement in southern Kansas (see main story).



HISTORIC COLLECTION / ALAMY STOCK PHOTO

evidence of habitation, such as pottery and arrowheads, had been found here as early as the 1950s - only now he was walking in the footsteps of Oñate, matching descriptions of his journey with landmarks on the ground.

"If you go out there and spend time in the landscape, things fall into place," says Blakeslee. Sure enough, he found the spot where he thinks the Spanish had to swing away to the east so that their ox carts wouldn't get stuck on rough ground, and the hill from which they first saw the Rayados across the river. He even located what he suspects is the rocky ravine from which the Escanxaques attacked Oñate's party as they sought to begin their journey home. "Nobody had even looked for it before," says Blakeslee. "But the accounts are very specific, and once you scour the landscape you see that there is only one ravine that could have hidden thousands of people."

In spring 2015, having secured permission from the landowner, Blakeslee drafted in archaeologists from the National Park Service and the Kansas Historical Society. They used remote sensing to search below ground for evidence of habitation, and they struck gold. Well, not quite. What they found was evidence of clusters of houses surrounded by gardens, which fits nicely with the eyewitness testimonies described by Oñate and his men. As Diego de Ayardia, a soldier on the expedition, reported, the houses "were all

made of poles stuck into the ground, covered with straw, and closed on top like tents" separated by a series of small "fields of corn, beans, and squash".

The archaeologists could also see the large storage pits described by Oñate and his men, not to mention pottery and stone shards thought to be debris from the manufacturing of tools to butcher game and scrape hides.

"It was clearly a well-populated area," says Vehik. "There is no doubt about that." What isn't clear, she says, is whether the artefacts that archaeologists and amateurs have uncovered in the area over the decades are from people who were living there all at the same time, or a result of small groups moving around over time.

For Blakeslee, the clincher came in the shape of an iron shot. He had taken a group of volunteers armed with metal detectors down to the rock-lined ravine he had identified as the spot where the battle took place. Just as everyone was thinking about packing up, the landowner's son dug up an iron ball roughly the size of a marble. It was pockmarked in a way that has convinced Blakeslee it had been fired from a Spanish gun. He has also found a Spanish horseshoe nail. "We have definitively found the site of the battle," he says.

Blakeslee is similarly bullish about having found Etzanao. "I think it's obvious at this point," he says - and he isn't alone. Scott

Ortman, an anthropologist at the University of Colorado, Boulder, who spent a couple of weeks at the sites around Arkansas City, is satisfied that the details in the accounts of Oñate's expedition checks out with what they are finding on the ground. "Everything I've seen of the landscape and archaeology is consistent with Oñate's descriptions," he says. "I'm convinced."

Robert Hoard, an archaeologist at the Kansas Historical Society, is more cautious. "I think it is plausible that the Walnut river valley sites are Etzanao. It also is plausible that they are not, that they are the result of long occupation by smaller groups of people," he says. "I would need firm evidence of Spanish contact with the indigenous people." Ideally, that would be some sort of quantitative metallurgical evaluation to unambiguously determine that the iron shot and the horseshoe nail really are Spanish.

If Blakeslee is right, though, the implications are profound. It would make Etzanao the second-largest prehistoric settlement ever found in North America after Cahokia, a city of at least 20,000 people in modern-day Illinois (see "The Mississippian metropolis", left), further reshaping our understanding of how the people of the Great Plains lived in the period before the Spanish arrived.

The conventional picture is that of a vast, empty space populated by nomadic people following bison herds. Etzanao tells a different story – that at least some tribes settled in large

"They used remote sensing to search below ground, and they struck gold"

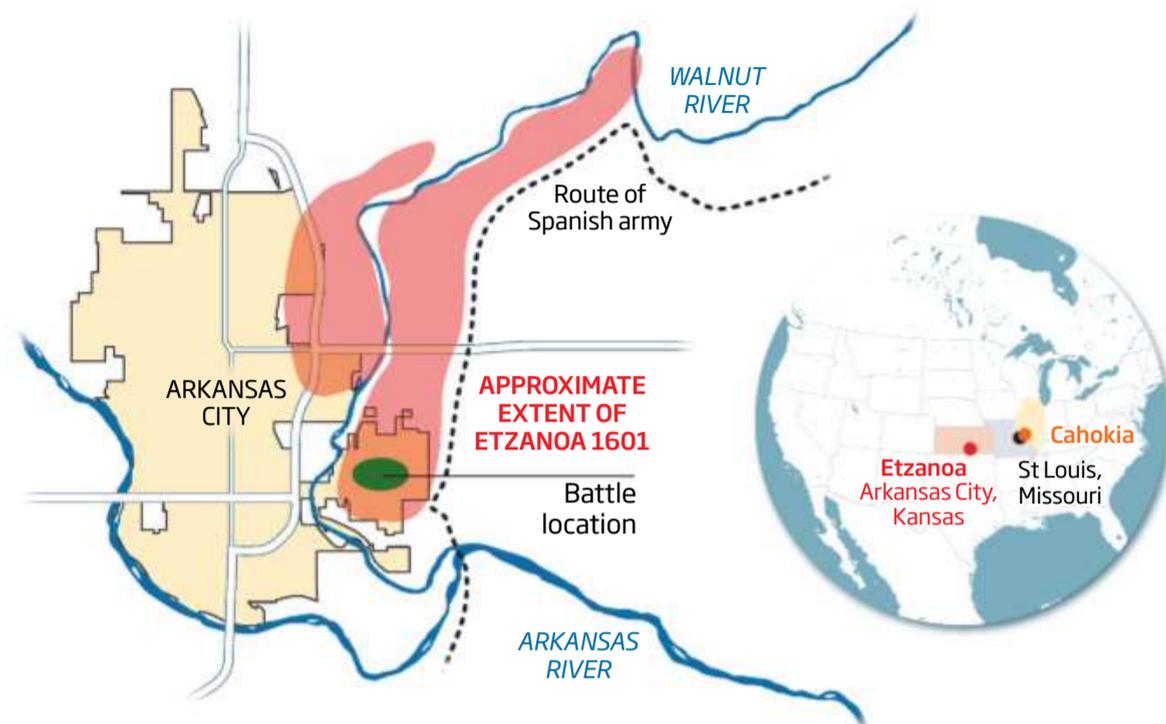
towns, raised crops, made pottery and processed bison on a huge scale. "I'm not sure if I'd call it an urban lifestyle," says Ortman. "But I do think the scale of the place and the extent to which that requires political organisation is greater than we might have imagined."

Hoard agrees. If we can show that there were "thousands of people living and working together, growing huge amounts of food for which they carefully planned planting, harvest, storage and redistribution", he says, then we have to consider that the people of the Great Plains created "a more complex social organisation" than anyone knew.

He also points out that they did so in a region that was nowhere near as promising

North America's lost cities

The Great Plains were home to the large Native American settlement of **Cahokia** in modern-day Illinois. Now archaeologists think they have found a second, **Etzanao** in modern-day Kansas, based on records from a Spanish expedition in 1601.



SOURCE: WICHITA STATE UNIVERSITY ALUMI MAGAZINE

as the floodplains on which Cahokia rose and fell. "It was famously referred to as the 'great American desert' by Europeans," says Hoard. "That was overstatement, but to find a large indigenous community in this difficult environment is testimony to the people living there."

