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WEEKLY June 17 - 23, 2017

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Astronomy's battle against
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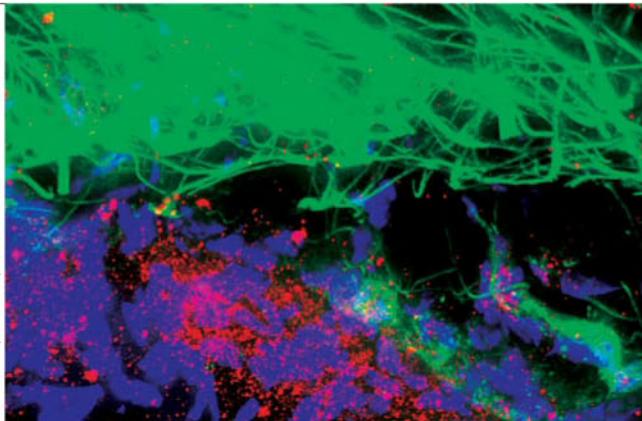
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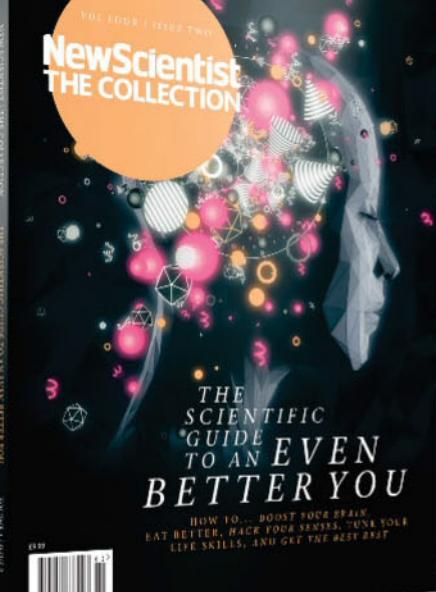
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Out of the chaos

Political turmoil is an opportunity for pro-science voices

AFTER the storm, the calm – at least for now. As *New Scientist* went to press, the UK's humiliated prime minister, Theresa May, was still trying to cobble together a deal to stay in office. The Democratic Unionist Party seems to hold the balance of power.

Beyond that, who knows? After needlessly plunging the UK into political chaos for the second time inside a year, the Conservative party is too busy trying to cling to power to articulate a coherent plan for governing the country.

Amid the political soap opera, serious issues are in play. The next few days and weeks will have great significance for science and enlightenment values generally.

Much has already been written

about the Tories' prospective partners in government. The DUP's antediluvian stances on the environment, abortion and evolution suggest they are unlikely to contribute much to evidence-based policymaking.

An even more pressing question for science is, whether Brexit? May justified calling the election by saying an increased majority would strengthen her hand in the negotiations. That was widely interpreted as her seeking a mandate for a hard withdrawal.

If so, the election result is a sigh of relief. May's extreme interpretation of the referendum result is unpopular among scientists, to put it mildly. They fear that the UK would lose access

to EU research funds and see opportunities for international collaboration weakened by tighter immigration controls.

Hard Brexit is now much less likely. Nonetheless, the new direction of travel is far from clear. "Consensus" appears to be the watchword, but it is possible that May will end up being held hostage by a hardline faction of her party. Another election or leadership race looks likely.

The minority government may be a lemon, but that is a chance to make lemonade. 105 MPs have a connection to science, technology or medicine. Now is a good time for them to press for policies – including on Brexit – that reflect pro-science values. ■

The acid test

TUNE in, drop out... and clock on. Workers in Silicon Valley and elsewhere have long extolled the virtues of LSD and other psychedelics. Small doses, they say, make them more productive, focused and creative (see page 22).

These are familiar claims. Every few years a new wave of "smart drugs" sweeps across university campuses and creative industries. They are always accompanied by

anecdotal reports of heightened mental powers, and concerns about adverse health effects and unlevel playing fields.

Microdosing ticks all of these boxes, but also raises a more serious issue. LSD is strictly prohibited worldwide, on the grounds that it poses a major health risk and has no therapeutic value. Meanwhile, microdosing is about to enter scientific trials

that could supply the first real evidence of effectiveness. This poses a potential dilemma.

The sensible option would be to downgrade the legal status of LSD. That would be entirely in keeping with growing evidence that it is relatively harmless and can be medically useful.

As for microdosing, experience with smart drugs suggests that people will do it anyway. The risks deserve further attention, but a serious criminal record shouldn't be one of them. ■



Anti-science fears for UK

IF YOU think the UK should be governed on the basis of sound scientific evidence, with climate change made a priority, look away.

After losing its majority in the election, the Conservative party wants to continue to govern with the help of Northern Ireland's Democratic Unionist Party, whose politicians' record on things scientific is abysmal. Last year, one DUP member of the Northern Ireland Assembly called for creationism to be taught in schools. And another thought only gay people could get HIV.

What's more, in a post-election reshuffle, Prime minister Theresa May has appointed Michael Gove as environment minister for England and Wales. Gove is infamous for his 2016 comment that "people in this country have had enough of experts".

As education minister, he reportedly tried to remove global warming from the school curriculum, and recently called for the abolition of European Union regulations protecting important wildlife habitats.

"His record of voting against measures to halt climate change and his attempt to wipe the subject from our children's curriculum show him entirely unfit to lead our country in tackling one of the greatest threats we face," said the co-leader of the UK's Green Party, Caroline Lucas. Since being appointed, though, Gove has criticised US president Donald Trump for deciding to withdraw the US from the Paris climate agreement.

Many think the Conservatives will fail to stay in power for long. Even if they do, the ability of the DUP and Gove to influence environmental

policies could be limited. If the UK leaves the EU, but remains part of the single market, as seems more likely given the result of the election, it will have to comply with almost all EU environmental regulations, but will lose the power to influence them.

With the government struggling to stay in power and focused on the upcoming Brexit negotiations, it seems certain that tackling climate change won't be high on the agenda. The UK has a target of cutting emissions by 80 per cent by 2050, but it is already failing to do enough.

The government has slashed numerous green policies since 2015, saying they were too expensive. It was supposed to unveil a "Clean Growth Plan" last year outlining how it would meet its climate targets, but this has been repeatedly delayed.

Heart attack drone

DRONES carrying defibrillators could help save lives by getting to someone whose heart has stopped quicker than an ambulance.

Every minute without CPR and defibrillation reduces someone's chance of survival by 10 per cent. So Jacob Hollenberg at the Karolinska Institute in Sweden and colleagues wondered if drones could transport a defibrillator to someone in need more quickly than an ambulance.

They attached a defibrillator to a drone stationed at a fire station in Norrtälje, a rural town north of Stockholm, and timed how long it took to reach locations within 10 kilometres where cardiac arrests had taken place over the past eight years.

"Every minute without CPR and defibrillation reduces someone's chance of survival by 10 per cent"

Over 18 flights, the median time taken was 5 minutes 21 seconds. During the real emergencies, the median time taken for the ambulance to arrive was 22 minutes (*JAMA*, DOI: 10.1001/jama.2017.3957).

Hollenberg's team is now working with the emergency services, preparing to dispatch the drone in real emergencies and test whether it improves outcomes.

Essential HIV meds

THE World Health Organization has added anti-HIV drugs to its list of essential medicines, in a move that turns the spotlight on the UK's rationing of such drugs.

Pre-exposure prophylaxis, or PrEP, involves two drugs in a combined pill that significantly reduces the risk of catching HIV through unprotected sex. Public Health England (PHE) said it was too costly for the NHS – even though it saves money in the long-term because fewer people

60 SECONDS

need lifelong HIV treatment.

PHE said it would begin a 10,000-person trial of the therapy early in the 2017 financial year, but it still hasn't started.

The WHO's list of essential medicines should help countries prioritise the provision of vital drugs. Several other countries, such as the US, provide PrEP. Scotland and Wales have recently said they will supply it too.

In England, gay men tend to buy cheap generics online, through websites such as I WantPrEP Now, which works with NHS doctors to check the quality of the medicines.

Serengeti invasion

WITH names like "devil's weed" and "famine weed", perhaps it's little wonder that these invasive plant species threaten to disrupt one of the great wonders of the natural world: the annual migration of 2 million animals across the savannahs of eastern Africa.

That's the grim message from a survey of the spread of invasive plants in the Serengeti-Mara ecosystem, focusing on six species that pose the most serious threat to the migrating animals.

Initially planted for decoration at tourist lodges in Kenya's Masai Mara National Reserve, the invasive plant species have spread into savannah grasslands, displacing natural vegetation (*Koedoe*, DOI: 10.4102/koedoe.v59i1.1426).

This is bad news for the migrating beasts that depend on native plants for food. "Rampant invasions in the Serengeti-Mara ecosystem will certainly reduce forage production, leading to drastic declines in the populations of wildebeest, zebras and other large grazing mammals," says Arne Witt of CABI Africa in Nairobi, Kenya. "These invasive plants are toxic or unpalatable, meaning there's less forage available for wildlife to feed on."

DIY space stations

A 1960s plan for building space stations from recycled parts may be getting new legs. NASA has signed an estimated \$10 million contract to look into turning spent rocket stages into labs with quarters for a crew.

A group of three US companies is on the case. United Launch Alliance will provide used second stages of Atlas V rockets, and NanoRacks will prefabricate a lab and living space for the rockets, with robotic outfitting from SSL. As with the old plan, the idea is to use two rockets, with the

astronauts in one and assembling a lab out of the other in space once the fuel tank is empty, instead of discarding it as happens now.

Sending two smaller rockets saves money, but it's still risky. Turning spent fuel shells into

"The astronauts will assemble the lab in space once the rockets' fuel tank is empty"

environments that can support both astronauts and experiments will be a challenge, as will asking astronauts to retrofit them for living and use while in orbit.

Drug too easy to abuse, says FDA

IN A bid to thwart the opioid epidemic, the US Food and Drug Administration has asked Endo Pharmaceuticals to withdraw its opioid pain medication - Opana ER - over concerns that the drug is too easily abused, the first time the agency has made such a move.

In a statement, the drug-maker said it is "reviewing the request and is evaluating the full range of potential options".

It is a small step in fighting the rising tide of opioid abuse. In a speech last week, Rod Rosenstein of the US Drug Enforcement Administration said that deaths from drug overdose rose nearly 20 per cent in 2016, compared with the previous year. Rosenstein also urged

law enforcement agencies to practise extreme caution when handling fentanyl, a synthetic opioid 50 to 100 times more potent than morphine. It is prescribed for severe pain, but is increasingly being sold on the street.

"Inhaling just a few airborne particles [of fentanyl] could be fatal," said Rosenstein. Last month, a police officer in Ohio collapsed after merely brushing some fentanyl off his shirt. He survived, but required four doses of the overdose treatment naloxone.

There is good news on the horizon, though. Last week, researchers in California reported that a vaccine that blocks the "high" of heroin has proven effective in non-human primates - the first vaccine against an opioid to do so.

**Green energy record**

The sun shone and the wind blew. And by lunchtime on 7 June, wind, solar, hydro and wood pellet burning were for the first time supplying more than half the UK's electricity needs, at 50.7 per cent of the total. With nuclear added in, low-carbon sources were providing 72.1 per cent of the electricity by 2 pm that day.

Brakes on booze

A new smartphone-connected breathalyser aims to prevent drink-driving. The device uses face-recognition technology to prevent it being fooled. Taxi and parcel delivery companies can use it to ensure their drivers are sober, says Hitachi, the Japanese tech giant that invented it.

China's dirty trade

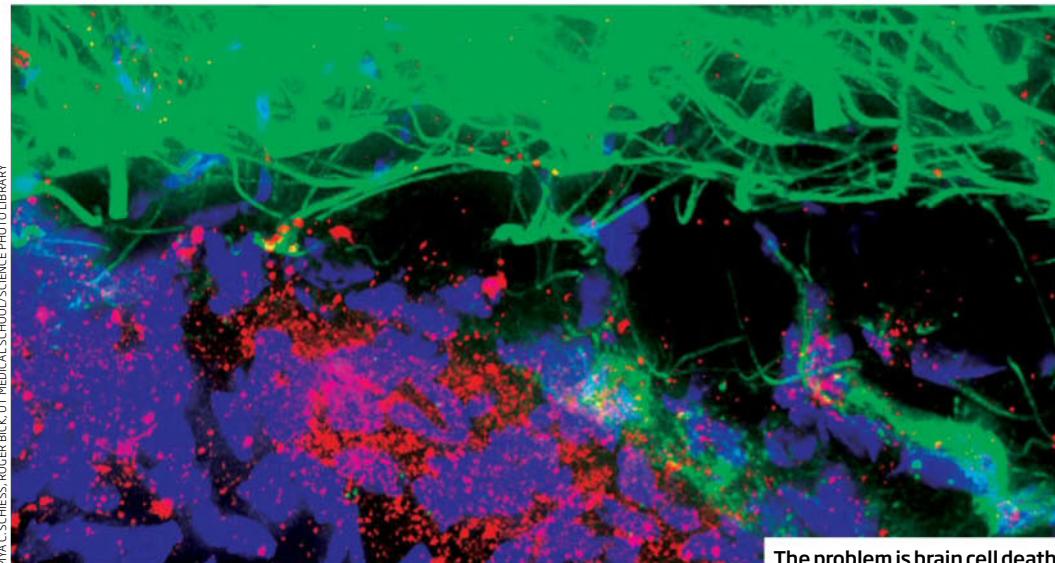
More than 140 tonnes of used plastic medical supplies, including syringes and blood bags, have been illegally sold off through an underground network of recyclers throughout China. Police officers in Hunan province say they fear the waste may have been reprocessed into plastic products for the food and medical industries.

No safe space

Tech companies, such as Google and Facebook, could soon become legally liable for "unacceptable content" posted on their platforms in the UK and France. This could include fines for failures to respond quickly. UK prime minister Theresa May was due to meet French president Emmanuel Macron this week to hammer out a deal on tackling extremist content online.

Fat world

A third of the planet's population are overweight. And 5 per cent of children and 12 per cent of adults are obese, according to a global study of 68.5 million people conducted in 2015. Between 1980 and 2015, the prevalence of obesity doubled in 73 countries (*NEJM*, doi.org/b8j3).



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Pig cells treat Parkinson's

Could animal implants heal damaged brain cells, asks **Clare Wilson**

WOULD you have pig cells implanted in your brain? Some people with Parkinson's disease have, in the hope it will stop their disease progressing.

The approach is still in the early stages of testing, but initial results from four people look promising, with all showing improvement 18 months after surgery.

Parkinson's is caused by the gradual loss of brain cells that make dopamine, a compound that helps control our movements. Current medicines replace the missing dopamine, but their effectiveness wears off.

Living Cell Technologies, based in Auckland, New Zealand, has been developing a treatment that uses cells from the choroid plexus in pigs. This brain structure makes a cocktail of growth factors and signalling molecules known to help keep brain cells healthy.

Last month, surgery was completed on a further 18 people in a placebo-controlled trial, using the choroid plexus cell implants. The hope is that compounds made by these cells will nourish

the remaining dopamine-producing cells in the patients' brains, slowing further loss.

The approach has been successful in a rat version of Parkinson's disease. "It's putting in a little neurochemical factory to promote new nerve cell growth and repair," says Ken Taylor, the firm's chief executive.

In the human trials, the pig cells are placed inside a porous coating of alginate, made from seaweed. This allows growth factors to move into surrounding brain tissue, yet should stop patients'

immune cells from entering to attack the pig cells. A similar approach is being used to treat other diseases (see "Implants also helping with diabetes").

Each alginate capsule is half a millimetre wide and contains about 1000 pig cells. In the pilot trial, four people had 40 capsules implanted in one side of their brain. The researchers have recorded average improvements among these people of 14 points, measured on a 199-point scale of symptom severity, which gauges things such as how well people

can walk and cut up their food.

But Steven Gill at the University of Bristol, UK, says that could have been due to a placebo effect, as people improved immediately after the surgery. "Nerve cells don't regrow that fast," he says.