Just as intriguing is that, as far as we know, the Etzanaoans built their society without any monumental architecture. Cahokia had a collection of giant mounds at its centre, sculpted from earth and used for ceremonies cementing the hierarchy through which society was governed. But Etzanao doesn't appear to have had anything of the sort. "How did these people accomplish this level of social organisation without monuments and the inequality they typically indicate?" says Ortman.

Blakeslee and his colleagues will seek answers to such questions next year, when they plan to carry out more extensive excavations. The dream scenario, he says, is to find some sort of communal structure. "If the community was as large as Oñate described, it is going to have some sort of public architecture," says Blakeslee.

In the meantime, the Wichita people, many of whom live nearby in Oklahoma, are watching with interest. Thought to be the descendants of the Etzanaoans, they have been involved from the beginning of the

excavations. Current residents of Arkansas City have also embraced the discovery by setting up the Etzanao Conservancy, a non-profit organisation that aims to preserve and study the sites, many of which lie in their own backyards. It is early days, but plans are afoot to create a visitor's centre and, ultimately, to apply for UNESCO world heritage status.

That would put Etzanao on a par with some of the world's most spectacular archaeological sites, from the Roman city of Leptis Magna in Libya to the ancient temples of Angkor Wat in Cambodia. This might seem like a stretch to some, given how few traces the thatched, bee-hive-shaped houses of the Etzanaoans left behind. But for Ortman, therein lies an important lesson. "Etzanao is not visually compelling in the same way as some of the world's most famous archaeological sites, but the human story it conveys is just as interesting," he says.

There is a tendency to equate the degree to which sites are preserved with the social development of the people who lived there, he says, but "big and well-organised communities don't always leave behind an obvious archaeological record. To me, that raises the question of how many other cases like this are out there." ■

Daniel Cossins is a staff features writer at *New Scientist*

The gift of reading

From the true nature of time to the world's oddest brains to why you should ditch social media, **our Culture team** picks the best books to give this Christmas

The Order of Time

Carlo Rovelli
Allen Lane



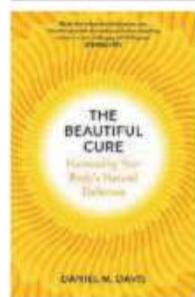
CARLO ROVELLI is the man who can spin hard physics into pure gold. *The Order of Time* is his third book. Like the first (*Seven Brief Lessons on Physics*),

it has been an instant bestseller. In this state-of-the-art survey of what physicists thought and now think about the nature of time, Rovelli is both unsettling (time does not exist) and philosophical (the study of time “does nothing but return us to ourselves”).

BEST FOR: precocious kids; lovers of lit-science; time fanatics

The Beautiful Cure: Harnessing your body's natural defences

Daniel M. Davis
Bodley Head



IT MAY not be a classic Christmas whodunnit, but *The Beautiful Cure* is a page-turner. Author Daniel Davis explains who did what in

the immune system story (poor Ralph Steinman's co-discovery of dendritic cells won him a Nobel, but he died before he found out). As an immunology professor, Davis has the right cred to claim that we now know enough to start curing diseases such as cancer.

BEST FOR: detective story nuts; medics; hypochondriacs

The Mind Is Flat: The illusion of mental depth and the improvised mind

Nick Chater
Allen Lane



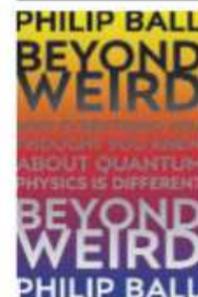
THE feeling that we have an inner life, that our minds have, well, depth is pretty ubiquitous. Brace yourselves then: Nick Chater says

this is just plain wrong. There is nothing under the hood, he writes in *The Mind Is Flat*: “Our flow of momentary conscious experience is not the sparkling surface of a vast sea of thought – it is *all there is*.” Find out why this isn't the end of your world.

BEST FOR: Buddhists; fans of neuroscience or neurophysiology

Beyond Weird: Why everything you thought you knew about quantum physics is different

Philip Ball, Bodley Head



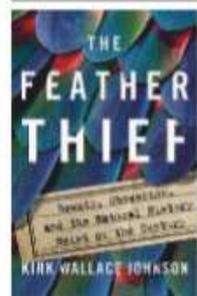
QUANTUM mechanics is less a theory about particles and waves, uncertainty and fuzziness, than one about what can be

known and how. In this, his 23rd book, human whirlwind Philip Ball tracks quantum mechanics from its roots as a rather desperate piece of hand-waving about objects too small to behave to a disturbing, fully worked-out theory about the world.

BEST FOR: quantum mechanics phobics; lovers of history of ideas

The Feather Thief: Beauty, obsession, and the natural history heist of the century

Kirk Wallace Johnson, Viking



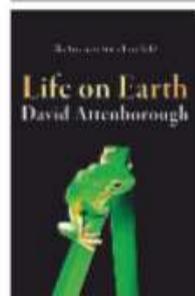
IN JUNE 2009, Edwin Rist, an American flautist studying at London's Royal Academy of Music, smashed a window at an outpost of

the Natural History Museum to steal the skins of 299 tropical birds, including some collected by Alfred Russel Wallace. This tale of greed, deception, sabotage and trade in rare feathers ranks among the most bizarre crimes ever.

BEST FOR: birdwatchers; true-crime fans; fly-fishing enthusiasts

Life On Earth (2nd edition)

David Attenborough
Harper Collins



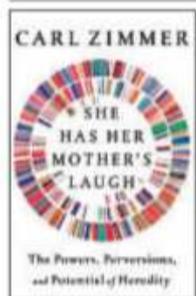
FIRST published in 1978, this natural history masterpiece was written by David Attenborough to accompany his iconic TV series.

It has received a timely makeover, with new pictures and updated text, much of it by zoologist Matthew Cobb. *Life On Earth* offers a spectacular snapshot of a once-wild planet, where new species are still being discovered.

BEST FOR: all kids from 1978; all kids in 2018; Attenborough fans

She Has Her Mother's Laugh: The powers, perversions, and potential of heredity

Carl Zimmer, Pan Macmillan



WHO knew that cells from the fetus can also pass to the mother, and even on to subsequent siblings? Carl Zimmer did. He

explains all in a deeply researched book about the complex and rarely less than controversial field of heredity that will arm you with more than enough high-quality information to hold your own at dinner parties or pub quizzes.

BEST FOR: gene watchers; students of ethics; most of us

Hello World: How to be human in the age of the machine

Hannah Fry
Doubleday



MACHINES rule, making important decisions in transport, finance, security and healthcare, even deciding who goes to jail. This is the

world we live in right now, a place of wonders ravaged by multiple data-driven disasters. Hannah Fry tours the algorithms surrounding us and wonders what happened to the human values supposedly encoded in this runaway maths.

BEST FOR: Luddites; technophiles; everyone in between

Superhuman: Life at the extremes of mental and physical ability

Rowan Hooper
Little, Brown



NEW SCIENTIST'S Rowan Hooper sought out some of the world's highest achievers in fields as diverse as novel writing, running and opera

singing to get an unusually accurate idea of whether genius is born or made. No one likes the idea their genes control destiny. Then again, no one ever did badly by playing to their strengths. "Accept the evidence," says Hooper, "and be empowered."