Previous work has found that Parkinson's disease symptoms

"It's putting in a little neurochemical factory to promote new nerve cell growth and repair"

seem particularly responsive to the placebo effect. But the improvements seen in these four people have now been maintained for 18 months. Those with the disease normally deteriorate by five points a year, says Taylor.

The larger, placebo-controlled trial should shed more light on the matter. Its results are due in November. In this trial, people had up to 120 capsules put in both sides of their brain. "The strategy is a good idea," says Roger Barker at the University of Cambridge, who has previously advised the firm. "The question is how competitive that will be compared with other cell therapies."

Another kind of cell therapy for Parkinson's that has shown some success uses implants of dopamine-making brain cells from aborted human fetuses. But such tissue is hard to obtain.

There are also hopes of turning adult stem cells into dopamine-producing cells. If this can be done using, say, a patient's skin cells, it would remove the risk of any immune rejection.

One concern with animal-to-human transplants is that viruses lying dormant within the pig DNA – called porcine endogenous retroviruses – could cross over into people and start a new disease. But this hasn't happened so far in those who have received pig pancreas cells for diabetes.

Other teams are attempting to use the gene-editing technology CRISPR to eliminate these viruses. ■

IMPLANTS ARE ALSO HELPING WITH DIABETES

Several people with type 1 diabetes have responded well to pig cell implants that are helping to replace lost insulin.

Type 1 diabetes occurs when insulin-producing cells in the pancreas are destroyed. People with the disease must have daily insulin injections to normalise their blood glucose levels, but this treatment can result in fluctuating

glucose levels that shorten lifespan.

Now, Living Cell Technologies in Auckland, New Zealand, is using pancreas cells taken from pigs to replace the missing insulin. Nine people with type 1 diabetes have been implanted with the cells, which secrete insulin. All of them appear to be responding well, reducing their daily insulin dose with no serious side effects.

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Rubber algae make artificial reefs off Italy

TINY, artificial algae are being deployed in the first such effort to restore reefs in the Mediterranean.

They resemble coralline algae, which have a similar ecological role to corals: forming reefs using calcium carbonate structures that create diverse and complex environments.

But as the reefs they build are made from a soluble form of calcium carbonate, they are vulnerable to ocean acidification. So Federica Ragazzola at the University of Portsmouth, UK, partnered with researchers from the Italian National Agency for New Technologies, Energy and Sustainable Economic Development to test out artificial reefs. They wanted to see if these mimics could protect the organisms that live on natural coralline algae reefs and act as scaffolds on which real reefs would grow.

The team developed small plastic structures to mimic the coralline alga *Ellisolandia elongata* and how it moves. The 90 synthetic mini reefs, each with 20 fronds made of a highly elastic rubber material called silicone elastomer, are anchored in clear resin. "The material was chosen to match the properties of the algae and, more importantly, is non-toxic to the marine environment," says Ragazzola.

Last month, the mimics were fixed close to existing coralline algae reefs in the Gulf of La Spezia, in north-west Italy. Each is just 10 centimetres in diameter, so they can be easily nestled within natural reefs to encourage small organisms such as crustaceans, mussels and worms to move to the mimics. They will be monitored to see if this happens.

After one month, there are already signs that biofilms have formed on some of the artificial reefs, suggesting that microorganisms are beginning to colonise them. After a year, we should start to see some of the larger species establishing themselves on the mimics, says Ragazzola. Sarah Griffiths ■



Top negotiator needed

Chatbots learn how to drive a hard bargain

WHAT'S in it for me? Facebook's chatbots are learning the art of the deal, bartering and deceiving their way to better terms in negotiations with humans and other bots.

Artificial intelligences that can negotiate effectively would make useful virtual assistants, says Mike Lewis at Facebook's research lab. Bots could be left to arrange appointments for people, sorting out calendar clashes by themselves. Or they could negotiate with several agents at once to book a holiday or make a purchase on your behalf.

Most existing bots – such as Apple's Siri or those built into chat apps like Facebook Messenger – may be able to get you a taxi or order a pizza but they can't engage in complex negotiations, says Lewis. If we want bots to help us with more complex tasks they need to become dealmakers, especially if the task involves

cooperation or compromise, like negotiating the purchase or sale of a property, for example.

Lewis and his team trained their bots on a database of more than 5000 text conversations between people playing a two-player game in which they had to decide how to divvy up a number of items. These included balls,

"If we want bots to help us with more complex tasks they need to become better dealmakers"

hats and books and were worth a different number of points to different players. The aim was to score more points than your opponent by making a deal that meant you ended up with the items of highest value to you.

The researchers got the chatbots to hone their skills by playing the game against both

humans and other bots. Three different approaches were tried. One bot was taught to mimic the way people negotiated in English, but it turned out to be a weak negotiator, and too willing to agree to unfavourable terms. A second was tasked with maximising its score. This bot was a much better negotiator but ended up using a nonsensical language impossible for humans to understand.

The team then combined these approaches. The hybrid bot was able to plan several steps ahead and assess how saying different things could change the outcome of the negotiation. On average, it scored only slightly worse than the humans it played against. It also learned the usefulness of deceit: the bot started pretending it really wanted items that had little or no value to it, offering to give them up in exchange for items it actually did want. The research will be presented at a natural language processing conference in September in Copenhagen.

The hybrid bot wasn't quite as good at the negotiating game as the nonsensical one, but the trade-off is important if we are to trust such bots to act for us. Having chatbots that negotiate in a language we can understand is useful for all kinds of reasons, says Oliver Lemon at Heriot-Watt University in Edinburgh, UK. If a virtual assistant made a decision you weren't happy with, you would want to go back and look at the negotiation to understand how it got there. It might book an early flight because the later ones were much more expensive, for example. This becomes even more important if dealmaking bots one day help negotiate things like insurance claims, for example.

Ultimately, virtual assistants might steer negotiations we are involved in ourselves. For example, a bot could listen to conversations between a house buyer and an estate agent, offering useful tips to the buyer such as when to withhold certain pieces of information. Matt Reynolds ■

Message from fake aliens decoded in SETI contest

DO YOU speak alien? For years, radio telescopes have been listening to the cosmos in the hope of picking up an alien message. We have had no luck yet, so while we wait, René Heller organised a trial run. He simulated receiving a message from outer space and then challenged the general public to decrypt it.

"I pretended to be an alien that could count and had a physical appearance. I then created a picture of my home planetary system encoded in binary – zeroes and ones," says Heller, who is at the Max Planck Institute for Solar System Research in Göttingen, Germany.

In total the message consisted of around 2 million digits. One portion of the message corresponded to a picture of the aliens, where 0s and 1s were coded as white and black dots making up the image. Another listed the first 757 prime numbers to give anyone decoding the message a clue that numbers were crucial to understanding its full meaning.

A third portion of the message was an imagined "about us" section from the aliens, such as their average height and lifespan,

and their location in space.

Rather than using human-centric units like metres or years to describe these details, Heller used units derived from natural constants like the speed of light and Planck's constant. "These are numbers that anyone in the

universe should be able to derive," says Heller.

On 26 April last year, he published the fake alien message on Twitter and Facebook, and set a deadline for solutions for just over a month later. A recent paper analyses the nearly 300 responses he received, of which 66 contained the correct solutions (arxiv.org/abs/1706.00653).

"The experiment confirms more about humans than it does

aliens," says Claudio Grimaldi at the Swiss Federal Institute of Technology in Lausanne. It's impossible to know how this message created by a human would differ from one created by aliens, he says.

The closest thing we have to alien messages may come from dolphins, says Grimaldi. We know they have some form of language, but we are unable to understand it despite many people trying.

"The experiment is still a really nice step though, and shows that humans have a good capacity to understand coded messages," he says.

The search for extraterrestrial intelligence (SETI) has been going for over 40 years, with radio telescopes around the world listening out for alien messages. When the most sensitive radio telescope ever built, the Square Kilometre Array, is finished in 2020, it, too, will spend some of its time listening for messages. It will be able to pick up signals from several tens of light years away.

As far as we know, we haven't received a message from lifeforms beyond Earth. "Who knows how an alien would try to communicate with us?" says Heller. "But from this experiment it's clear that the general public should help decode a message if we ever think we've received one." Timothy Revell ■



Listening out for alien missives

Ocean plastics used in laptop packaging

WHAT if pieces of plastic strewn across the world's beaches ended up in brand new computer boxes, not floating in the middle of the ocean or lodged inside seabirds?

That's what computer company Dell has set out to do, testing a supply chain in which litter picked up from Haiti's beaches is worked into recycled packaging. Anyone buying the XPS 13 2-in-1 laptop can expect to find the machine sitting on a tray

made of recycled material that's 25 per cent ocean plastic – complete with the image of a whale and a link to information about marine litter.

"We'll be using 8 tonnes of ocean plastics, and we will be scaling in the coming years," says Louise Koch, Dell's corporate sustainability lead for Europe, the Middle East and Africa, who presented the initiative at last week's World Circular Economy Forum in Helsinki, Finland.

Up to 40 per cent of plastic litter dumped on land enters the oceans each year, estimated to amount to between 4 million and 12 million tonnes in 2010. More than 5 trillion pieces of plastic float in the world's

oceans, breaking into smaller pieces that sink to the seabed or hurting animals that get entangled in bags or eat pieces with sharp edges.

The UN, which last week held its first conference focused on oceans, has praised Dell for the initiative. But not everyone is convinced it will make a real difference. "Most marine debris does not reach the oceans via beaches," says Emma Priestland, marine litter policy officer at the NGO Seas at Risk. The sources are mainly

rivers, landfills near the coast, or the shipping and fishing industry, she says. "What is on those beaches has most likely been washed up there," says Priestland. "Recycling it will be difficult and energy-intensive."

Mine Banu Tekman at the Alfred Wegener Institute in Bremerhaven, Germany, agrees that the impact is likely to be small, but says it is a great way of raising awareness.

It will take a large number of companies getting involved in this type of recycling to see a benefit for the environment, says Francois Galgani, an expert on plastics pollution at the French institute IFREMER. Anita Makri ■

"The new initiative could take out 8 tonnes of plastic a year, but that's still just a drop in the ocean"

Low-carb diet might make you more tolerant

A LOW-CARB diet might do more than affect your health – it could make you a more tolerant person.

People who cut out carbohydrates tend to have a higher protein intake because they replace carb-filled foods such as bread and pasta with protein-rich meat and dairy.

Since protein boosts dopamine in our blood and dopamine affects decision-making, Soyoung Park of the University of Lübeck in Germany, wondered whether a low-carb diet might change people's behaviour.

To find out, her team asked people to participate in the “ultimatum game”, in which you are split into pairs. Your partner is given some money and they decide how much to share with you. If you accept the offer, both of you get the cash, but if you reject it, no one gets anything.

In theory, people should always accept, but in practice, people often reject low offers. We seem to have an urge to punish those who split the money unfairly, even if we suffer a small loss, says Park.

In several experiments, participants who had eaten a low-carb meal earlier in the day were more likely to accept unfair offers in the game, than those who had eaten a high-carb meal. In one experiment, 76 per cent of low-carbers accepted an unfair offer compared with 47 per cent of a high-carb group.

Blood taken from the volunteers found that low-carb meals raised a chemical precursor to dopamine, which correlated with more tolerant behaviour in the game. No such link was seen with a range of other blood measurements (*PNAS*, doi.org/b8jt).

Dopamine might have this effect because it is involved in signalling that we have experienced a reward. Perhaps people with higher baseline dopamine levels found a lower sum of money offered by their partner more satisfying and were therefore more likely to find their low offer acceptable, speculates Park. Clare Wilson ■



Superhero in training

Pilot a drone with your entire body

Timothy Revell

I FEEL half-superhero, half-idiot. The jacket I'm wearing is letting me fly a drone around a virtual university campus just by spreading my arms and moving my body from side to side – like a kid pretending to be a plane. And a virtual-reality headset gives me a perfect bird's-eye view. But I'm sitting in the Swiss embassy in London, with the jacket's creators looking at me across a table wondering if I'll fall off my chair.

The jacket is a prototype drone controller kitted out with sensors that measure body movement. This motion is then translated into the controls of an airborne drone – or, for my test flight, a virtual drone in a simulator.

When I move my body to the left, the drone moves to the left, and when I dive forwards and almost lose my balance, so does the drone.

The VR headset lets me see where I'm going. Headphones provide the sound of wind rushing past my ears and metal supports under my elbows keep my arms aloft for flight. I might look like a plucked chicken in a harness, waving my arms and staring at the floor, but from where I sit, I'm an eagle soaring in the sky.

“The goal is to make people fly without ever leaving the ground,” says Dario Floreano at the Swiss Federal Institute of Technology (EPFL), who created the jacket.

Floreano believes that the jacket

gives drone pilots a more intuitive way to control their aircraft, letting them focus on other tasks at the same time. Pilots on a search-and-rescue mission could communicate with the ground team more easily if they didn't have to focus all their attention on using their hands to control a drone, for example.

The team's initial tests have shown that people learned to control a drone more quickly

“I might look like a plucked chicken in a harness, but from where I sit, I'm an eagle soaring in the sky”

with the jacket than with standard joystick controls. What's more, people handled stressful situations better with the jacket than with a joystick. For example, testers were more likely to get their drone through tight gaps between buildings using the jacket.

“People with a lot of practice are really good at controlling drones with traditional controls,” says team member Corine Rognon. “But with the fly jacket, people reach the same level without the practice.”

The next version of the jacket will also provide the wearer with physical feedback. Cables running through the material that can be tightened or relaxed will give the sensation of turbulence. The cables can also be used by an AI co-pilot to tug people into the right body position for the optimum flight path.

“Piloting drones is a difficult thing,” says Karen Anderson at the University of Exeter, UK. It's hard to keep track of everything like flight direction and telemetry read-outs while also thinking about what your fingers are doing on the controller. “Wearing a suit that can control the drone without that brain-eye-finger coordination gives a more direct way of sending commands to the flying machine,” she says. ■



ESA/ROSETTA/NAV/CAM - CC BY-SA/GO 3.0

Icy comets ferried xenon to Earth

Leah Crane

THE origin of the xenon in our atmosphere has been a mystery for decades. Now, data from the Rosetta spacecraft shows 22 per cent came from comets. These celestial bodies may also have transported ingredients for life.

Earth's atmospheric xenon has more heavy isotopes than xenon found in the solar wind or meteoroids. Researchers couldn't figure out where this heavy component came from. The idea that it could have been brought by comets was often suggested, but evidence was sparse.

In 2014 Rosetta orbited mere kilometres from the surface of the comet 67P/Churyumov-Gerasimenko, sampling the gas coming off its ice patches. Bernard Marty at the University of Lorraine in France and colleagues found that it closely matched the makeup of Earth's heavy xenon.

"Earth's atmospheric xenon is a mixture between meteoritic and cometary, and we know the

composition of each now," he says. "So we mix them, we make up a cocktail, until we find the taste of the atmosphere."

The cocktail that best matched our atmosphere was about 22 per cent cometary xenon, with the rest coming from meteors (*Science*, DOI: 10.1126/science.aal3496).

However, this does assume that all comets are similar to 67P, says Colin Jackson at the Smithsonian Institution in Washington DC.

The comet also had a surprising amount of a particular type of

"It may have caused us to overestimate the age of the atmosphere and the moon"

the gas: xenon-129. On Earth, we presumed this isotope primarily came from decaying iodine. We know the rate at which iodine decays, so we use its abundance to gauge the timeline of planetary events. But if 22 per cent of the xenon in Earth's air came here on comets, models based on iodine

decay overestimate the age of the atmosphere and the moon.

So when did the xenon arrive? Earth's mantle doesn't contain the cometary xenon, so what's in our modern atmosphere must have arrived after the mantle stopped incorporating gases from the air.

At that time, 4.5 to 3.5 billion years ago, it seems comets would have struggled to get here. Jupiter, Saturn, Neptune and Uranus are thought to have formed a barrier between the inner and outer solar system, attracting objects like xenon-laden comets and lowering their chances of landing on Earth.

But some theories say the orbits of the giant planets changed around 100 million years after the solar system began to form, which Marty says could have let some comets reach Earth.

Those could have contained not just xenon, but also the volatile elements crucial for life, like hydrogen and nitrogen. The inner solar system was probably too hot for these elements to survive the cloud of dust and gas that formed Earth, so it's long been said that at least some was delivered after the planet's formation by comets.

"It doesn't mean that comets brought life, but they could have brought the bricks of life," Marty says. ■

Baby brain scans reveal future autism

BRAIN scans of 6-month-old babies may now be able to predict who will show signs of autism by the age of 2. This means it could become possible to intervene to try to reduce the impact of some more difficult autistic behaviours before symptoms emerge.

"We have been trying to identify autism as early as possible... before the behavioural symptoms appear," says Robert Emerson at the University of North Carolina at Chapel Hill.

Emerson and his team used fMRI to scan the brains of 59 sleeping infants, all of whom were aged 6 months and had older siblings with autism, which means they were at high risk of developing autism themselves.

The scans collected data from 230 brain regions, showing the 26,000 connections between them. When the group followed up with the children at the age of 2, 11 had been diagnosed with autism.

The team used brain scans and behavioural data from the 2-year-olds to train an algorithm to identify any brain connectivity patterns that might be linked to later signs of autism.

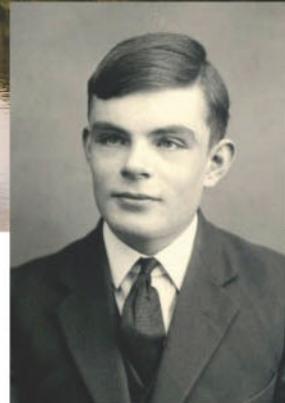
The program then used only the patterns from the 6-month-old brains to predict which children would show signs of autism at 2 years old. It correctly identified nine of the 11 who had been diagnosed (*Science Translation Medicine*, DOI: 10.1126/scitranslmed.aag2882).

"The study confirms that autism has a biological basis, manifest in the brain before behavioural symptoms appear, and that autism is not due to environmental effects that occur after 6 months, for example, vaccinations," says Uta Frith of University College London. "This still needs pointing out."

The results raise the prospect of using early interventions to help with some aspects of autism, such as difficulty with language. The scanning technique hasn't yet been tested on children with a lower risk of developing autism. Anil Ananthaswamy ■

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AI learns to reason about the world

Matt Reynolds

THE world is a confusing place, especially for an AI. But a neural network developed by UK artificial intelligence firm DeepMind could help bring it into focus by giving computers the ability to understand how different objects are related to each other.

Humans use this type of inference – called relational reasoning – all the time, whether we are choosing the best bunch of bananas at the supermarket or piecing together evidence from a crime scene. The ability to transfer abstract relations – such as whether something is to the left of another object or bigger than it – from one domain to another gives us a powerful mental toolkit with which to understand the world. It is a fundamental part of our intelligence, says Sam Gershman, a computational neuroscientist at Harvard University.

What's intuitive for humans is very difficult for machines to grasp, however. It is one thing

for an AI to learn how to perform a specific task, such as recognising what's in an image. But transferring know-how learned via image recognition is a big challenge. Machines capable of such versatility will be one step closer to general intelligence, the kind

that lets humans excel at so many activities.

DeepMind has built a neural network that specialises in this kind of abstract reasoning and can be plugged into other neural nets to give them a relational-reasoning power-up. The researchers trained the AI on images depicting 3D shapes of different sizes and colours. It analysed pairs of objects in the images and tried to work out the relationship between them.

The team then asked it

questions such as "What size is the cylinder that is left of the brown metal thing that is left of the big sphere?" The system answered these questions correctly 95.5 per cent of the time – slightly better than humans. To demonstrate its versatility, the relational reasoning part of the AI then had to answer questions about a set of very short stories, answering correctly 95 per cent of the time.

Still, any practical applications of the system are still a long way off, says Adam Santoro at DeepMind, who led the study. It could initially be useful for computer vision, however. "You can imagine an application that automatically describes what is happening in a particular image, or even video, for a visually impaired person," he says (arxiv.org/abs/1706.01427).

Outperforming humans at a niche task is also not that surprising, says Gershman. We are still a very long way from machines that can make sense of the messiness of the real world. Santoro agrees. DeepMind's AI has made a start by understanding differences in size, colour and shape, but there's more to relational reasoning than that. "There is a lot of work needed to solve richer real-world data sets," says Santoro. ■



What's next to the blue thing?

Fetuses follow faces from inside womb

BABIES look for faces as soon as they are born, and now it seems they can do this from inside the womb, too.

"We already know that fetuses can see," says Vincent Reid of Lancaster University, UK. "But until now, no one has displayed visual information to the fetus and triggered a response."

To test this idea, Reid's team shone three red dots through the skin of women in the final trimester of their pregnancies. When the dots were configured to resemble two eyes

above a mouth, the team saw 40 occasions when a fetus seemed to follow this pattern when it moved.

High-definition ultrasound let Reid's team watch each fetus's movements. They used red light because it is the best at getting through to the uterus.

The team shone the lights in a pattern to one side of the fetus's head and moved them slowly, to see if the fetus turned to track them.

As a control, the team inverted the three dots – one dot sitting above two dots, instead of two dots sitting above one. This experiment replicates those conducted in the 1990s that identified what newborn babies preferentially look at, says Reid.

The team tested both patterns on 39 healthy fetuses. Out of 195 tests of each configuration, fetuses turned to follow the "face" shape 40 times, and the inverted image only 14 times (*Current Biology*, doi.org/b8hr).

"It's interesting that these predispositions might be there from earlier on to prepare the infant for birth," says Mark Johnson at Birkbeck College, London, whose team demonstrated in 1991 that newborns preferentially turn to look at faces.

"We know that fetuses receive

a lot of sensory stimulation from the outside world," says Marco Del Giudice at the University of New Mexico, Albuquerque.

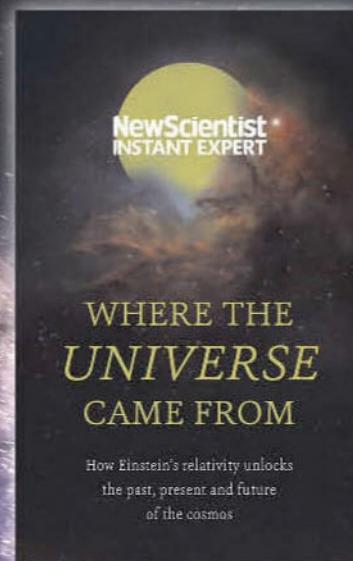
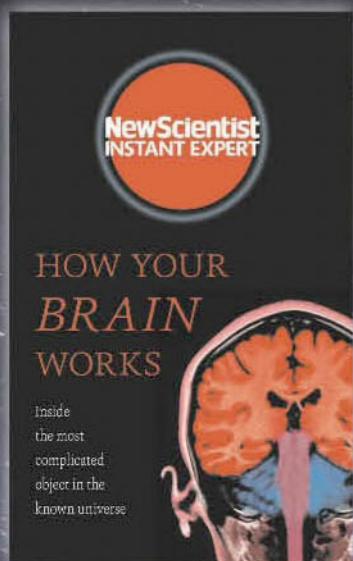
In 2011, Del Giudice's team showed that on a bright summer's day, with no clothing in the way, a fetus receives the same amount of light you get in a typically lit house.

"This brilliant new study demonstrates how we can use these windows to learn how the remarkable skills of human infants begin to develop before birth," says Del Giudice. "I've suggested, for example, that fetuses might develop some visual and coordination skills by observing the movements of their own hands and feet." Andy Coghlan ■

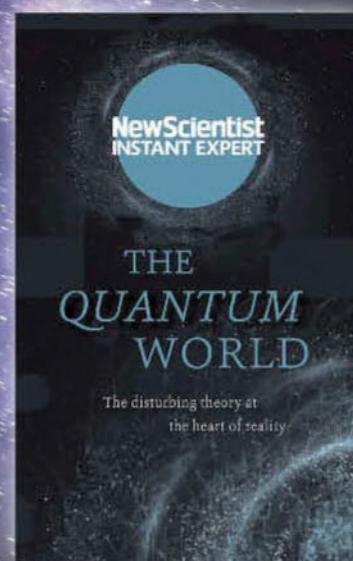
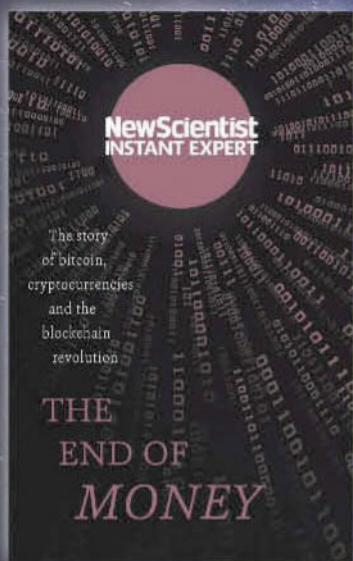
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How to bake daily bread in space

Sandrine Ceurstemont

ASTRONAUTS could soon be waking up to the smell of freshly baked bread. A new dough mixture and oven specially designed for use on the International Space Station will be tested during a mission next year.

Ready-made space meals have improved over the years, but for long missions it is impractical for astronauts to take all their food with them. So efforts are underway to produce a range of fresh food in space, including growing vegetables and using bacteria to make sugars.

Fresh food would also make life in space more pleasant, for astronauts and sightseers. "As space tourism takes off and people spend more time in space we need to allow bread to be made from scratch," says Sebastian Marcu, founder of Bake In Space, the company behind the project, based in Bremen, Germany.

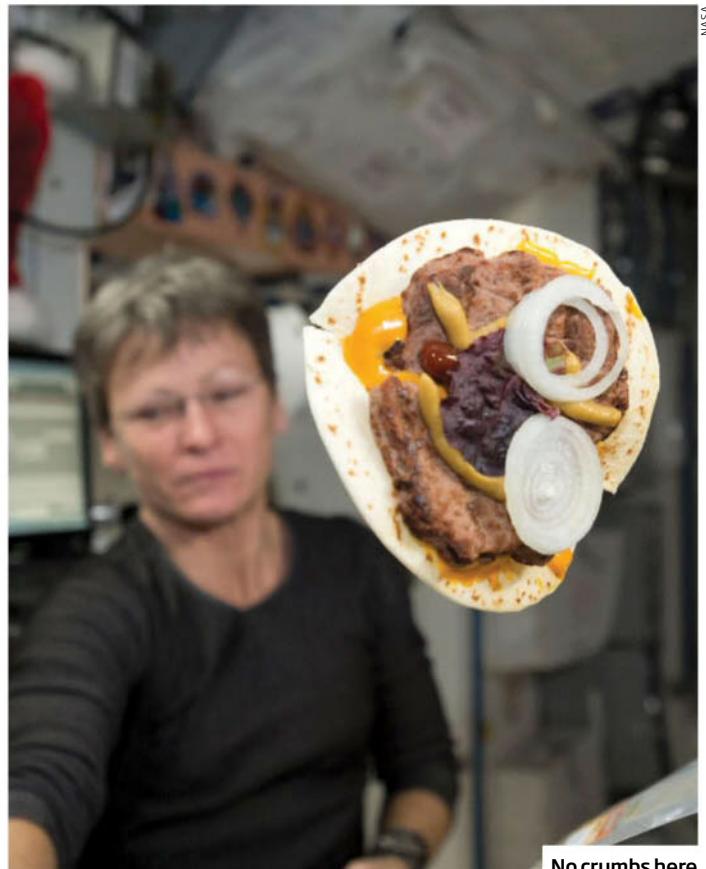
Bread is a staple food on Earth but can be life-threatening in space. The first and last people to enjoy bread in space were the two astronauts on NASA's 1965 Gemini 3 mission, who shared a corned beef sandwich one of them had smuggled on board.

The crumbs flew everywhere in the microgravity and could have got into their eyes or into the electrical panels, where they could have started a fire. Bread has been banned ever since – tortilla wraps are the accepted alternative.

Marcu thinks he has a solution. Bake In Space is working with the German Aerospace Center and others to develop a dough mixture and baking process that produces a crumb-free bread. They haven't yet figured out how to mix the dough in microgravity so initial batches will be of bread part-baked on Earth.

But crumb-free bread could be tough and chewy. So Matthias Boehme at Bremen-based OHB System AG, who is part of the team, is trying to adapt a convection oven to the constraints of the ISS. Electricity on the space station is limited so any oven must work on just 250 watts – a tenth of the power used by a standard oven on Earth. And exterior surfaces cannot exceed 45°C.

Boehme is also looking at vacuum baking, in which the pressure inside a sealed oven is lowered. Since the boiling point of water decreases as atmospheric pressure decreases, a low-



No crumbs here

pressure oven would bake at lower temperatures. He thinks this would make the crumb-free bread fluffier and more palatable.

Various methods will be tested on board the ISS during the European Space Agency's Horizon mission in April 2018.

"The comforts of home, like the smell of fresh baked bread, could energise astronauts physically

and psychologically," says Jennifer Levasseur at the Smithsonian National Air and Space Museum.

Bake in Space also plans to experiment with sourdough bread, creating starters – fermented batter-like dough – in space. If successful, they plan to bring some of this dough back to Earth. "We could sell original space rolls in bakeries," says Boehme. ■

Deep Earth is enveloped in mantle ocean

THE deep Earth holds about the same amount of water as our oceans. That's the conclusion from experiments on rocks typical of those in the mantle transition zone, a layer 410 to 660 kilometres beneath us that separates the upper from the lower mantle.

"If our estimation is correct, it

means there's a large amount of water in the deep Earth," says Hongzhan Fei at the University of Bayreuth in Germany. "The total amount of water there is nearly the same as the mass of all the world's ocean water."

The team combined laboratory experiments with real-world measurements of the mantle viscosity in the deep Earth to conclude that the rock must be saturated with water (*Science Advances*, DOI: 10.1126/sciadv.1603024).

The results add to mounting

evidence that there is much more water than expected beneath us, mostly within mineral crystals. At least one team has discovered water-rich rock fragments in volcanic debris originating from the mantle. Another group has conducted experiments suggesting that the water at these depths was formed

"Where this vast amount of water came from is a key question about the evolution of Earth"

on Earth rather than being delivered by comets and asteroids.