BEST FOR: high achievers; the rest of us to see where we went wrong



LUCAPIERRO/GETTY

Eye of the Shoal: A fishwatcher's guide to life, the ocean and everything

Helen Scales, Bloomsbury Sigma



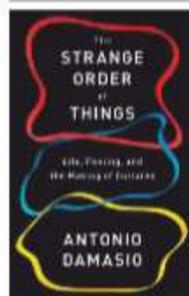
THE marvellously monikered Helen Scales is out to convince us that the most interesting life is in the sea. Her cast list includes giants that live for centuries and thumb-sized tiddlers that survive weeks.

Some shout with colour, others hide in plain sight. Along with citing surprising examples of fish ecology and physiology, Scales asks such complex questions as whether fish feel pain.

BEST FOR: beachcombers; vegans looking for offbeat ammunition

The Strange Order of Things: Life, feeling, and the making of cultures

Antonio Damasio
Penguin Random House



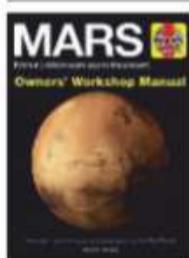
THE toughest intellectual question is how do our brains not only produce images of the sights, sounds and smells around us, but also

accompany them with private feelings and a sense of us "being there". Pioneering neuroscientist Antonio Damasio has spent years on the so-called "hard problem" of consciousness. Find out what he thinks in his brilliantly clear book.

BEST FOR: consciousness freaks; anyone who likes thinking hard

Mars: From 4.5 billion years ago to the present – Owners' workshop manual

David M. Harland
Haynes Publishing



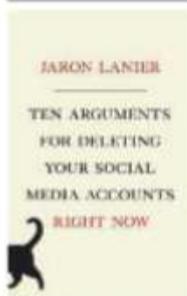
AFTER the news of a massive lake of water beneath Mars's south pole and now NASA's InSight lander, the planet is definitely

in the spotlight this year. Sealing the deal, Haynes Publishing has added Mars to its Earth and moon manuals. The guides are a must-have for all who lust after deep details of how, for example, the Viking lander's biology lab actually worked.

BEST FOR: space geeks; Mars Society members; makers

Ten Arguments for Deleting Your Social Media Accounts Right Now

Jaron Lanier
Bodley Head



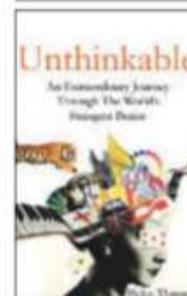
SOCIAL media's fall from grace continues to sell, er, books. The great thing about Jaron Lanier's offering is that he has a plan to

outfox the companies selling your life back to you. Delete all your accounts, reconnect to others in person, seek out nuance and real context. This is strong self-help from a Silicon Valley insider and VR guru.

BEST FOR: everyone on the planet; Lanier's cult following

Unthinkable: An extraordinary journey through the world's strangest brains

Helen Thomson, John Murray



THINKING you are a tiger, being perpetually lost in your own house, remembering every day of your life, or literally feeling someone

else's pain. We knew other people's brains were strange, but how strange is the subject of Helen Thomson's *Unthinkable*. She meets the real people whose brains create these odd experiences. Gripping stuff.

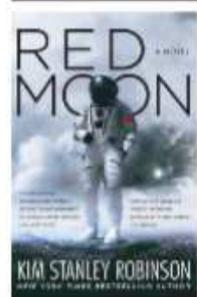
BEST FOR: fans of neuroscience; lovers of human oddness

Strange stories

Rowan Hooper and Jacob Aron offer their pick of the year's best fiction and sci-fi

Red Moon

Kim Stanley Robinson
Orbit



A STORY of espionage set both on the moon and in China in 2047, *Red Moon* describes burgeoning lunar settlements,

mostly built by the Chinese. The protagonists are a US quantum engineer, a famous Chinese poet and the daughter of a top Chinese politician. Robinson is famous for the scientific detail and plausibility of his novels, and this one is no different. He has created a deeply realised world that feels more like a peep into our future than a work of fiction.

Rowan Hooper

Letter 44

Charles Soule
Oni Press

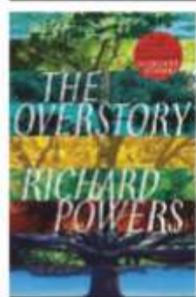


PRESIDENT Stephen Blades (think Barack Obama) finds a letter from his predecessor about a secret NASA mission. Aliens

have been spotted in the asteroid belt and a crew of astronauts sent to investigate. Over the course of the comic series, a conspiracy unfolds against a backdrop of political machinations. *Letter 44* began in 2014 as a criticism of Obama's continuation of wars in Iraq and Afghanistan, while the final collected volume, out earlier this year, contends with Trump's presidency. Jacob Aron

The Overstory

Richard Powers
William Heinemann



THIS eco-epic affected me as no novel has for many years. It's not just a matter of its ambition, (it is a hefty 512 pages long), the book

also brings to life the greatest problems of our time – climate change and biodiversity collapse – and gets under the skin in a way that just reading about the science doesn't always manage. There are nine major characters and you will get to know them all well. This important novel manages to celebrate the natural world and warn about our impact on it in a compelling and affecting way. RH

Dogs of War

Adrian Tchaikovsky
Head of Zeus

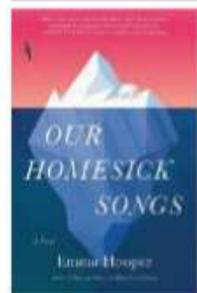


REX, a 2-metre-tall bioengineered dog, is one of the most achingly human characters I have ever encountered in a science-fiction

novel. He and his companions – Dragon, a lizard with a sniper rifle; Honey, a superintelligent hacker bear; and Bees, a literal swarm of bees – are designed and programmed to be an elite strike force. But when Rex starts questioning his masters, his world unravels as he fears becoming a Bad Dog. A gripping dive into bioethics and artificial intelligence. JA

Our Homesick Songs

Emma Hooper
Fig Tree

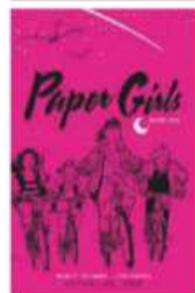


HERE is another story set around biodiversity collapse, but this time focused on one family. The entire economy of the island of

Big Running in Newfoundland, Canada, is based on cod fishing. When the fishery collapses through overexploitation, as it did in the early 1990s, almost everyone has to move to the mainland to find work. The Connor family attempts to make ends meet, but it falls to the children, Finn and Cora, to hold everything together. A touching and poetic novel. RH

Paper Girls

Brian K. Vaughan and Cliff Chiang
Image Comics



THIS ongoing comic series starts out a bit like *Stranger Things*, with four friends encountering mysterious goings-on in the

1980s, but quickly ramps up into something much weirder. A war between time travellers sees our female protagonists shunted between the past and future. If you want to see a battle between giant tardigrades, the future of the iPhone or even just *Doctor Who* levels of timey-wimeyness, this is the comic for you. Volume 5 is out next week. JA

Murmur

Will Eaves
CB Editions

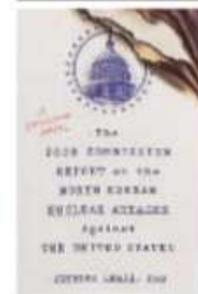


THE narrator of *Murmur* is a mathematician and computer pioneer in pre-1960s Britain. Sentenced to hormone therapy

for the "crime" of being gay, Alec Pryor is very obviously standing in for the computer genius and codebreaker Alan Turing. The book is a disorientating and hallucinatory exploration of a mind warped by the oestrogen medication stilboestrol, the treatment forced on Turing. An extraordinary exploration of dreams, consciousness, science and the future. RH

The 2020 Commission Report On the North Korean Nuclear Attacks Against the United States

Jeffrey Lewis, WH Allen



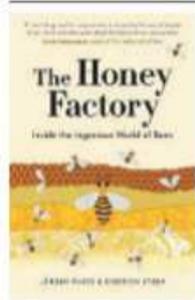
TRUMP rears his head again in this worryingly realistic techno-thriller, which imagines the aftermath of a nuclear war

kicked off by a presidential tweet. You won't be able to stop reading: the book is both ripped from the day's headlines and meticulously researched (Lewis is, after all, an arms control expert). Lewis says he hopes his detailed fictional destruction of central Manhattan will bring home the true horror of nuclear weapons – and it does. JA

Living the hive life

We're unlocking the secrets of bees, finds **Sandrine Ceurstemont**

The Honey Factory: Inside the ingenious world of bees by Jürgen Tautz and Diedrich Steen, Black Inc



IF IT wasn't for the honey and the fragrant, versatile wax, we would probably have steered well clear of bees. Early humans are

thought to have discovered the delights of wild honey some 2 million years ago, with bee domestication dating to 9000 years ago in what is now Turkey and North Africa.

Initially, the result was a lot of stings and destroyed nests. But the keeping of bees evolved, with advantages for both parties.

So claim the authors of *The Honey Factory*, Jürgen Tautz, a bee researcher at the University of Würzburg in Germany, and Diedrich Steen, a beekeeper for over 20 years. They have joined forces to write a fascinating book

Domesticating bees may make them less able to fight parasites

that explores hive life, from the roles of honeycomb cells to bee communication. They show how 300 years of hive use has helped keepers hone the craft. Artificial chambers now allow us to extract bee products but leave the colony relatively intact, for example.

There are misconceptions to correct, say Tautz and Steen. For example, the saying "busy as a bee" is far from the truth. The authors say honeybees are quite lazy and achieve great feats only by teamwork; some experiments show foraging bees make three or four flights per day. But if 25,000 foragers bring 50 milligrams of nectar per trip, that still makes an impressive 5 kilograms daily.

Their famous waggle dance is misunderstood, too. It has long been seen as a sophisticated form of communication used to convey the exact location of food to their hivemates. But recent work by Tautz and others shows that, while the dance may tell the bees where to head, it isn't that precise. In fact, when a food source is remote, bees rely on experienced foragers carrying the scent of the flowers

they are seeking to guide them.

Fortunately, our understanding of bee behaviour is good enough for keepers to tweak it. In the wild, honeybees start a new colony by swarming when their home gets overcrowded. To prevent this, keepers realised all they had to do was increase the size of a hive by adding a special box. New colonies can also be formed by removing the queen, thereby tricking bees into rearing a new queen, which can then be given its own hive.

Over the past 40 years, though, domestication has faced a new challenge – varroa mites, parasites that feast on bee "blood" and bee larvae. As the unwelcome guests reproduce and cripple more bees, the colony eventually collapses. The insects don't seem to have a way to tackle the mites. But beekeepers now know the power of formic acid, produced by ants. Birds get ants to squirt it at them, since it keeps parasites at bay. The same trick seems to work against mites when formic acid vapour is spread through a hive.

If they weren't domesticated, honeybees might have evolved ways to protect themselves, Tautz and Steen tell us. They advise studying them in the forests where they originated, as we know little about their lives in the wild and how they coexist – and perhaps even cooperate – with fungi, bacteria, arthropods and animals that share their hives. "The rediscovery of wild bees may reveal a way to construct honey factories of the future that at the moment we can't imagine," they write. Good news for us, but better for bee survival strategies. ■

Sandrine Ceurstemont is a writer based in Morocco



RICHARD BECKER/ALAMY STOCK PHOTO

Listen

Experimental psychologist Daniel Freeman presents *A History of Delusions* on BBC Radio 4 (from 3 December, 1.45 pm). The first episode features some spectacular cases of delusions of grandeur.

Play

Coming to all major VR platforms on 4 December, *Arca's Path VR* (pictured below) is a game without controllers: just use your gaze to navigate. Instinct, awareness and skill will help you steer through its world of crumbling beauty.

Visit

Architects Mamou-Mani offer a glimpse of the exciting future of construction when they set their prototype robot builder loose in Sir John Soane's Museum in London. *Code Builder: A Robotic Choreography* opens 5 December.

Watch

A Polish builder, injured while working on a towering statue of Christ, gets a face transplant in Malgorzata Szumowska's award-winning black comedy *Mug*, in UK cinemas from 7 December.

Read

Animal behaviourist Fred Provenza reckons animals are much pickier and healthier eaters than we give them credit for. His book *Nourishment: What animals can teach us about rediscovering our nutritional wisdom* is published by Chelsea Green.



2018 REBELLION



The 2019 Louisa Gross Horwitz Prize for Biology or Biochemistry

NOMINATIONS

All materials must be written in the English language and submitted electronically at:

<http://www.cumc.columbia.edu/research/horwitz-prize>

Deadline date: January 22, 2019

Renominations are by invitation only.
Self-nominations are not permitted.

The Louisa Gross Horwitz Prize was established under the will of the late S. Gross Horwitz through a bequest to Columbia University and is named to honor the donor's mother. Louisa Gross Horwitz was the daughter of Dr. Samuel David Gross (1805-1889), a prominent surgeon of Philadelphia and author of the outstanding *Systems of Surgery* who served as President of the American Medical Association.

Each year since its inception in 1967, the Louisa Gross Horwitz Prize has been awarded by Columbia University for outstanding basic research in the fields of biology or biochemistry. The purpose of this award is to honor a scientific investigator or group of investigators whose contributions to knowledge in either of these fields are deemed worthy of special recognition.

The Prize consists of an honorarium and a citation which are awarded at a special presentation event. Unless otherwise recommended by the Prize Committee, the Prize is awarded annually. Bert W. O'Malley, MD, Baylor College of Medicine; Ronald M. Evans, PhD, Salk Institute for Biological Studies and Howard Hughes Medical Institute; and Pierre Chambon, MD, Institute for Advanced Study of the University of Strasbourg, Institut de Génétique et de Biologie Moléculaire et Cellulaire are the 2018 awardees.

Qualifications for the award

The Prize Committee recognizes no geographical limitations. The Prize may be awarded to an individual or a group. When the Prize is awarded to a group, the honorarium will be divided among the recipients, but each member will receive a citation. Preference will be given to work done in the recent past.

Nominations should include:

- 1) A summary of the research on which this nomination is based (no more than 500 words).
- 2) A summary of the significance of this research in the fields of biology or biochemistry (no more than 500 words).
- 3) A brief biographical sketch of the nominee, including positions held and awards received by the nominee.
- 4) A key publication list of up to ten of the nominee's most significant publications relating to the research noted under item 1.
- 5) A copy of the nominee's curriculum vitae.

NRC Research Associateship Programs

The National Academy of Sciences, Engineering, and Medicine offers postdoctoral and senior research awards on behalf of 23 U.S. federal research agencies and affiliated institutions with facilities at over 100 locations throughout the U.S. and abroad.