"The vast amount of water locked inside rocks of this deep region of the mantle will certainly force us to think harder about how it ever got there, or perhaps how it could have always been there since the solidification of the mantle," says Steven Jacobsen of Northwestern University in Illinois. "It's a key question about the evolution of the Earth, which extends to extrasolar planets as well." Andy Coghlan ■



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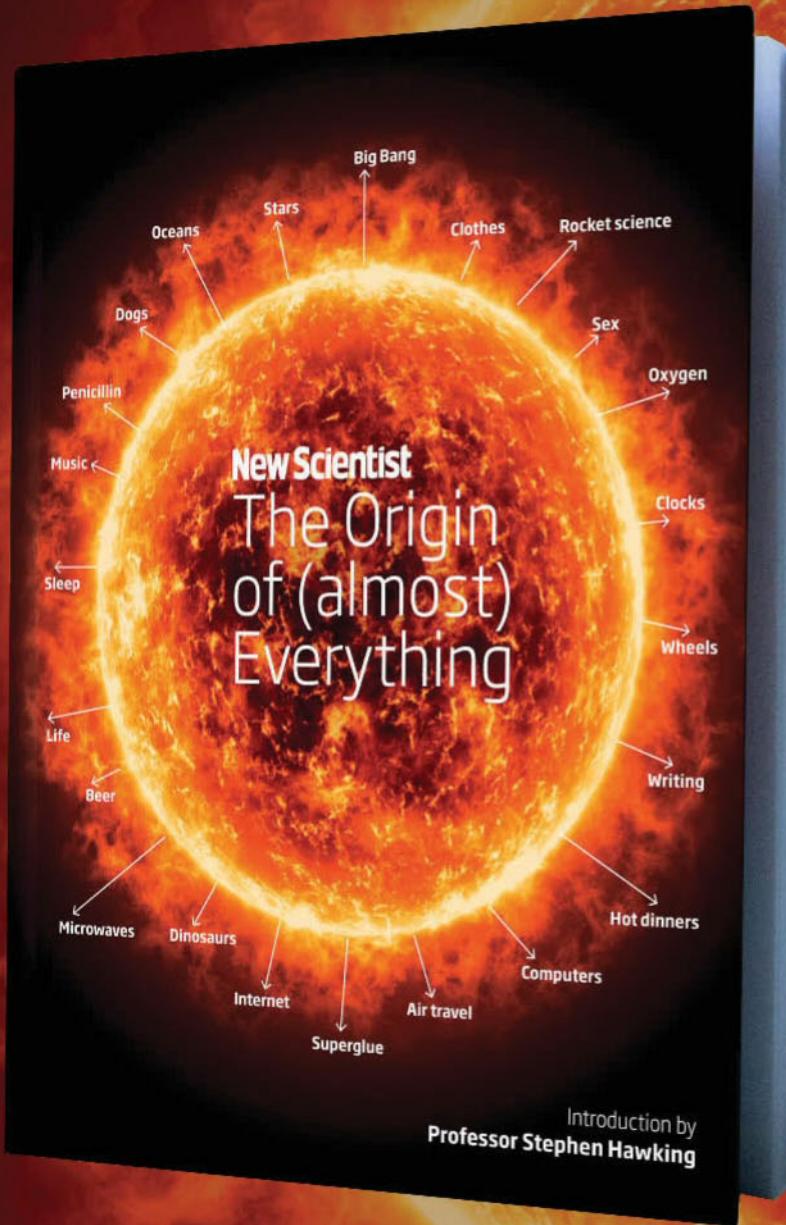
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Introduction by **Professor Stephen Hawking**

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Extreme plants live at 72°C in New Zealand's volcanic field

SOME like it (very) hot. A survey of plants growing in a highly active volcanic area in New Zealand, where soil temperatures can reach 98.5°C, has revealed several species that are able to survive the extreme conditions.

Geothermal fields where the ground is heated by molten rock below are known for their hot springs and geysers. But they contain distinct vegetation, too. Mark Smale at Landcare Research in New Zealand and his team surveyed 15 of these fields in the Taupo Volcanic Zone of North Island. They found that plants with shallow roots, for example mosses and liverworts, were the only

survivors in extremely hot soil. Temperature was measured at a depth of 10 centimetres.

The most heat-tolerant species in the areas surveyed was dwarf swan-neck moss, which lives in soil where temperatures hit 72°C. In areas where the soil was a few degrees cooler, at 68°C, Smale's team found geothermal kanuka, an endemic shrub, and staghorn clubmoss, which is widespread in tropical climates (*Journal of the Royal Society of New Zealand*, doi.org/b8fc).

Since soil temperature at such sites increases with depth, even these heat-tolerant species are restricted to the top few centimetres of soil. They have adapted by having short roots or roots that spread out laterally instead of downwards. "No plants can survive temperatures above about 80°C," says Smale.

Cystic fibrosis drug boosts lung health

A DRUG has improved lung function in children with cystic fibrosis, raising hopes that the life-threatening damage caused by the genetic disease can be halted or even reversed.

Since the gene behind cystic fibrosis was discovered in 1989, researchers have tried to develop drugs that directly target the faulty protein it makes in those with the disease. They have had

some success. Kalydeco, which has been available since 2012, helps cells make a correct protein. But it only works for 5 per cent of people with the condition.

By combining Kalydeco with another drug to create a single medicine called Orkambi, clinicians have since attempted to extend treatment to half of all people with cystic fibrosis. A placebo-controlled trial of

Orkambi in 204 children aged from 6 to 11 with cystic fibrosis has now demonstrated that the drug enables them to take in 10 per cent more oxygen from their lungs (*The Lancet Respiratory Medicine*, doi.org/b8dx).

"We've shown that even in younger patients who have relatively mild disease, Orkambi led to improvements in lung function," says Felix Ratjen of the Hospital for Sick Children at the University of Toronto, Canada.

Weighing a white dwarf with gravity

MEASURING a star's mass isn't an easy feat – you can't exactly pop it on a pair of scales. But thanks to a key prediction in general relativity, we have directly measured the mass of a white dwarf for the first time.

Einstein predicted that light would curve around massive bodies because of gravity. Kailash Sahu and colleagues at the Space Telescope Science Institute in Baltimore, Maryland, measured bending light from white dwarf Stein 2051 B as it moved in front of another star over two years.

It turns out the star has about 68 per cent of the sun's mass. Early estimates assumed it had an iron core, but this finding suggests that is incorrect (*Science*, DOI: 10.1126/science.aal2879).

The measurements for Stein 2051 B may be off by up to 7.5 per cent owing to a lack of perfect resolution, says Sahu, but it is still our best calculation of its mass.

Synthetic tongue gets into the spirit

NEW blend or 20-year-old single malt? An artificial taster that builds up a similar flavour profile to a human tongue can pick out different qualities in whisky, such as brand, age and country of origin. "If you buy a crate of expensive whiskies, you can test if they are what you think they are," says creator Uwe Bunz at Heidelberg University, Germany.

Existing analysis techniques use mass spectroscopy to identify the chemical composition of a whisky. Bunz instead uses a combination of 22 different fluorescent dyes. Mixed with a whisky, the brightness of each dye subtly changes, revealing a fingerprint for that drink. Overall, the process is quicker and cheaper than many existing methods.

Zombie beetles crave flowers

DYING on a bed of flowers might seem like a good way to go. Perhaps not, though, when you're a beetle suffering from a gruesome fungal infection.

North America's goldenrod soldier beetles feed and mate on flowers - and that's where some of them meet their end, too. When infected with the fungus *Erynniopsis lampyridarum*, the beetles clamp their jaws onto a flower only to die soon after. Hours later and still stuck to the flowers, the dead beetles' wings snap open as though about to fly.

"If you went to a morgue where there was somebody that had been killed, and about 24 hours after their death they suddenly sat up or raised their arms, it would be very spooky," says Donald Steinkraus at the University of Arkansas in Fayetteville. That happens in these beetles and is the result of the fungus infection, he adds.

Steinkraus thinks this strategy increases the chance of the fungal infection being picked up by healthy beetles. It fixes the infected beetles to spots where other healthy beetles are feeding and looking for mates. Indeed, with their wings raised, the dead beetles did attract mates - live males were seen having necrophiliac sex with zombie females (*Journal of Invertebrate Pathology*, doi.org/b7tx).



DR. DON STEINKRAUS/PROFESSOR OF ENTOMOLOGY/UNIVERSITY OF ARKANSAS

How Jupiter split the asteroid belt in two shows its great age

IT'S one hell of a bowling ball. In its youth, Jupiter carved a path through the solar system, with its orbit separating the asteroid belt into two distinct families. And it did so within a million years of the dawn of the solar system, meaning it was huge early on.

Meteorites found on Earth have different proportions of elements' isotopes in them, depending on whether they are from a rock that started life inside or outside Jupiter's original orbit. This split is seen even in pieces chipped off protoplanets that were made

within a million years of the solar system's birth, so the split must have happened before then.

At this time, our solar system was made up of a young sun and the protoplanetary disc: a cloud of dense gas and dust orbiting the sun. To carve a gap in this disc big enough to prevent mixing, Jupiter's core needed to be about 20 times Earth's mass (PNAS, DOI: 10.1073/pnas.1704461114).

The work by Thomas Kruijer and colleagues at the University of Münster in Germany supports the timeline of a leading theory of the

early solar system – the grand tack hypothesis – which supposes that Jupiter was born a few million years before Saturn. Jupiter's huge mass was tugged towards the sun, but once Saturn formed, its gravity pulled Jupiter back from the brink of stellar destruction and towards the outer solar system.

These two drifts across the solar system meant Jupiter crashed through the asteroid belt twice, mixing asteroids that had formed either side of its original orbit and leaving behind the well-mixed objects we see today.

Gas marbles are the strongest bubbles

IT'S a bubble, but better. Tough bubbles called gas marbles have been made for the first time. They are 10 times stronger than regular soap bubbles – a trait that could lead to stronger foams and better drug delivery.

Yousra Timounay at Syracuse University in New York made these fortified, stable droplets by trapping a small amount of gas in a single layer of particles set in a liquid film like soap. Unlike soap bubbles, gas marbles can hold their shape even under a pressure differential between the air inside and outside them. They also resist inflation and deformation.

With enough pressure, gas marbles can rupture and collapse. But they can withstand both positive and negative pressures far more than regular bubbles or liquid marbles, a similar concept in which liquid drops are trapped in a particle layer (*Physical Review Letters*, doi.org/b8d7).

Because gas marbles can be stacked without losing their shape, they could be used to make lighter, stronger foams for cosmetics or insulation. They could also deliver drugs through the lungs, or hold gases used as tracers to study air or water flows.



L.XING,JINGMAIK,OCONOR, R.C.MCKELLAR, LUIS, CHIAPPE, K.TSENG, G.LIUMBAI

Dinosaur-era bird preserved in amber

A 100-million-year-old chunk of amber found in Myanmar contains the head, neck, wing, tail and feet of a hatchling. It was just a few days old when it fell into a pool of sap oozing from a conifer tree. "It's the most complete and detailed view we've ever had," says Ryan McKellar of the Royal Saskatchewan Museum, Canada. "Seeing something this complete is amazing."

While it looks as if the actual skin and flesh of the bird are preserved in the amber, it's just a very detailed impression of the animal. Studies of similar finds show the flesh has

broken down into carbon – and there's no usable DNA, fans of *Jurassic Park* will be disappointed to learn. The amber does preserve some of the feather colours, but in this case they aren't terribly exciting. "They were little brown jobbies," McKellar says (*Gondwana Research*, doi.org/b8dw).

The unfortunate youngster belonged to the "opposite birds" that lived alongside the ancestors of modern birds and appear to have been more diverse and successful – until they died out with the dinosaurs 66 million years ago.

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Leading the high life

People are increasingly taking small amounts of psychedelic drugs to up their game. Could it really work, asks **Sam Wong**

FOR over a year, Janet Lai Chang took magic mushrooms a few times a week before going to work. She says it made her happier, reduced her social anxiety and helped her build relationships.

Chang is one of many who have added a pinch of psychedelic drugs to their daily routine in recent years. Followers say this “microdosing” regime doesn’t send them tripping, but merely gives them a boost to improve their mood or performance.

The effects they report seem plausible, but as psychedelics are illegal in most countries, such claims have not been backed up by much research. There has been a recent revival in scientific trials of psychedelic drugs for treating depression and anxiety, but with microdosing people are doing their own experiments, away from the strict regulations of clinical research.

Yet as Chang’s experiences show (see interview, right), the findings are tantalising. So can these new investigations into psychedelic pick-me-ups yield any decent insights? And could you one day be dropping acid alongside your morning vitamin?

Up and at ‘em

You would be forgiven for thinking your work performance might suffer under the influence of mind-warping illegal drugs. But microdoses, about a tenth of a recreational dose, don’t seem to induce hallucinations; instead, people who do this report in internet forums that they are happier, more creative and more productive. They may say things look more beautiful than usual, but that’s as trippy as it gets.

“I am studying more effectively, retaining more of the lecture content, and not letting the pressure of ‘everything is due at the same time’ get to me as much as previous semesters,” says one person online.

The extent of microdosing is unclear, but James Fadiman, who popularised the idea in his 2011 book *The Psychedelic Explorer’s Guide*, speculates that it’s more than 100,000 people worldwide,

“Microdoses, about a tenth of a recreational dose, don’t induce hallucinations or trip-like effects”

based on the number he has been in contact with.

Psychedelics have been linked with creativity since the 60s, when LSD was widely used by artists and musicians. Fadiman and his colleagues gave LSD to engineers, mathematicians and architects as they worked on professional problems they had been struggling with. They all performed better on tests after being given the drug, compared with an earlier sober session, and reported finding the experience helpful to the creative process.

This line of research ended when LSD was made illegal in the

late 60s, but a recent revival has made progress in understanding how psychedelics act on the brain.

LSD and psilocybin, the active ingredient in magic mushrooms, achieve most of their effects by binding to serotonin receptors responsible for mood and cognition. Earlier this year, a study found that part of the receptor closes on LSD like a lid, trapping the drug in place for hours. This may explain why it can have effects at very low doses.

Neuroimaging studies show that LSD and psilocybin change how different parts of the brain talk to each other. In particular,



Useful in small doses?

the visual cortex communicates more with other areas.

It's difficult to get permission to study the effects of psychedelics on the day-to-day lives of healthy volunteers, but some researchers are trying to collect data anyway. From February to May this year, Fadiman and his colleague Sophia Korb invited people to follow a research protocol and report on their experiences. Participants have to source their own drugs – LSD, magic mushrooms or other psychedelics; the effects of microdosing seem to be similar across other hallucinogens.

The methodology falls well short of the normal standards of scientific rigour. There is a control group, but participants aren't randomly chosen to unknowingly receive a drug or placebo, as would be the case for a standard trial.

Korb says it would be unethical to give someone an illegal drug without them knowing, and for safety reasons participants with high-stakes jobs – like aircraft maintenance for the army – are encouraged to be in the control group. Collecting flawed data is better than no data at all, she says.

The people taking part have a wide range of ages and backgrounds. Many have depression or other mental health conditions, but some are merely hoping for self-improvement or well-being. "You don't have to be sick to get better," says Fadiman.

The protocol instructs participants to take a microdose every three days, while reporting their scores on a range of 30

"Microdosers report feeling more determined, active, and enthusiastic, but also more nervous and jittery"

variables each day for a month. Fadiman and Korb presented their preliminary analysis of 418 microdosers at the Psychedelic Science conference in San Francisco earlier this year.

People with depression appear to benefit from microdosing,

whereas those with anxiety find it less helpful or makes symptoms worse. Overall, the microdosers report feeling more determined, active, alert, proud and enthusiastic, but also more nervous and jittery. They report feeling less depressed, upset, guilty and afraid.

Positive effects on depression aren't entirely surprising. A small study published last year found promising results for psilocybin, taken during psychotherapy sessions. Robin Carhart-Harris at Imperial College London, who led the study, thinks low doses could offer some of the same beneficial effects. "A full dose of psychedelics can be mind-shattering, almost. These little doses are subtly mind-loosening," he says.

Next steps

Korb's results show few signs of harmful effects of microdosing. Five men with colour blindness dropped out because they were experiencing visual effects. No participants reported serious adverse effects, but Korb wouldn't recommend microdosing for people with anxiety.

Many subjects report the same unexpected benefits, such as better sleep, improved athletic performance and relief from symptoms of menstrual disorders and migraines. Fadiman says this suggests they aren't just placebo effects, but until controlled trials are carried out, we can't be sure.

So could psychedelics be available on prescription one day? Korb says several research groups are interested in using their data to plan formal studies. She is also talking to the US Food and Drug Administration about research on cluster headache syndrome – a severe condition with few effective treatments, but some patients say psychedelics help.

Convincing evidence of microdosing improving work performance remains elusive. However, later this year Amanda Feilding, director of the Beckley

INSIDE THE MIND OF A MICRODOSER



COURTESY OF JANET CHANG

Janet Lai Chang, a digital marketer based in San Francisco, will present her experience of microdosing at the Quantified Self conference in Amsterdam from 17 to 18 June.

HOW DID IT AFFECT YOU?

I was less anxious, less depressed, more open, more extroverted. I was more present in the moment. It's harder to get into the flow of the focused solo work that I'm normally really good at. But it's good for the social aspect.

WERE THERE OTHER NEGATIVE EFFECTS?