We are actively seeking highly qualified candidates including recent doctoral recipients and senior researchers. Applications are accepted during 4 annual review cycles (with deadlines of February 1, May 1, August 1, November 1).

Interested candidates should apply online http://sites.nationalacademies.org/PGA/RAP/PGA_046398

Awardees have the opportunity to:

- conduct independent research in an area compatible with the interests of the sponsoring laboratory
- devote full-time effort to research and publication
- access the excellent and often unique facilities of the federal research enterprise
- collaborate with leading scientists and engineers at the sponsoring laboratories

Benefits of an NRC Research Associateship award include:

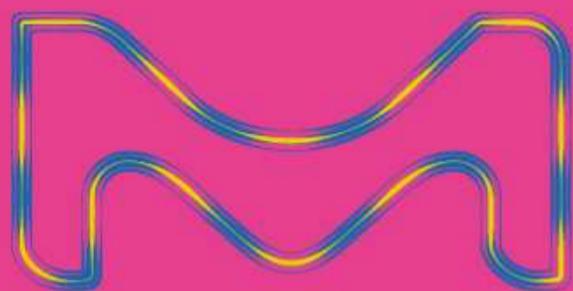
- 1 year award, renewable for up to 3 years
- Stipend ranging from \$45,000 to \$80,000, higher for senior researchers
- Health insurance, relocation benefits, and professional travel allowance

DESIRED SKILLS AND EXPERIENCE

Applicants should hold, or anticipate receiving, an earned doctorate in science or engineering. Degrees from universities abroad should be equivalent in training and research experience to a degree from a U.S. institution. Some awards are open to foreign nationals as well as to U.S. citizens and permanent residents.

ABOUT THE EMPLOYER

The National Academies of Sciences, Engineering, and Medicine's Fellowships Office has conducted the NRC Research Associateship Programs in cooperation with sponsoring federal laboratories and other research organizations approved for participation since 1954. Through national competitions, the Fellowships Office recommends and makes NRC Research Associateship awards to outstanding postdoctoral and senior scientists and engineers for tenure as guest researchers at participating laboratories. A limited number of opportunities are available for support of graduate students in select fields.



BIOPHARMA INNOVATION CUP 2019



Great minds come together at Merck

What's in it for me?

If you are a post-graduate student with an interest in the pharmaceutical industry, the Biopharma Innovation Cup is your chance to gain in-depth knowledge about pharmaceutical research and development, to network with top students from around the world and build a business case together with experienced professionals. On the last day of the Summer Camp, a conference with alumni from previous editions of the Innovation Cup will be organized.

Who can apply:

Advanced students and post-docs in the fields of life-science, data-science and business administration from all over the world can apply:

- Sciences: Post-graduate students on their way towards a PhD in biology, medicine, biotech, bioinformatics, data sciences, biochemistry, chemistry, pharmacy or engineering.

- Business: Advanced MBA students or recent MBA graduates with an interest in the pharmaceutical business and a life science background.

How it works:

During a one week summer camp, 30 selected students will attend in-depth presentations about the pharmaceutical industry given by Merck management and external experts. The participants will be divided into teams, work together to develop a business plan and present it to a grand jury, who will award the best plan with the Biopharma Innovation Cup and a cash prize of EUR 20,000 plus EUR 5,000 for the runner-up.

The Innovation Cup will comprise the following teams: Oncology, Immuno-Oncology, Autoimmunity, Small Molecule Drug Discovery, Protein Engineering and Digitalization.



Further information about the program and how to apply online from November 1st 2018 until January 31st 2019: <http://innovationcup.merckgroup.com>

Location:

Near Frankfurt, Germany, June 23–29, 2019. Travel, accommodation and food expenses will be paid by Merck.

MERCK



Located in Boston, Dana-Farber Cancer Institute brings together world renowned clinicians, innovative researchers and dedicated professionals, allies in the common mission of conquering cancer, HIV/AIDS and related diseases. Combining extremely talented people with the best technologies in a genuinely positive environment, we provide compassionate and comprehensive care to patients of all ages; we conduct research that advances treatment; we educate tomorrow's physician/researchers; we reach out to underserved members of our community; and we work with amazing partners, including other Harvard Medical School-affiliated hospitals.



Job title	URL to apply
Research Scientist	jobs.newscientist.com/job/1401654459
Research Fellow	jobs.newscientist.com/job/1401654086
Research Fellow	jobs.newscientist.com/job/1401654168
Research Fellow	jobs.newscientist.com/job/1401655832
Research Fellow Marasco Lab	jobs.newscientist.com/job/1401655933
Research Fellow Training in Oncology Population Sciences	jobs.newscientist.com/job/1401653957

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Research Associate, NMNH-IZ—Smithsonian Institution

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EDITOR'S PICK

It is the world that has failed the rainforest



From Craig Sams,
Hastings, East Sussex, UK

As Mary Menton and Felipe Milanez say, the policies of President Bolsonaro of Brazil may threaten the Amazon rainforest (10 November, p 24). But it is global policy on carbon pricing that fails to protect the forest. The *Human Development Report 2007/8* points

out that if carbon dioxide emissions are priced at \$20 per tonne, a hectare of rainforest should be worth up to \$15,000. Yet it may be chopped down to grow soya beans or graze cattle with a market value of \$300 per hectare. The Prince of Wales has quoted Lord Stern calling this "the greatest market failure in history".

If we had a carbon tax on emissions and used it to pay just 5 per cent interest on the "capital" of stored carbon in the "bank" of the rainforest, then a hectare of undisturbed rainforest would be worth \$750 a year and nobody would dream of cutting it down for beef or beans. Instead, we ask Bolsonaro to hold back from exploiting an asset that is garnering no reward, while other nations benefit from the free contribution to climate stability represented by Brazil's trees.

Gravity wave critics respond in turn

From Andrew D. Jackson,
spokesperson for "The Danish Team",
Copenhagen, Denmark
Michael Brooks's recent article on reports of gravity wave detection (3 November, p 28) and a response from the LIGO and Virgo teams (Letters, 24 November) raise a number of interesting questions.

If, as Brooks reports, the "residuals" for the event labelled GW150914 were published for the sole purpose of illustration, what are the correct data sets and why has LIGO not made them public? If LIGO believes that our analysis of correlations between residual noise at different detectors is incorrect, why have they not stated clearly where we have made a mistake? And if our calculations are correct, why does LIGO consider this statistically

significant 80 per cent correlation irrelevant for the interpretation of the observed signal?

Despite LIGO's claims of openness, we have been unable to identify members of the collaboration who can speak authoritatively and officially on LIGO's behalf on matters of data analysis. We believe it would be useful for LIGO to identify some individual or a group of scientists to represent it with the aim of resolving these differences of interpretation in an appropriately professional manner.

From Bryn Glover, Kirkby
Malzeard, North Yorkshire, UK

I remember marvelling at the ability of the gravity wave analysts to tell us not only that a squiggle represented the collision of two black holes, but also their respective solar masses, from half a dozen wobbly peaks standing

Concerned about the future?

Wildlife filmmaker Richard Brock says:

"There is still time to save the planet. My *WILDLIFE WINNERS AND LOSERS* series is my contribution. Now it's your turn."

Watch these free films.

Choose from 80+ films of different lengths to inspire you to take action.

They're free to watch and share with as many people as possible. Use the series to give you ammunition to help save the planet."

Watch these on our YouTube channel:
[youtube.com/brockinitiative](https://www.youtube.com/brockinitiative)

RB@brockinitiative.org
www.brockinitiative.org

As part of the BBC's prestigious Natural History Unit, Richard has witnessed the changing threats to the natural world first hand. His credits include work on the landmark series *Life on Earth* and *The Living Planet* alongside David Attenborough.

Richard Brock

wildlife
W&L
winners and losers
how to turn losers into winners

twitter.com/Winners_Losers_

facebook.com/winnerslosersfilms

“I have the coordination of Mr Bean going forwards - don't make me do that as well”

Katya von der Goltz King is alarmed by a finding that walking backwards can boost short-term memory (24 November, p 20)

out from a mushy background. I thought that was wonderful.

Now Michael Brooks informs us that the experimenters first calculated what they might expect to see, then subtracted that from what they actually saw, and made profound assumptions from that. I remain very confused and not a little disillusioned.

Florence Bell, an unsung physics and DNA pioneer

From Kersten Hall, Leeds, UK

Valerie Jamieson reports real-life experiences of women in physics in her article on why there are so few women in that field (10 November, p 32). The physicist Florence Bell would have agreed.

Her PhD supervisor, William Astbury, declared that “there is a creative spark in the male that is absent from women, even though

the latter do such marvellously conscientious and thorough work after the spark has been struck”.

When Bell gave a presentation about her work at an Institute of Physics conference in Leeds in 1939, the local press reported under the stunned headline “Woman scientist explains”.

She would have wanted to be remembered, though, for helping to lay the foundations for one of the biggest scientific discoveries of the 20th century. Her PhD research included taking the very first successful X-ray diffraction images of DNA – which helped to pave the way for later X-ray work on its structure by Rosalind Franklin and Raymond Gosling.

While most scientists at the time thought DNA to be a boring molecule of little interest, Bell recognised that, in conjunction with proteins, it might play an important role in biology.

Sadly, this promising work was brought to an abrupt end by the second world war: she served in the Women’s Auxiliary Air Force, then emigrated to the US and gave up science to raise her family. Her thesis has just been made available online by the University of Leeds at bit.ly/2A63RVs.

I nominate Rosalind Franklin for the £50 note

From Anthony Burton, Stroud, Gloucestershire, UK

Alice Bell suggests that Dorothy Hodgkin should be on the Bank of England’s new £50 note as a pioneer in the field of X-ray crystallography (10 November, p 24). I suggest that the most appropriate scientist to feature would be Rosalind Franklin.

She was a vital member of the team that worked out DNA’s structure, but the only one not to

share the Nobel prize, simply because of her early death. This is an opportunity to give her the recognition she deserves – not to mention acting as a role model for female would-be scientists.

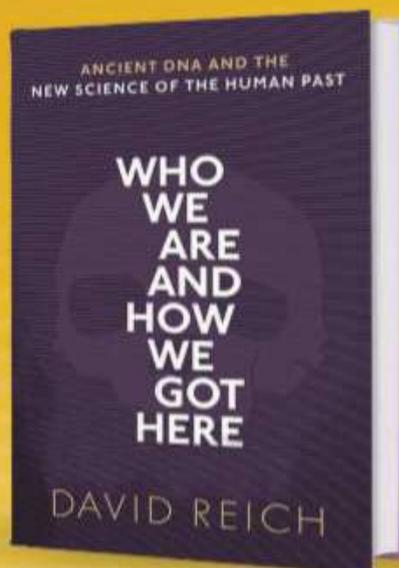
Elon Musk’s satellite plan is a great deal of garbage

From Karen Hinchley, Newark-on-Trent, Nottinghamshire, UK

The plan to put 4425 satellites in orbit for Elon Musk’s “space internet” seems impressive at first (10 November, p 5). But it is not just the financial cost that will be high. Does SpaceX plan to retrieve and recycle obsolete satellites?

There is too much debris in orbit as it is. Simply shunting old satellites to a different orbit is surely not a long-term solution. Besides, if Musk litters orbit with debris, he will make his own Mars plans more challenging: ➤

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space vehicles will find it harder to plot a safe path through all the junk.

As for all manufacturing, plans should be made at the design stage to retrieve and recycle an object at the end of its useful life. Sports cars are included.

From Robert Hill,
Leeds, West Yorkshire, UK
Musk's plans require keeping 4425 working satellites in orbit. If each lasts an average of five years, the replacement rate would be 17 satellites a week. This would be several times the current total world launch rate for all purposes.

The Polynesians could help us read Inca writing

From Peter Ashby,
Dundee, Angus, UK
Daniel Cossins discusses the possibility that Inca *quipu* might encode stories as well as numbers (29 September, p 33). Apparently those master navigators and peerless blue water sailors the Polynesians used knotted cords to encode sailing instructions and these have been used for modern

trips in recreated voyaging canoes. It seems the Polynesians reached Central America and brought back sweet potatoes. These were ubiquitous when Europeans entered the Pacific and the Maori of Aotearoa/New Zealand had developed semi-temperate cultivars.

So it seems entirely possible that the Polynesians picked up the idea for knots from the Incas. As we know how to read knotted sailing instructions, can these be used to get an idea of *quipu*?

Yes, electric car owners may feel entitled to drive

From Steve Swift,
Medstead, Hampshire, UK
Rosemary Sharples asks whether the lack of pollution at the point of use of electric cars makes their drivers feel entitled to make more and longer trips (Letters, 27 October). It is true with me. My mileage in my Nissan Leaf is greater than it was in my previous fossil-fuelled behemoth.

I now make more trips to the recycling centre, but carrying the same volume. I drive to local

shops when they are cheaper than online deliveries. I joined a voluntary group that offers rides to the elderly. When disposing of my belongings online, I offer free delivery within the Leaf's range. These are all local journeys. My Leaf is one of the oldest in the UK and needs to be charged every 80 kilometres.

Further, I am concerned at the prospect of 100-per-cent-electric vehicles, with accelerations faster than a racing car, on the roads. Let's pray that safer self-driving vehicles form the majority.

More problems with economics as science

From John Davnall,
Radcliffe, Greater Manchester, UK
Features of economics that lead Sam Edge to state that it is not a science (Letters, 10 November) are found in much of the social sciences. Particles, planets, animals, chemical reactions and tectonic plates do not change their behaviour in response to new theories. Humans do change in response to economic theories. This is not necessarily a bad thing,

but there is no theory capable of predicting where those responses will take us. As far as economics goes, we are the butterflies whose flapping triggers the storm.

Things that make your brain tingle

From Luce Gilmore,
Cambridge, UK
Michael Marshall discusses the "brain tingles" of autonomous sensory meridian response or ASMR (3 November, p 35). It seems these were what Vita Sackville-West, lover of her fellow-writer Virginia Woolf, had in mind in her 1950 radio talk "Walking through leaves". As well as the sensation of the title, she mentioned the silky glide of a filing-cabinet drawer with roller bearings and putting on a freshly ironed skirt.

She also mentioned sensations that have the opposite effect, such as the nasty feel of treading on granulated sugar on a tiled floor.