I have some symptoms of PTSD left over from childhood abuse. Pretty much the only other negative thing was being more aware of negative emotions I had. I have a repressed anger response, according to my therapist. When I was microdosing I felt like I could really feel it; I felt the anger.

ARE YOU STILL MICRODOSING NOW?

Occasionally, but I've stopped the experiment. I don't want to be dependent on a substance to enable me to achieve certain desirable states of productivity.

WOULD YOU RECOMMEND IT TO OTHERS?

I think everyone would benefit from having at least one kind of experience with psychedelics. The dosage really depends on the individual and what they're looking to get out of it.

may be risky compared with taking bigger doses in a therapy session. "No longer do you have a controlled environment," he says, and regular doses could lead to as-yet unknown side effects.

We may know more soon. Korb is advising a citizen science group in Boston on a randomised, placebo-controlled study, with results due in a few months.

People are doing this anyway, so collecting data will allow them to do it safely, says Korb. "The bigger ethical question is 'Why can't we study these sort of things that seem to be so helpful to people?'" Without such studies, microdosing will remain a risky practice, both medically and legally. ■

Use your loaf

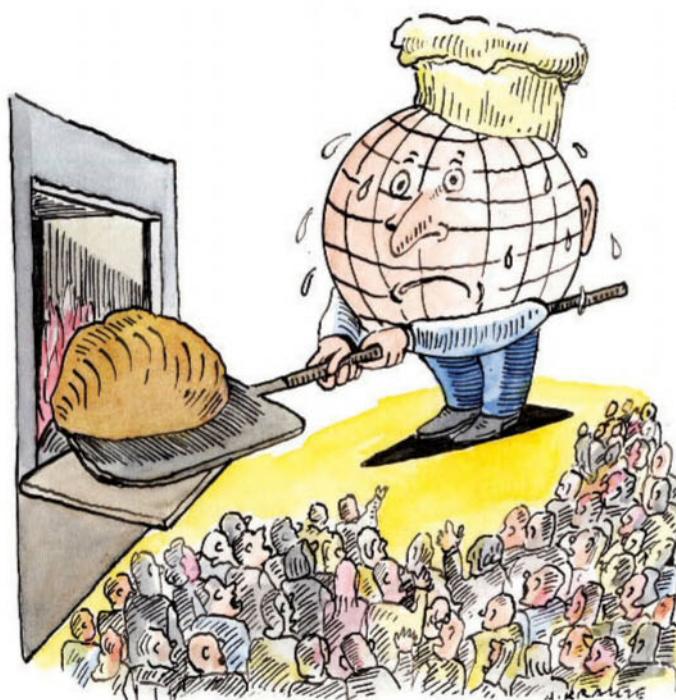
Don't be a #JERF, all food is real no matter what the dietary fadsters try to tell us, says **Anthony Warner**

I RECENTLY attended a "wellness" festival and was told that #JERF is a food trend set for big things. For its followers, it represents the distillation of many dietary philosophies into a simple, if slightly annoying, acronym. Many also claim it is the key to tackling the obesity crisis.

JERF stands for Just Eat Real Food, and appears to have grown out of the death throes of "clean eating", a movement criticised for attaching a potentially damaging dichotomy of clean and dirty to food choices. JERF claims to be less judgemental, but is it a sensible approach rooted in evidence?

The proof of the pudding is in the eating, as a recent small study shows. It compared the effects of two breads on the metabolism of 20 people in a randomised trial.

One was a traditionally made wholegrain sourdough, the kind of loaf that costs a small fortune



from a trendy, beard-loving biodynamic pop-up. The other was an industrially produced white loaf.

The study found no significant differences in major metabolic markers regardless of which was eaten. Metabolism seems to care little for price tags and artisanal "real food" marketing tropes.

Like other dietary fads, JERF is a loose doctrine, a restrictive and judgemental diet masquerading as a holistic lifestyle. Followers are asked to reject sensible choices for not being "real" enough, in much the same way that the clean eating movement demonised foods as "dirty" for arbitrary reasons.

If you aren't buying misshapen organic veg in distressed crates made from reclaimed Radiohead albums, then your choices will probably be deemed fake. And by implication, you too will be fake.

This language is insidious in an

Do brains need rights?

Does a new era of neurotech mean your mind needs its own legal rights, asks **Jamais Cascio**

ADVANCES in neurotechnology offer the potential for precise observation, collection and even alteration of our brain activity.

Emerging cognitive tools, such as brain-computer interfaces, could bring big advances in medicine and understanding behaviour. However, bioethicists Marcello Ienca and Roberto

Andorno say these techniques also raise questions about human rights that need extra protection.

Their concerns are valid and appropriate, but there would be consequences from such rights.

Humans have manipulated brains for centuries – from caffeine to meditation and even advertising – and we have legal

and socially acceptable tools for this. But cognitive manipulation, once a kind of alchemy, is giving way to a much more technological approach. The methods to control use of earlier tools – largely crude regulation and opprobrium – are unsuited to this new era.

So Ienca and Andorno propose four rights: cognitive liberty (the right to alter one's own mental states); mental privacy (the right to forbid involuntary reading of mental status, structure and

"Cognitive manipulation, once a kind of alchemy, is giving way to a much more technological approach"

content); mental integrity (the right to forbid involuntary alteration of the same); and psychological continuity (the right to forbid the application of neurotools to alter personality). In short, these are a right to say "yes" to your own cognitive alterations and "no" to their imposition.

Such rights are already under threat, from Facebook trying to change user moods through social contagion to the rising industry of neuromarketing. This suggests a future of intentional alteration of individual thoughts to achieve social, political or economic goals.

These rights would also raise dilemmas. Should parents have

age obsessed with social media, where keeping things “real” is deemed a central moral trait and being “fake” is the ultimate online taboo. These could be just as damaging associations to attach to food as “clean” and “dirty”.

Away from wellness festivals, all foods are real. Although there are many products that shouldn’t be eaten to excess, healthfulness is defined by chemical composition, not price, nor where it was made.

JERF isn’t an answer to complex problems such as obesity. Obesity is a structural problem that goes beyond individual dietary choice. For reasons poorly understood, some people find maintaining a constant weight easy. This can fool them into thinking they have found a solution, leading them to spew out meaningless platitudes like “Eat Clean” or #JERF in a misguided attempt to help.

If this was completely harmless it would be easy to ignore. But the damaging associations, the shame attached to perfectly sensible food choices, the reinforcement of class divides and stigmatisation of obesity as a disease of personal choice are far more likely. ■

Anthony Warner is a food industry development chef who blogs about pseudoscience as The Angry Chef. His first book is due out this summer

the right to alter the mental states of their children? Should we have the right to know if someone we rely upon – a pilot, say – uses or refuses cognitive augmentations?

Does society have its own right to impose interventions that appear to offer a significant social benefit (a neurotech “vaccination” against paedophilia, perhaps)?

These may be hard questions, but this fact doesn’t render the idea of basic mental rights invalid. Instead, it emphasises the need to begin discussion now, before these technologies spread. ■

Jamais Cascio is a distinguished fellow at the Institute for the Future

INSIGHT Space law



The new Wild West?

It's time to update the laws that govern space

Timothy Revell

IN SPACE, no one can hear you stream. Self-styled “space nation” Asgardia is planning to put a data centre in orbit, beyond the reach of Earthly laws, but lawyers say that leaving the planet isn’t enough to get around them. As more organisations seek to exploit space in this way, it’s time we decide how to govern the final frontier.

Asgardia announced itself last year as a space-based nation, independent of countries on Earth, and has since convinced 180,000 people to become citizens by filling out an online form. Now it is planning its first foray into orbit, with the launch later this year of a compact satellite called Asgardia-1 holding a 512-gigabyte solid state drive filled with data chosen by its citizens.

Asgardia-1 will hitch a ride aboard a resupply mission to the International Space Station, and will orbit Earth for five years before burning up in the atmosphere. While in orbit, more data can be uploaded using radio signals.

A spokesperson for Asgardia says the data will be vetted before being put into space to avoid any legal challenges. For now, Asgardia-1 is

likely to contain family photos and messages with the data held “under Asgardian jurisdiction”. But if they really are under Asgardian jurisdiction, a similar set-up could be used as a data haven, beyond the laws of Earth.

How might this work? Servers on the ground offering pirated video can be seized by governments, but in space that would be trickier. Personal information stored in orbit would surely be safe from governments too. For the privacy conscious, maybe

“For those who are privacy conscious, maybe above-the-clouds storage is just what’s needed”

above-the-clouds storage is just what’s needed.

International treaties say it’s not that simple. The United Nations Outer Space Treaty requires that nations provide “authorization and continuing supervision” of space activities by “non-governmental entities” under their jurisdiction.

Asgardia-1 will be sent into orbit from a NASA launch pad, so the US government, a signatory to the treaty,

will be legally responsible for what Asgardia-1 gets up to. If the storage aboard was used for illegal purposes according to US law, the US could hold Asgardia to account. At least that’s the theory. The Outer Space Treaty has never been tested this way.

“There’s no precedent here,” says Joanne Wheeler, a specialist in satellite and space law at London law firm Bird & Bird. “The Outer Space Treaty gives general principles that were negotiated at the end of the 60s to try to stop nuclear weapons in space. The idea of data centres in orbit simply wasn’t on the agenda,” she says.

If someone sent a server into space, they would have to explain its purpose to get a licence from the nation they were launching from. But once in orbit, revoking the licence for doing something illegal may have little effect. In principle, the owner of the satellite could control it from anywhere in the world.

So efforts to prevent space data-havens need to be international ones. One approach, if a satellite goes rogue, might be to blast it out of space. China tested this in 2007 by destroying a derelict weather satellite with a missile launched from Earth. But the country received international condemnation, because blowing things up in orbit increases the risk of deadly space junk hitting other satellites. Perhaps that means Asgardians and their ilk really will be untouchable once freed from the clutches of Earth. ■

APERTURE





Tip of the iceberg

DEEP in Patagonia lie the largest icefields in the southern hemisphere outside Antarctica. This section, in the southern stretch of the Chilean Andes, was captured on a cloud-free day by the Operational Land Imager on the Landsat 8 satellite.

To the left of the image – where the ice hits the water – are glaciers: San Rafael (top) and San Quintín (middle). Both flow down the mountain valleys until they hit water, creating icebergs, a process called “calving”. San Rafael does it quickly, too: it flows at 7.6 kilometres per year, making it one of the world’s fastest and most actively calving glaciers.

But this spectacular landscape is in trouble because of climate change. San Rafael shrank by 11.5 per cent between 1870 and 2011. San Quintín glacier shows what San Rafael would have looked like before it shrank, but it’s also getting smaller. It contracted by 14.6 per cent during the same period. This is a pattern repeated across the Andes. Farther north, the mountains host more than 95 per cent of the world’s tropical glaciers, which are thinning more quickly than those in Alaska, Iceland or Greenland. Georgina Hines

Photograph

NASA Earth Observatory/Landsat/USGS



The fire inside

Stress fuels inflammation, the hidden cause of many modern ailments. It is time to put out the blaze, finds **Caroline Williams**

JOB, kids, mortgage, bills, groceries, housework... coping with modern life can sometimes feel like a remorseless treadmill. Many of us end up exhausted, with a vague feeling that all this pressure can't be doing us any good. But we do it anyway, driven by the notion that stress is for wimps. And there's always a glass of wine and a takeaway to look forward to at the end of the week.

Big mistake. Far from being for wimps, physical and psychological stress are major triggers of a modern scourge that has been linked with every malady from heart disease, depression and chronic pain to neurodegenerative diseases. That scourge is inflammation. Until recently, we have known little about how what starts as a protective immune process in the body goes awry, and there have been frustratingly few evidence-based suggestions on what we should do about it. But now we are starting to learn more about how the process works, how it connects body and mind, and what we might do to keep it in check. This new understanding is leading to treatments that may finally let us douse this constant fire – not by stopping it from happening, but by turning it off when it is no longer useful.

Such treatments could benefit the millions of people around the world who have chronic inflammatory conditions like rheumatoid arthritis, asthma and coeliac disease. They could also assist those of us who want to have our cake, eat it and not end up inflamed. Finding a way to manage inflammation could help prevent modern life from damaging our long-term physical health.

"There's no question, inflammation is everything," says Charles Serhan, an

immunologist at Harvard Medical School. "In the post-genomic era, understanding inflammation is the next frontier."

Inflammation is the body's first line of defence. Without it, we would be at the mercy of every pathogen going. When the body's protective barrier has been breached by injury or infection, the classic inflammatory response brings redness, heat, swelling and pain. First, damaged cells secrete chemicals known as cytokines, which increase blood flow to the affected area and alert the rest of the immune system to prepare for a fight. Heat comes as a side effect of increased blood flow, redness as blood vessels dilate, bringing blood closer to the surface of the skin, and swelling happens as blood vessels become more permeable, allowing fluid and white blood cells to leak out and flood the tissue. These cells then attack and gobble up any invading pathogens, and later clear up the debris.

This basic response comes in different flavours, depending on what challenge the body is facing. If you sprain your ankle, for example, the joint swells and becomes hot, painful and difficult to move. If you have a cold, it is the blood vessels in the airways that swell, blocking the nose while inflammatory histamines stimulate mucus production, which in turn sets off coughs and sneezes. If you have flu, you get all of this, plus inflammation spreads throughout the body, causing joints and muscles to ache.

Throughout our evolutionary history, acute inflammation has mostly worked just fine, flaring up, tackling the problem and dying away again when the danger has passed. But now modern life is stacked against this delicate balance. Obesity, stress, pollution, ➤

bad diet and ageing can all tip us into a low-level state of inflammation that, rather than being confined to a specific tissue, keeps the entire body in a perpetual state of readiness for a threat that never comes.

This persistent background inflammation might not always make us feel ill, but it can store up problems for the future, from heart disease to type 2 diabetes and neurodegenerative disease. In 2008, immunobiologist Ruslan Medzhitov of Yale University dubbed this “para-inflammation” and argued that it is an unfortunate consequence of our longer, calorie-rich lives.

Stress is a particular problem. The hormone noradrenaline, which is released in anticipation of an impending life-or-death situation, sets off the same chain of events as an infection or injury. Yet although stresses passed quickly in our evolutionary past, these days many of us are walking around with a ticking time bomb of stress-induced inflammation that never quite goes away. “Chronic, low-grade inflammation is being discussed in our field as one of the main pathways linking stressful life conditions with disease,” says Nicolas Rohleder of Brandeis University in Massachusetts. Over the past few years, for example, Rohleder has found that the long-term strains of caring for a seriously ill family member, and a series of short-term stresses, both increase levels of inflammatory markers in otherwise healthy people.

Obesity is another inflammation-inducing modern disease. A small amount of body fat is healthy, and in fact necessary for regulating not just the immune system, but also appetite, mood and metabolism. Once the scales tip past 25 to 30 per cent body fat, however, the



deposits in the arteries that are one of the main risk factors for heart attacks and strokes.

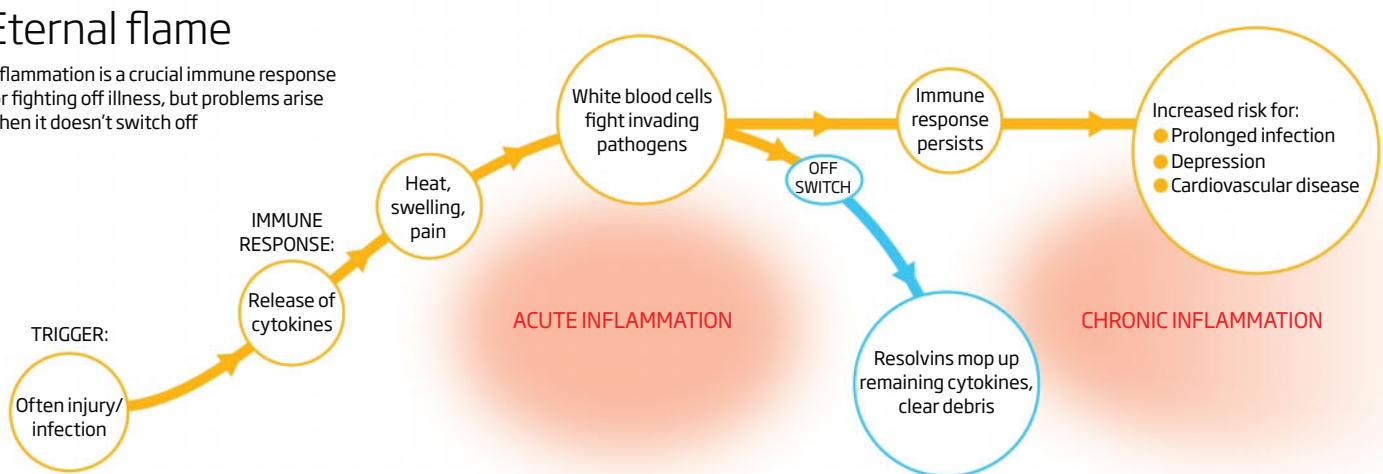
The longer these inflammatory markers hang around, the more likely they are to cause problems. These can be relatively minor, prolonging colds by keeping up the response when it is no longer needed, for instance. Or they can be life-threatening. A recent study of nearly 300 people found that inflammation is directly linked to the early stages of heart disease. Over the course of three years, people with higher levels of reported stress and stress-related brain activity, not only had higher levels of C-reactive protein, a marker of inflammation, but also had a greater risk of cardiovascular disease. It seems that when there are higher levels of white blood cells in circulation, they get attracted to any fatty plaques accumulating in the arteries, making these more likely to build up and eventually rupture. This can lead the vessel wall to bleed and form a clot, which could go on to cause a heart attack or stroke.

Chronic inflammation might also increase the risk of depression. Many of the psychological symptoms that come with such inflammation – tiredness, malaise and a loss of appetite – look a lot like depression. Some people are beginning to wonder if a rumbling level of inflammation is behind at least some cases of depression and other mental health problems. This might be the reason why antidepressant drugs, which don’t reduce inflammation, are often ineffective.

The key then seems to be to keep the life-saving properties of the acute inflammatory response without allowing it to become chronic. But how?

Eternal flame

Inflammation is a crucial immune response for fighting off illness, but problems arise when it doesn’t switch off



One clue came in 2000 when Serhan and his team revealed that inflammation has an off switch. Until then, the reaction was thought to peter out as the immune cells that secrete cytokines gradually reduced in number and their effects became diluted. In fact, Serhan found that neutrophils and macrophages, the types of white blood cell that kick off the process, actively change tack once it has got going, releasing a second set of chemicals – called resolvins – that help mop up any remaining cytokines and sweep away any debris.

Broken switch

This made Serhan and others wonder whether chronic inflammation might be caused not by the on signals being turned up too high, but by a problem with the off switch. In the years since, he has been studying resolvins and related chemicals to see if there is a way to harness or mimic their actions.

One fly in the ointment is that there is so far no way to tell the difference between the various stages of acute inflammation – from a cut or cold, perhaps – and more troublesome chronic, low-level inflammation. That's partly because immune cells and cytokines circulate around the body all the time, so any snapshot of the blood or tissues might make them seem inflamed when actually they are healthy.

Serhan thinks that looking at levels of circulating resolvins might be a better option. He has found that people with type 2 diabetes tend to have higher levels of cytokines in circulation, but lower levels of resolvins. This is relevant because the same white blood cells that kick-start the inflammation response should also step in to secrete resolvins to end it. So if someone has lots of cytokines but few resolvins, it is a sign of chronic inflammation – and a problem with the off switch. "I think that this can start to be diagnostic," Serhan says.

He has also been working with periodontal researcher Thomas Van Dyke of the Forsyth Institute in Cambridge, Massachusetts, on a mouthwash containing resolvins. In rabbits, the mouthwash not only cleared up their inflamed gums, it also reduced inflammatory markers for cardiovascular disease. Human trials are now under way.

As well as finding ways to diagnose and treat low-level inflammation in healthy looking people, researchers are searching for drugs to stimulate the body to resolve inflammation in those with chronic conditions like arthritis and inflammatory bowel disease. The current



JEROME DERIGNY/ARCOS/PICTURE TANK

Double whammy: regular exercise reduces both stress and inflammation

generation of anti-inflammatory drugs, including steroids and non-steroidal anti-inflammatories such as ibuprofen and naproxen, inhibit the onset of inflammation, but do nothing to bring it to an end. Taking these drugs can reduce painful swelling in the joints, but by turning down the immune response, they leave people more vulnerable to recurring infections and less able to fight off a virus or recover from an injury.

Increasing resolin levels would help to solve the problem, rather than just mask its effects. Resolvins actively assist in ridding the body of bacteria and viruses, says Serhan,

Chronic inflammation may be a main pathway linking stressful life with disease*

"so there is little to no chance for immune suppression or becoming vulnerable to recurring infections like there is with a lot of the current drugs". It's a win-win situation.

Although trials of new treatments are under way, the only drug currently available that has some resolin-like effects is aspirin. It does block pro-inflammatory mediators, but Serhan's group has found that low-dose aspirin has another unique ability: to trigger the production of more stable versions of natural resolvins. With currently available drugs, there is only one thing you can do to jump-start resolution of inflammation.

"Take low-dose aspirin," Serhan says.

That may soon change, however. Gilroy and his team are trialling a new drug called anabasum that mimics natural painkillers called cannabinoids in the body. So far, it is proving to work as well as a steroid at preventing inflammation but with fewer side effects. It also actively clears bacteria from wounds. "No matter how effective your drug is, if you don't clear the antigen then inflammation won't resolve," says Gilroy. "It's showing, at least in a healthy group of individuals, a pro-resolving effect that we simply don't see and have never seen in any other drug." The experiments he has done so far have been with skin inflammation, but the drug has since been tested in cystic fibrosis with promising effects.

Pain-relieving drugs could also benefit from a new understanding of how inflammation comes to an end. Resolvins have been found to regulate pain, and their receptors have been identified in the dorsal root ganglion, a kind of junction between the sensory nerves and the spinal cord. "If they can be harnessed therapeutically they could, in the future, replace opioids as a pain-control mechanism and one that would not lead to addiction," says Serhan.

Gilroy, however, warns against getting too carried away with the resolin story. The reason that inflammation seems to be the root of all health problems, he points out, is because it is not one thing, but many.

"The inflammation that we have in diseases like Alzheimer's, cancer, autoimmune diseases like osteoarthritis, all of these are very ➤

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different inflammatory processes," he says. "It is hard for me to understand, given that there are many ways that a disease occurs, that they can resolve by the same mechanism."

A moving target

This was demonstrated in recent experiments where Gilroy's team injected bacteria under the skin of people with osteoarthritis – a painful condition characterised by chronic inflammation often due to autoimmune disease. Their osteoarthritis-related inflammation remained, but they had no problems in shutting down the skin-based inflammation that followed the injection. The two types of inflammation, and their resolution pathways, seemed to be completely different. This is also true for the same disease in different people, as well as for different tissues in the same person, says Gilroy. Then there are gender differences in susceptibility: for some unexplained reason, women are far more likely than men to get autoimmune diseases. "Inflammation is not inflammation," says Gilroy. "The requirements to resolve that process will be, I think, disease, organ and circumstance specific."

Pinning down the solutions – and even figuring out which to use in which instance – won't be simple. "It's like you walk into a bar and there is a great big bar-room brawl, but you don't know who is involved, and you don't know who started it and how it's going to end up," says Gilroy. "Teasing and separating these separate factions will make it much easier to understand the processes going on."

While we wait for these insights, there are simple things we can do at home to keep inflammation at bay. All of the resolvins so far identified are made in the body from omega-3 essential fatty acids. These aren't produced in the body to any great extent, so can only come from the diet, the richest source being oily fish. Making sure we get the recommended three weekly portions of oily fish, or equivalent, might help ensure that our bodies have enough raw material to wind down inflammation, says Serhan. The link between omega-3s and the resolution of inflammation might explain why a diet rich in these is associated with a lowered risk of heart disease.

Studies also link diets containing more fat and sugar to inflammation. This, combined with research suggesting that pigments found in fresh fruit and vegetables help to regulate inflammation, indicate that the standard advice about eating well applies here too: consume fewer processed foods and plenty

Too much body fat increases the risk of chronic, low-grade inflammation



BRUCE GILDEN/MAGNUM PHOTOS

of whole grains, fruit and vegetables.

Certain kinds of exercise seem to help, too. In recent experiments in rats with inflammation of the back, stretching the affected muscles twice a day stimulated the release of resolvins within the muscle, which enabled the rats to regain movement and heal more quickly than control rats. The team that did this work, led by Lisbeth Berrueta of Harvard Medical School, is investigating whether this "yoga experiment" works in human volunteers.

Exercise in general certainly seems to tackle inflammation. Admittedly, it causes a spike of the cytokine IL-6 in the muscles and blood, which is often taken as a sign that

PUTTING OUT THE FIRE

5 ways to keep inflammation at bay

1. Lose excess weight

Fat is a storehouse of inflammatory cytokines

2. Eat your omega-3s

The body uses them to make resolvins, which help switch off inflammation

3. Exercise

Being active releases anti-inflammatory chemicals and tells the liver to metabolise fat

4. Stretch

Extending inflamed muscles seems to soothe them in rats

5. Take low-dose aspirin

The only currently available drug that stimulates cessation of inflammation (check with your doctor first)

inflammation is on its way. Yet according to Mark Febbraio of the Garvan Institute in Sydney, Australia, who discovered the effect in 2008, in this case, IL-6 works as an anti-inflammatory molecule, peaking only briefly before signalling to the liver to metabolise fat and remove excess IL-6 from the blood. So, Febbraio says, unless it leads to injury, there is no amount of physical activity that will push you into an inflammatory state. "Exercise is completely anti-inflammatory. Even in heavily trained athletes, most of the time IL-6 is [very low]," he says.

But you don't need to be training for triathlons for exercise to help tamp down inflammation. Researchers have found that even a 20-minute stroll can be enough to make a difference.

Beyond advice to eat well and exercise, these days it seems everyone from celebrity chefs to pop stars has a quick-fix tip for how best to fight inflammation. So is there a sliver of substance to endorsements of basil-leaf infused bubble baths or turmeric lattes? The jury is out. Curcumin, the active ingredient in turmeric, has anti-inflammatory properties in cells in a Petri dish, but clinical trials in humans have so far been underwhelming. This might be because most of it passes through the body without being absorbed. Likewise, quite how the basil in your bath is supposed to infuse into your body is anyone's guess. On the other hand, if it helps you unwind – and as long as following the latest fads doesn't become a source of stress on its own – go for it. In the fight against chronic inflammation, every firefighter helps. ■

Caroline Williams is a consultant for *New Scientist*



Right to silence

Radio astronomers are struggling to hear the cosmos through our increasingly crowded airwaves.

Stephen Battersby listens in

DECADES ago, the ether was a peaceful wilderness. With a sensitive radio ear, you could just about pick up the faint sounds of nature: the hiss of ancient cosmic microwaves, the delicate drumbeats of spinning neutron stars, the crackle and low whistle of lightning strikes. Then came radio and TV, their hulking transmitters filling the atmosphere with electromagnetic noise.

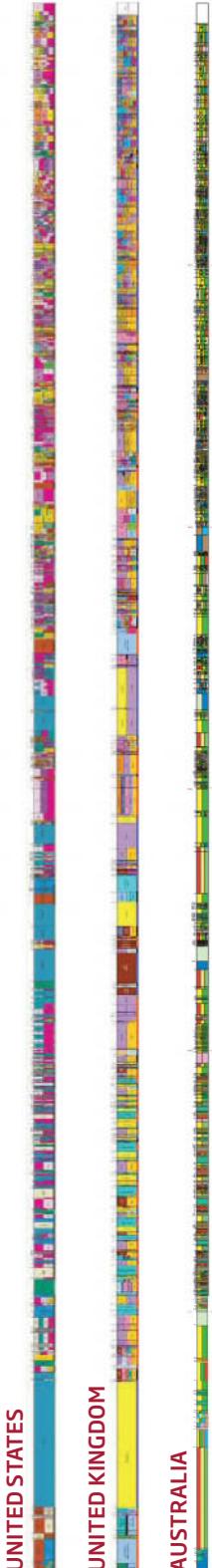
Now they have been joined by mobile phones, GPS receivers, CCTVs, wireless broadband

connections and all manner of other stuff, fracturing the once-pristine airwaves into a crazy cacophony. Even cars have Wi-Fi hotspots that can't be disabled and wireless sensors that constantly communicate their status with the dashboard computer. "There are transmitters in everything," says astronomer Harvey Liszt. "And they're mobile."

Liszt works at the US National Radio Astronomy Observatory in Virginia, and he knows the problems this causes. His kind need pin-drop quiet to detect ➤

TUNE IN YOUR RADIO

Taking into account international rules, different nations allocate radio spectrum frequencies differently



To see more:

US: National Telecommunications and Information Administration <http://newscientist.st/SpectrumMapUS> (pdf download)

UK: Ofcom <http://newscientist.st/SpectrumMapUK>

AUS: Australian Communications and Media Authority <http://newscientist.st/SpectrumMapAUS> (pdf download)

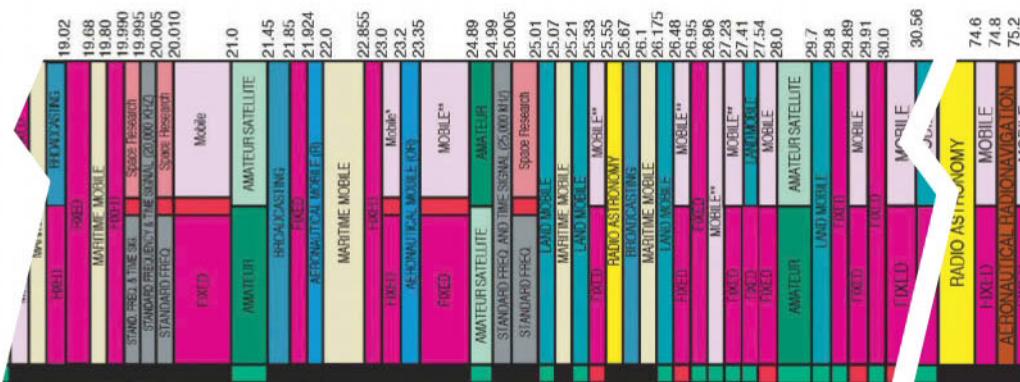
THE UNIVERSE IN RADIO

Radio waves provide a unique window on the cosmos. Distant, extreme objects such as pulsars, quasars and black holes send out radio signals at many different frequencies, as does the coldest thing in the universe - the cosmic microwave background, the relic radiation of the big bang. In our cosmic backyard, meanwhile, chemical molecules send out radio waves at set frequencies, determining which bands radio astronomers are particularly keen to keep clear of noise (see right).

15-30 MHZ JUPITER CALLING

Charged particles in Earth's ionosphere absorb radio waves with frequencies below about 10 MHz, stopping them from reaching Earth's surface. Just above this barrier lies a band perfect for tuning in to a near neighbour: Jupiter. Storms in the giant planet's atmosphere generate radio waves. With just a single narrow band reserved for radio astronomy at 22.55–26.1 MHz, however, they must generally be heard over a human cacophony of broadcast and telecoms signals now sharing this part of the airwaves.

Extracts from US Spectrum



emissions from across the cosmos, produced by interstellar molecules that might be early stages in the emergence of life, or clouds of hydrogen that will soon form stars, or giant galaxies where black holes generate plumes of hot gas. As the airwaves fill up with chatter, that quiet is becoming increasingly difficult to find. Right now Liszt and his colleagues are squaring up to do battle for a fundamental right – their right to silence.

The clamour for spectrum space affects us all. It would be no good if your TV signal cut out every time you made a phone call, or if car radars wiped out air traffic control. Everyone has to agree what radio waves belong where, across the whole planet. “Every country is sovereign, they could do what they want, but radio waves don’t respect borders,” says Liszt.