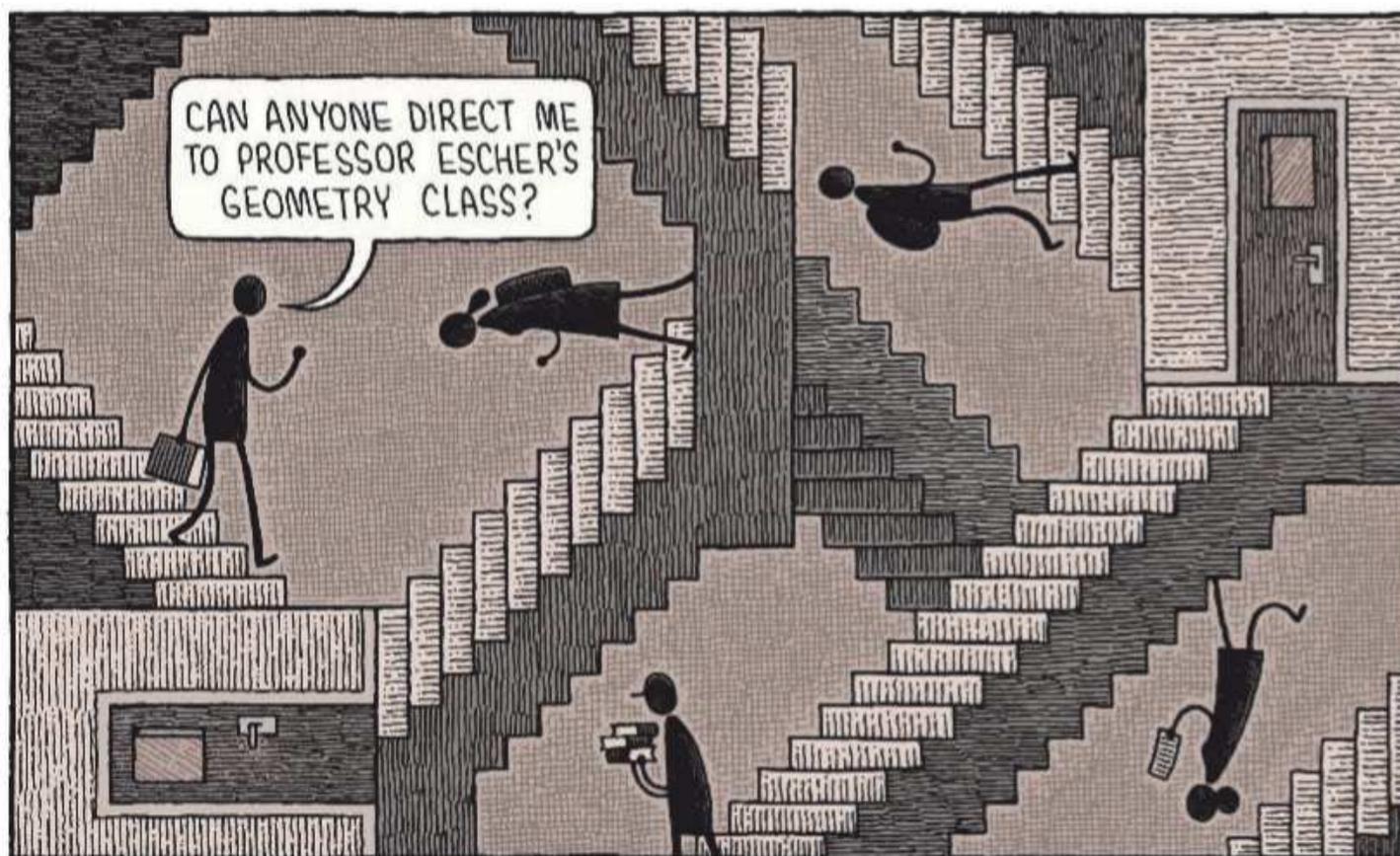
Closer contact with brainwaves

From Jim Skeels,
Toronto, Ontario, Canada
Chelsea Whyte reports people collaborating to play the game *Tetris* via electroencephalography (EEG) caps to record brain signals and a transcranial magnetic stimulation cap to transmit them (13 October, p 5). These seem rather cumbersome.

Why not try receivers closer to the brain? People wear dentures right against the roof of the mouth. One day, miniaturisation and signal transmission advances in sensors could make it possible to use a tooth implant.

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TOM GAULD for NEW SCIENTIST

FROM THE ARCHIVES

Sixty years ago, *New Scientist* considered exploding bombs in the Arctic Ocean



GALERIE BILDERWELT/GETTY IMAGES



Sixty years ago, meteorologists were beginning to think about climate change. On 4 December 1958, *New Scientist* ran a short story on “a way in which man might drastically alter the weather”.

Harry Wexler was director of meteorological research at the US Weather Bureau and one of first to write about what we now call geoengineering. We reported on

an article he wrote for *Science* (vol 128, p 1059), which considered “what would happen if ten ‘clean’ 10-megaton bombs were detonated in the Arctic Ocean in winter”.

The bombs would “produce steam, which would then condense ... and form a cloud of ice covering the entire region”. This would have a warming effect, Wexler thought: “Such a cloud might reduce by half the loss of heat by radiation from the Earth’s surface around the Pole.”

Another possible consequence of the giant ice cloud would be “to accelerate greatly the disappearance of the Arctic pack ice, and so open up the Arctic to shipping”. Sub-Arctic regions would see an increase in snowfall, and so “glaciers would grow in size and a new Ice Age might begin”.

Wexler was not advocating Arctic explosions, although *New Scientist*’s story was too short to make this point. And while he did think that climate control was becoming “respectable to talk about”, Wexler revealed one major motivation for his article in *The New York Times*. Nuclear weapons testing was at its height in 1958. There were 116 nuclear explosions that year, mainly carried out by the US and USSR, more than twice as many as the year before. Wexler worried that too many might lead to a nuclear winter and thus a new ice age.

And he understood even then that geoengineering would be suggested as a way of tackling climate change. His advice is worth repeating: “The full resources of knowledge ... must be brought to bear in predicting the results so as to avoid the unhappy situation of the cure being worse than the ailment.” **Julia Brown** ■

To delve more into the *New Scientist* archives, go to newscientist.com/article-type/old-scientist/



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THE work of Anthony William, better known online as the Medical Medium, has returned to Feedback's attention this week. It appears that William possesses a miracle cure for all life's ills, a feat rendered all the more remarkable when one considers his total lack of medical qualifications.

The cure in question is celery juice, best consumed early on an empty stomach, he says. The likely source of this unusual remedy? A spirit guide with whom William has regular psychic communication on matters medical. The saga reminds us of an excerpt from our favourite Victorian ghost story:

It was on my second night at Wydehealth Hall that the visitations commenced. I was roused from deepest sleep by a ghastly apparition, the spectre of a decapitated woman in Tudor dress who shook her gory locks at me and asked: why aren't you drinking more celery juice?

With a wild cry, I flung myself into the adjoining bathroom, little heeding the reverberations in the ancestral

pipework urging me to keep myself hydrated throughout the day.

Having locked the door, I suddenly grew cold, as though plunged into an icy bath of the sort that, the ghost shrieked, provided a good way to reduce unwanted swelling after physical exercise. Some unseen presence was tapping on my shoulder.

I turned around slowly. There I beheld a severed hand, which offered me what I took to be five portions of fruit and vegetables before starting to scrawl upon the mirror glass in its own blood. And oh, what it wrote there fills me with terror even now: try to get 75 minutes of moderate exercise every week.

Screaming, I fled the room, colliding with a pair of floating candlesticks carrying aloft a metric tonne of vitamin B12.