That’s the starting point for one of those unknown, essential processes that determine the smooth functioning of modern life. It comes to a high point every four years at the World Radiocommunication Conference (WRC), held in Geneva under the auspices of

the International Telecommunications Union. Around 3000 or so delegates representing commercial, government and scientific interests from more than 180 nations attend. Similar meetings have been regulating the airwaves for more than a century, and so far they have apportioned frequencies from 10 kHz – in the land of very low frequency, where wavelengths are measured in tens of kilometres – right up to 275 GHz near the top of the extremely high frequency band, with wavelengths around a millimetre.

Thanks to these internationally agreed rules we have things such as the international aircraft mayday frequency at 121.5 MHz. These agreements flow down to national bodies who fill in the gaps, producing detailed plans of who can use what bandwidth where (see “Tune

“It would be no good if your TV signal cut out every time you made a phone call”

81.5 MHZ THE FIRST PULSAR

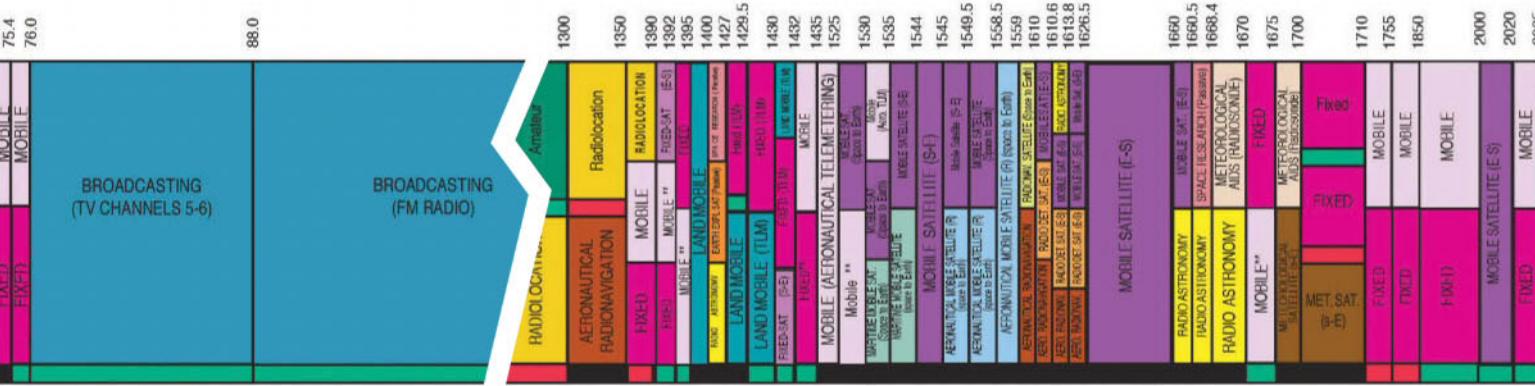
When Jocelyn Bell Burnell first heard an eerily regular, repeating radio signal in 1967, she gave it the nickname LGM-1, for "Little Green Man". It turned out to be the signal of a pulsar, a rapidly rotating neutron star. The original detection was almost stymied when the observing frequency was accidentally allocated to a local police force for their car radios. Today these frequencies principally broadcast TV transmissions and FM radio in the band from 88 to 108 MHz.

1420 MHZ THE 21-CENTIMETRE LINE

From a few hundred MHz to a few GHz is now prime spectrum real estate for mobile and wireless broadband services – and for astronomers. In 1951 Harold Ewen and Edward Purcell pointed a radio antenna out of a Harvard University window and measured 1.42 GHz radio waves from the Milky Way. This is the signature of clouds of neutral hydrogen gas ready to collapse and form new stars. Mapping out this radiation is key to determining the evolution of our galaxy and the wider history of the universe.

1660-1670 MHZ HYDROXYL AND THE WATER HOLE

A few hundred MHz up from the atomic hydrogen 21-centimetre line lies the signature of another molecule produced when water splits up, hydroxyl (OH). Radiation at these frequencies travels relatively unimpeded through interstellar space. The theory goes that any alien civilisation doing radio astronomy will know this too. Astronomers searching for signs of extraterrestrial intelligence think this "water hole" is where different species may meet.



in your radio", above left). The result is a set of accepted frequencies on which television and radio are beamed, where mobile phone and broadband signals can be broadcast, on which amateur radio hams can communicate, and where GPS, climate monitoring satellites, RFID tags, car parking radar, radar for detecting obstacles on railway level crossings and all manner of other signal-beaming devices can operate.

For radio astronomers, the WRC process means a quadrennial battle to defend their territory: "reserved bands" where quiet from other radio sources is particularly essential. One instance is the interval from 1400 to 1427 MHz in which hydrogen atoms emit a spike of radiation. This 21-centimetre wavelength reveals clouds of interstellar gas, and can be used to map our galaxy's spiral arms and follow its rotation. More reserved bands cover frequencies where other crucial cosmic molecules such as water or ammonia give out energy in the form of radio waves (see "The universe in radio", above).

Such frequencies lie well above the KHz and MHz frequencies of traditional broadcast radio and television. But the higher a radio wave's frequency, the greater its bandwidth, which quantifies the amount of information it can transmit in a given time. Frequencies from a few hundred MHz to a few GHz represent a sweet spot for mobile 3G, 4G and broadband services. Now, with the drive for even more data-hungry 5G services, telecoms companies are encroaching on higher-frequency territories that radio astronomers once called their own.

Don't interfere

At the last WRC meeting in 2015, the agenda item on mobile broadband amounted to "find some bands between 400 MHz and 6 GHz" says Wim van Driel, chair of Europe's Committee on Radio Astronomy Frequencies (CRAF), which works to prevent interference in reserved bands. This dangerously vague proposal included the important hydrogen

band around 1420 MHz. "It got crazy – an enormous circus," says Van Driel. "We had meetings with 500 people attending. But it concerned the 21-centimetre band, which is sacrosanct to us, so we were very vigilant."

Based on what governments have been able to demand auctioning various parts of it to commercial interests, the entire radio spectrum is worth trillions of dollars. Perhaps surprisingly, though, telecoms companies can't play purely on profit. Diplomacy and good intent tend to carry the day, and the voices of the astronomers have "surprising weight", says Liszt. "If people try to come up with monetary arguments, they are whistled down by the chair – that is not the way the game is played," says van Driel.

At CRAF, spectrum manager Talayeh Hezareh is in charge of studying any potential threats to astronomers' interests. If there's a serious risk of interference, she might suggest "guard bands" – buffer zones to prevent overspill reaching an astronomy band. If that's not enough? "We ask that no allocation be

269 -2.70 GHz

IONISED HYDROGEN

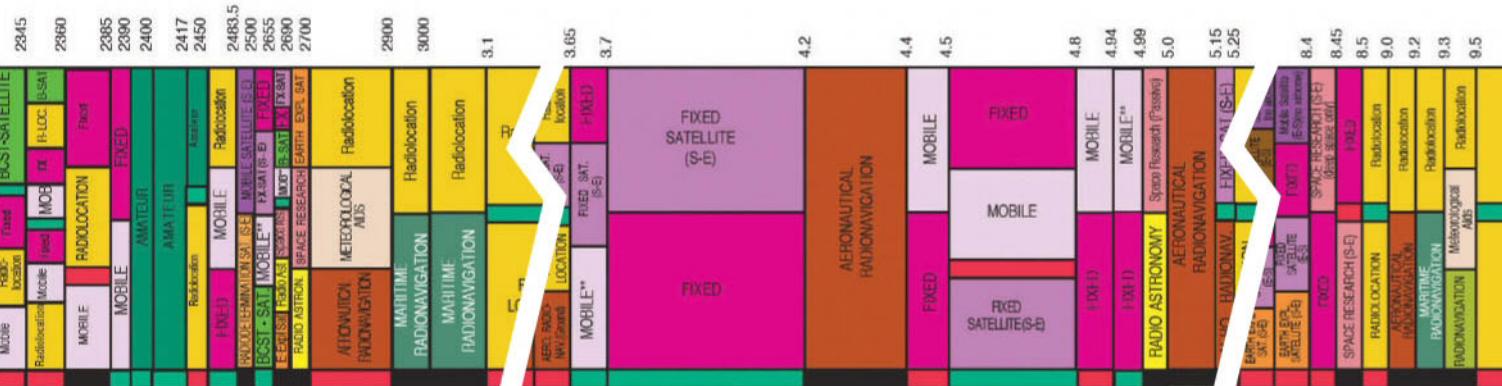
Radio astronomy bands just below 2.70 GHz (2700 MHz) are used, for example, to study the distribution of ionised hydrogen in the cosmos. In the UK, US, Australia and other countries, they now sit cheek by jowl with bands used by mobile phone operators for 4G. Radio astronomers aren't the only ones worried about interference. A recent UK proposal to auction off spectrum between 2.35 and 2.39 GHz met with concern from the National Deaf Children's Society: many hearing aids work at a frequency of 2.4 GHz.

4.08 GHz

THE COSMIC MICROWAVE BACKGROUND

In 1964 Robert Penzias and Arno Wilson of Bell Labs in New Jersey were aiming to use a radio horn antenna to catch 4 GHz signals being transmitted by the newly launched Telstar satellite when they noted a persistent, mysterious low hiss at a neighbouring frequency. They had discovered the cosmic microwave background, the residual heat of the big bang. This radiation comes in a continuum of frequencies, and peaks in intensity at just over 100 GHz. It is now mainly observed by dedicated satellites tuned to these higher frequencies.

"One climate satellite saw how things can go wrong in 2011: all of a sudden, all of Japan lit up"



given," she says. In the case of services proposed in 2015 threatening the 21 centimetre band, CRAF produced studies showing there could be no ground stations within 500 kilometres of any radio observatory. The proposals were eventually dropped.

Another win in 2015 concerned orbiting high-resolution radars operating at frequencies around 9.6 GHz, which are used for ground mapping, including covert surveillance. "The spooks use this because most structures are transparent to 9.6 GHz," says Liszt. At the meeting, operators agreed not to point these satellites at radio astronomy sites. "They are incredibly powerful. If we looked at one of these when it was pointed at us, it would burn out our receivers in a flash."

Often, the solution is an uneasy coexistence, creating shared bands where two or more uses are permitted. "When it says there is a shared band, practically speaking we can use it as long as telecoms aren't using it," says Liszt. Again, fair play rules the day. Once reserved or shared bands are agreed, nobody tries to pull a fast

one, even though the whole agreement is voluntary. "There are no international cops, going round with a robot enforcing electromagnetic compatibility," says Liszt.

A more insidious problem is broadcasts spilling over from their allotted territory. The Iridium satellite communications network is supposed to operate between 1617.775 and 1626.5 MHz, but a design flaw means that since their launch almost 20 years ago the satellites have been generating interference at other frequencies. Slap bang next door is a band that radio astronomers use to detect hydroxyl. This was the first radio-emitting molecule identified in interstellar space, and reveals the inner structure of the gas clouds there even better than the 21 cm hydrogen band. Or at least it would, were it not for the interference. "It's not bad in the southern hemisphere," says Liszt. "But over Europe and the US it's toxic. If you want to do cutting-edge research in this band, forget it." The problem should finally be resolved with the new generation of Iridium satellites now being launched.

It's not just astronomers who suffer: researchers studying Earth from space also need clean airwaves, for example, so they can bounce radio waves off clouds to study global air circulation. One climate satellite saw what happens when things went wrong in 2011. "All of a sudden, all of Japan lit up," says Liszt. It wasn't until 2015 that the source was found: a new satellite TV station. It was broadcasting at the right frequency, but equipment used to receive the signal in individual homes was generating interference in a band reserved for Earth observation satellites.

For the next WRC meeting in 2019, Japan has already submitted plans to use real-time video transmitted at various frequencies between 1 and 100 GHz as part of a train control system. "It's astonishing how much of the spectrum they would use for that – parts of the spectrum currently used for satellites looking down at clouds, for climate research. They assume there's nothing near those bands."

The 2019 meeting is likely to see battles spread to still higher frequencies. One of the

10.6 - 10.7 GHz CONTINUUM ACCESS

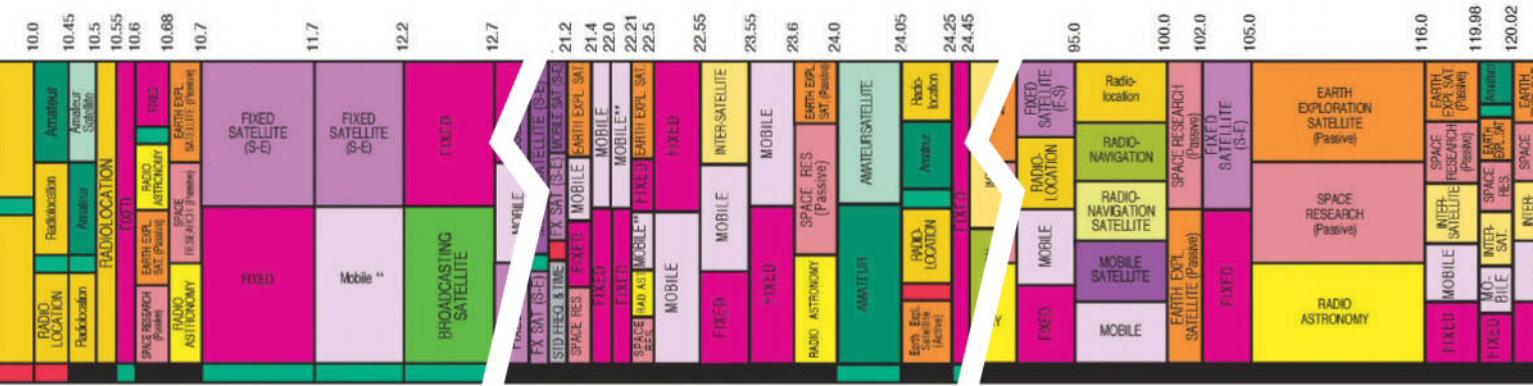
Many sources of radio waves, for example, black holes and quasars, do not emit at specific frequencies, but over a broad range. Thanks to the universe's expansion, radiation travelling towards us is also shifted to lower frequencies. To take account of these effects and allow a broad sampling, radio astronomers maintain reserved bands at various GHz frequencies, for example, around 5 GHz and 10.6 GHz. Often these frequencies are shared with other passive, non-broadcasting services, such as Earth monitoring satellites.

22-24 GHz WATER AND AMMONIA

Radio signatures left by water and ammonia molecules just above 20 GHz allow astronomers to study the interstellar medium and star formation and potentially look for signs of life elsewhere. In the EU, the area around 24 GHz has been used in recent years for automotive short-range radar – the sort of echolocation that tells you if your car is about to bump into something. The plan is to move such services to around 79 GHz when receiver technology allows, but for the moment the potential clash remains.

100 GHZ + VIRGIN TERRITORY

In the wide open spaces above 100 GHz or so, radio emissions from cosmically important molecules such as carbon monoxide, water and formaldehyde allow astronomers to use millimetre waves to study interstellar chemistry and star formation. It's still relatively quiet territory – at least until the next international carve-up of radio spectrum due in 2019 (see main story).



main flash points will probably be between 24 and 86 GHz. This is ideal for short-range radar that driverless cars will use, while the vast bandwidth available makes it promised land for data-hungry new 5G services. "While you are walking to your airplane, your phone can download a movie," says Liszt. "The people promoting 5G are trying to put their hands on as much spectrum as they can."

Onwards and upwards

At these higher frequencies, sharing the airwaves is easier: radio waves are absorbed quickly by the atmosphere, especially in the tens of GHz and above. As long as people coordinate where and when they are blasting out transmissions, radio telescopes can avoid being overwhelmed. Still, with several bands crucial to radio astronomy standing squarely in the way, there are squatters' rights to be defended, for example in reserved bands around 23 GHz, where emission from ammonia molecules can reveal the

temperature of gas in star-forming regions.