"Begone, foul apparitions," I cried, attempting to light a pipe to keep my nerves together, only to have it seized from my lips by an enormous purple tentacle.

"By all that is holy," I declared, "what do you shades of darkness want from

me?" "Only this," the dread voices replied as one, "half of your profits for peddling that celery stuff."

HOLD on to your patriarchs, folks, there is a liberal wind blowing through the corridors of the Church of England.

In a recent speech, the Archbishop of Canterbury said it was nonsensical to speak about God as a man. Forget that he never shows up, gets all the credit, and expects everyone to do exactly what he says (that's God, of course, rather than the Archbishop).

Instead, he said, we should consider the Almighty to be above such petty notions of gender, a bit like David Bowie or the moon. The problem, quoth the most reverend Justin Welby, lies in the intrinsic limitations of language.

How are mere mortal words supposed to contain the ineffable oneness? {shrug emoji}

DOUBLE entry: on Twitter, Ali Lister reports that her mother lost the password to her account with genomics firm 23andMe. "Instead of getting a new one, she ordered another spit kit, gave another sample, and had another DNA test," writes Ali. "Today, she rings me: baffled, but excited and happy, that they've found a twin she didn't know about!"

PREVIOUSLY Feedback discussed the ill portent of the Titanic II cruise liner – a replica of the original – having one Clive Mensink as its project director (10 November). But that is just, as they say, the tip of the iceberg.

Kevin Lee reports that Mensink previously headed his uncle's firm, Queensland Nickel, before it collapsed, sparking legal proceedings. His uncle then placed him at the helm of the project to build a second Titanic.

Well, who better than someone experienced in an enterprise built on tonnes of metal that went on to sink?

FIREFIGHTERS in Daventry, UK, responded to reports of a smoke alarm

sounding at a residential property. Arriving at the scene, however, the homeowner assured them that there was no fire.

After checking the smoke detectors, the source of the siren was traced to the man's pet parrot, Jazz, which had learned to perfectly imitate the shrill alert. It's one way to save on batteries, we suppose.

IN TETBURY, Gloucestershire, Cedric Lynch has taken possession of a powerful new leaf blower. According to the rating plate, the 1.0 horsepower motor runs on 240 volts at 2.8 amps, meaning it seems to deliver more power (746 watts) than it draws from the electrical supply (672 watts).

Cedric says he could point it at a wind turbine for infinite clean energy, but those leaves aren't going to tidy themselves.



A COURT in the US has ruled that Facebook friends don't count as real friends. Florida's Supreme Court justices convened to decide whether a judge and attorney who were friends on Facebook could be trusted to work on the same trial without bias.

The court ruled that "a 'friend' on a social networking website is not necessarily a friend in the traditional sense of the word... attached to another person by feelings of affection or personal regard". Soon, they'll be telling us that people didn't really "like" our last selfie after all.

You can send stories to Feedback by email at feedback@newscientist.com. Please include your home address. This week's and past Feedbacks can be seen on our website.

"I have never used a computer in my life," confessed Yoshitaka Sakurada, Japan's cybersecurity minister. Well, it's one way to ensure you never get hacked

Ski slope catwalk

During the Winter Olympics, TV commentators said it is advantageous for ski jumpers to be light because they will travel further. But being light is seen as a disadvantage for slopestyle snowboarders. What's the difference? And what effect do the snowboarders' baggy clothes have on performance? Would they do better in body-hugging ski suits?

■ On a downward slope, a heavier skier or snowboarder will go faster than a lighter one because gravitational energy and kinetic energy are both proportional to mass. But in the air, a ski jumper also enjoys lift. For the lighter ski jumper, this may overcome the disadvantage they experienced on the slope.

*Derek Bolton
Sydney, New South Wales,
Australia*

■ Lighter ski jumpers do tend to fly further than heavier ones. During the descent to the ramp, a heavier skier has the advantage of air drag holding them back less than it does a lighter skier.

But the lighter skier has an advantage during flight. We are all familiar with the almost-horizontal position skiers assume after launch. They do this because the lift force on a skier travelling through the air has a large upward component. Even the air drag has a slight upward element.

These aerodynamic forces don't depend on the skier's mass. But the amount of downward

acceleration does. Imagine a rectangular piece of paper and a book with an equal area. Drop them both and the paper will float to the ground well behind the book. Similarly, for comparable cross-sectional areas, the lighter skier's downwards acceleration will be less than a heavier skier's. Having a large mass is great for overcoming drag, but having a small mass is great for allowing lift to keep you in the air.

*John Eric Goff
Professor of physics, University
of Lynchburg, Virginia, US*

Unseemly seams

When I buy a new cotton vest or T-shirt, the side seams are always straight and parallel. After a few washes, one piece of material seems to move relative to the other, and the seams are never again parallel. Why is this?

■ If you look closely at the fabric of a T-shirt, you will see that it is made up of thin, vertical rows of ribbing. For the front and back to be aligned, these rows must be parallel. This is difficult to achieve. In a factory, multiple layers of fabric will be laid on top of each other before cutting out the T-shirt pattern, so there is a high possibility that the cuts will not fall exactly along vertical rows.

As a home sewer, I often choose T-shirt fabric for its softness and ease of wear, but it does require more care at the cutting-out stage.

*Claire Gregson
Portadown, Co. Armagh, UK*

■ T-shirt fabric is often manufactured as a tube in which bands of interlooped yarn run through the fabric in spiral rows of stitches. When the tube is slit open to make a flat piece of material, the rows of stitches may lie at a slight diagonal across the fabric. When this fabric is cut and

“We're all familiar with the almost-horizontal position ski jumpers assume - this helps keep them in the air”

sewn into a T-shirt, then washed, the stitch rows tend to straighten, resulting in the seam twist.

*Martin Bide,
Department of textiles, fashion
merchandising and design,
University of Rhode Island, US*

■ T-shirt material is knitted from a continuous thread, forming loops that interlink with rows above and below. The loops allow it to widen in any direction, while narrowing in the direction at right angles, giving you a nice, stretchy T-shirt with a stable shape.

It will stay like that until you wet the material and the threads relax. It is the drying that is crucial to maintaining shape. If you lay out your T-shirt flat and pat and pull it into the right shape before leaving it to dry, it will be fine. If you just chuck it over a line and hope for the best, it will probably end up a different shape. It can still be rescued by reshaping while gently steaming with an iron.

*Adrian Foulds
Glasgow, UK*

Tipple tummy

The beer belly is a particular form of (usually male) weight gain. Is there credible evidence that beer is capable of producing this localised fat deposition? If not, what causes it?

■ Beer is high in calories and is often consumed with high-calorie foods. Because beer is lower in alcohol than other alcoholic drinks and because there is more of a cultural norm to drink large amounts in one sitting than, say, wine, beer is usually the alcoholic drink from which the most calories are taken, leading to accumulation of fat. So drinking beer (and not vodka, for example) is associated with large bellies. It is not so much beer itself, as how much of it is drunk. More men have beer bellies as fat tends to gather there more in men than women. In women, fat is deposited more evenly around the body.

*Eleanor Horton
Canterbury, UK*

This week's question

FIRST TRANSMISSION

The Europeans who arrived in Sydney Cove in Australia from the 1780s onwards weren't decimated by disease after contact with the local Aboriginal people, whereas the reverse was all too true. Were the local population free of contagious diseases?

*Bonita Ely
Sydney, New South Wales,
Australia*

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