A whole new swathe of virgin territory will be on offer at the 2019 meeting. Delegates will slice up and hand out the chunks stretching from the existing boundary at 275 GHz all the way up to 450 GHz. The radio telescopes operating in this band tend to be in isolated spots at high altitude, such as Mauna Kea in Hawaii, so they should be safe from interference. An exception could be the dish on Pico Veleta in southern Spain, which has a direct line of sight to the city of Granada.

As the technological pressure increases, Liszt wants to extend the concept of radio quiet zones. He lives next to a huge quiet zone around the Green Bank dish in West Virginia, the world's largest steerable radio telescope. Another zone protects the ALMA radio array in Chile. Although effective for the moment, under current rules these zones don't have to be observed by satellite broadcasts or aircraft – a particular worry as it becomes possible to use mobile phones on planes.

Another option for astronomers is to keep

on trekking, heading out across the spectral plane to explore new frontiers and find new signatures for what's out there. "We are always out front, going to higher and higher frequencies, until technology catches up," says Liszt. "Things get more difficult but we continue to operate somehow." And of course there are new frontiers in spatial terms too, with dishes being built on the most remote mountains and at the South Pole – and perhaps someday on the far side of the moon.

But still this most civilised of conflicts continues on Earth, and astronomers can't afford to stop fighting their corner. "Our colleagues sometimes say – you spend your whole time going to these meetings – what successes do you have to show for it?" says van Driel. "I reply: once we stop going then you will see what happens. They want your frequencies – they know what a hertz is worth." ■

Stephen Battersby is a consultant for *New Scientist*

THE EASIEST WORD

Why do we apologise so much, and is it really a problem, asks Moya Sarner

IN THE past week, I've caught myself apologising to a stranger who was staring at her phone and nearly bumped into me, to a passenger who had placed his bag on the only available seat on the bus, and to a waiter for serving me the wrong drink. In this, I am not alone. A third of British adults think they apologise excessively in everyday conversations and a quarter of Americans would apologise if someone else bumped into them. It is with good reason that academics from science, history and politics have named ours the "Age of Apology".

You might think there's nothing wrong with just being polite, but the media tells us all this over-apologising is damaging our self-esteem, undermining us in the workplace, and could even be bad for our health. So as an ardent over-apologiser, should I do something about it? The answer is complex and depends on what the apology is for, but it's starting to become clear that saying sorry can have surprising upsides.

Much of the recent discussion on over-apologising has focused on the idea that women are particularly prone to it. One survey on the problem found that 44 per cent of women thought that women tend to apologise too much, whereas just 5 per cent of

them thought this was true of men. Men on the other hand tended to think that women and men both "got it about right".

When Karina Schumann of the University of Pittsburgh, Pennsylvania, began her post-graduate studies in psychology 11 years ago, she was confronted with similar ideas. "I kept coming across this stereotype. Big claims were being made with no real evidence: people were saying that men never apologise because they're unwilling to admit fault and their egos get in the way, whereas women apologise for everything without even thinking about it. I felt there needed to be some science to back this up," she says. So Schumann asked a group of Canadian students to keep a daily diary of any events that could have potentially deserved an apology, and whether they said sorry.

The women did indeed apologise more than the men, but that's as far as the stereotype went. The reason women apologised more was because they committed more offences that they felt were deserving of an apology than men did. In fact, both genders were equally likely to apologise when they perceived an offence had been committed, it's just that women apologised for things that men wouldn't.

Schumann and her team call this the

threshold hypothesis, which has been confirmed by other studies. "Men have a higher threshold for what might deserve an apology – or, to put it another way, women are more sensitive to what might require an apology," she says. This makes me wonder if I might be over-sensitive when thinking about which actions require an apology.

But even if women are apologising for more things than men, is it as big a problem as we are being led to believe? For instance, last year saw the launch of an email plug-in aimed predominantly at women, called Just Not Sorry, which scans draft messages to highlight diffident or apologetic words and phrases. The idea is to intercept such language because it weakens your authority, lowers your self-esteem, and damages your image in the workplace.

These assumptions might stem less from research and more from our cognitive biases. For a start, it can often feel very hard to apologise, even if we know the relationship will benefit. Research has also shown that people make "forecasting" errors about the potentially negative effects of apologising. "It is possible that people wrongly expect less benefit and more costs from apologising," says Michael Wenzel at Flinders University in South Australia, "so they fail to see or predict the positive psychological outcomes of apologies, and may be more preoccupied with the possible costs."

Wenzel and his colleagues wanted to understand why people might refuse to show contrition despite the obvious benefits.

Unthinkingly apologetic

They found that when people refused to apologise for something they did that upset someone else, they reported feeling more powerful and felt that they'd stuck to their values more. As a result, they also had more self-esteem than in situations where they did nothing after committing the transgression.

"Our research shows what may be behind our refusals to apologise – a defensiveness of our ego, our desire to maintain our power and control, and our sense of having integrity and acting in a way that is consistent with our values," says Wenzel.

But what surprised the team was the finding that when people did apologise, they got the same benefits – an increased sense of power and the feeling they were sticking to their values – compared with when no action was ➤



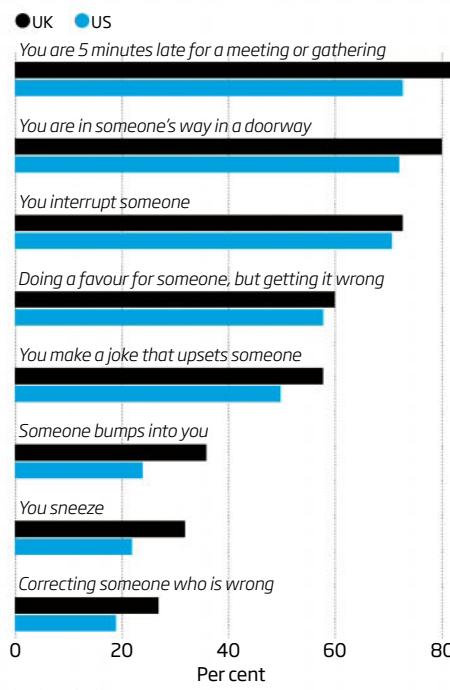
taken. This also makes sense, says Wenzel, because with apologies, offenders can express their commitment to the values they violated, and uphold the idea that they are good and moral people. They may also regain a sense of power and control, "because they are taking action to repair the wrong they have committed – or, a more sinister possibility, because they manage to manipulate their victims", says Wenzel.

So apologising can bring the same psychological benefits as outright refusal to do so, but importantly for those of us who have a tendency to ruminate, deciding on either option is better for you than doing nothing at all.

It may have more wide-reaching health benefits too. Preliminary findings from Schumann's lab suggest that apologising can make people feel less ashamed, which in turn motivates them to behave more healthily. "If people apologise, instead of ruminating or performing a self-distraction task, they feel a reduction in shame and that leads to greater intentions to engage in healthy behaviours such as eating healthily, exercising and sleeping enough," she says.

There could even be material benefits to saying sorry; it can make you appear more

Who says sorry and when?



approachable and trustworthy to strangers, according to work by Alison Wood Brooks at Harvard Business School.

In one study, three groups of participants were told to imagine they were waiting for a flight that had been delayed, and that a passenger from a different flight had approached them. They then watched a short video in which that passenger asks to borrow their mobile phone – in two videos, the passenger apologised before asking the favour, in the third, he did not. The passenger was rated as more trustworthy by the groups who watched the videos with the apologies. In another experiment, Wood Brooks found that even apologising for the weather increased perceptions of trust. This is worth knowing if your phone runs out of battery and you find yourself at the mercy of a stranger.

Apologising, then, isn't necessarily such a bad habit, at least when the apology is genuine. But what about when the apology isn't even conscious, let alone sincere? While writing her book *Watching The English*, anthropologist Kate Fox at the Social Issues Research Centre in Oxford, UK, decided to get "seriously bruised in the interests of science". She wanted to find out whether people would apologise if she bumped into them – what she viewed as the epitome of an English propensity to over-apologise.

So she travelled the country, and later internationally, pretending to accidentally bump into people and counting how many apologised to her. Like Schumann, she didn't find that gender made a difference. But nationality did: in England, about 80 per cent of her unwitting victims apologised to her, more than any other nationality – except for Japanese people, who were too adept at sidestepping attempted collisions for conclusions to be drawn.

What Fox learned from the experience was not that English people apologise more than other nationalities – they just say "sorry" more. Or rather, a monosyllabic "sry". "It was mechanical, an automatic 'sorry' that was usually barely audible," she says. "It becomes meaningless." This doesn't fit the standard definition of an apology as an expression of remorse for what one has done, Fox says. "I've caught myself saying 'sorry' after bumping into a stationary shopping trolley in a supermarket – clearly you cannot say that these count as apologies."

So although she found that the English blurred out an apologetic word more often than did people of other nationalities, that doesn't mean she found the English more

TYPES OF APOLOGY

SUPERFLUOUS

Apologies made out of habit, rather than remorse. When we say "sorry" automatically (see main story), the receiver might as well be a shopping trolley.

emailing "sorry" after committing a grave offence can underplay what took place. These can be frustrating to receive, as they leave you thinking the person has not understood their behaviour was bad..

A common example is, "I'm sorry if anyone has been offended". The conditional "if" implies that the apologist hasn't accepted an offence has taken place, never mind accepted responsibility for it.

AVOIDANT

When the transgression is something you'd rather not admit to, making the apology can be challenging, says Paul Drew, who studies conversation at Loughborough University, UK. As a result, apologisers avoid naming the offence, for example: "I'm sorry about what happened."

POSITIVE FACE ATTACK
This is not an apology at all, but is in fact, "downright rude," says Mats Deutschmann, professor of linguistics at Umeå University in Sweden. The "sorry" serves as a sarcastic preface to an insult, as in: "I'm sorry, but you are being an idiot!"

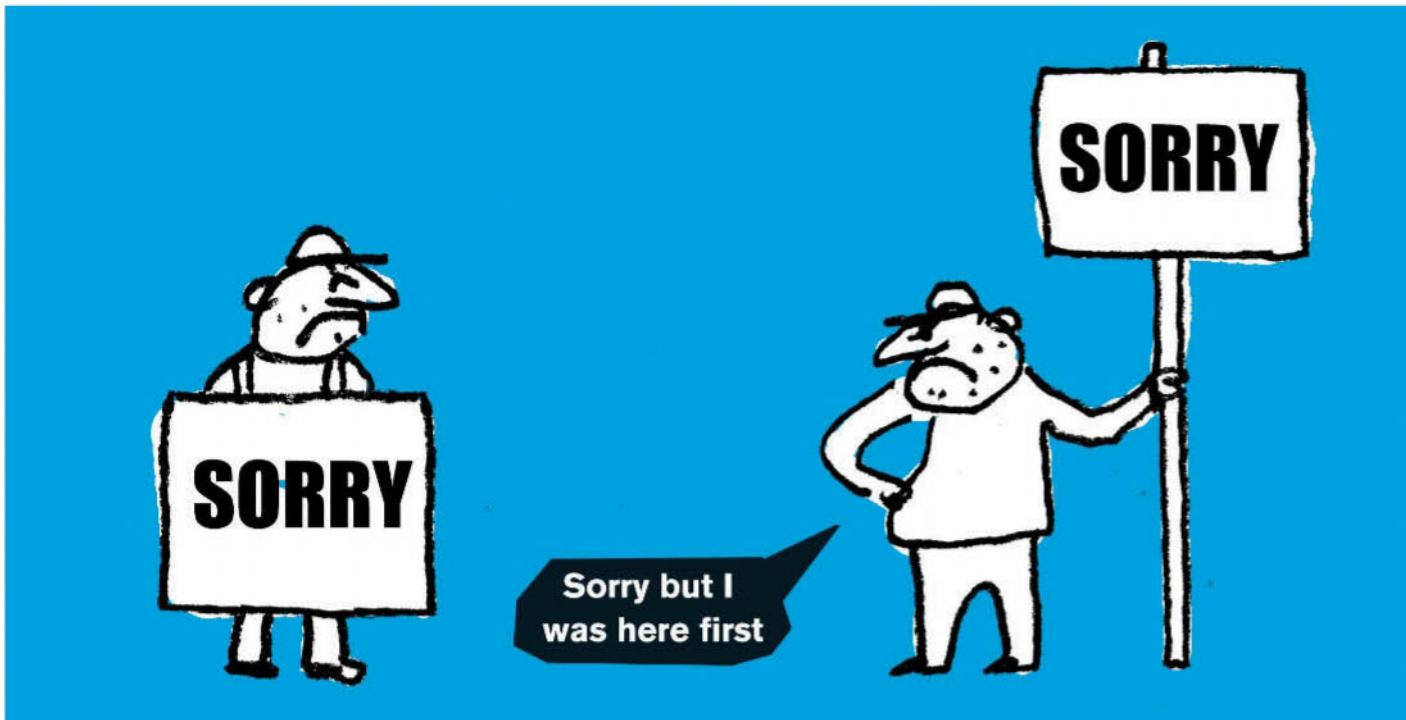
IRONIC
The tone and context make it clear that the apology isn't genuine. A classic example is: "I'm sorry if you disagree, but..."

UNDERMINING

The type of apology is chosen to give the impression that the transgression was not very significant. For instance,

FAUXPOLOGY
Masters of the fauxpology are expert at shifting the blame for the offence onto the person they are pretending to apologise to.

PARASITIC
These apologies are slipped into other statements that are ostensibly about something else. For example: "I would like to explain our returns policy, but not before apologising for the inefficient way your complaint has been handled."



courteous: "People of other nationalities would say, 'careful!' or 'watch out!' and put an arm out to steady me or check I was OK before moving on. We aren't any nicer or more polite than other countries – it's just a different kind of politeness."

This idea that apologies aren't all created equal builds on findings from work done by Mats Deutschmann, who studies linguistics at Umea University in Sweden. He spent some five years studying the British National Corpus, a databank of language collected in the 1990s. It is made up of about 10 million words transcribed from recordings made by 200 individuals walking around with tape recorders, as well as from TV and radio programmes and parliamentary debates.

Deutschmann analysed this material for apologetic forms, hoping to look at the impact of gender. He had to change his angle, however. "Women and men, if you look at it statistically, use more or less the same number of apologies in the material that I looked at," he says. More significant was the social situation: people had a greater tendency to apologise when they were being seen and heard by other people, not just the recipient of the apology: "It was more of a show, perhaps not to the person they were apologising to, but to the audience present," he says.

Deutschmann also found that the apologies that seem genuine on the surface aren't always intended as such (see "Types of apology", left). "Very often, apologies were used as a respectable vehicle for an attack, for

example "excuse me" was used to contradict or belittle someone.

Boasts can also be dressed up as apologies, such as when a person said: "I'm sorry about the soup – normally I would cook a proper stock."

Perhaps surprisingly, Deutschmann found that young people were more likely to issue a sincere apology than older people. "There was definitely a more genuine kind of politeness among younger people, contrary to a lot of claims that they are more rude. They swore a lot as well, but they did also make a lot of genuine apologies," he says.

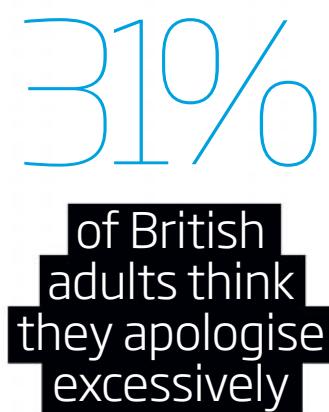
It is not yet clear whether the benefits of apologising apply to all types, or just genuine apologies. But if your aim in apologising is

straightforward forgiveness, there is an approach you can be confident in taking.

Last year, Roy Lewicki at Fisher College of Business at Ohio State University and his colleagues set out to discover the ingredients of a perfect apology by looking at how 755 people reacted to different apologies. They found that the most effective apologies contained six elements: an expression of regret, an explanation of what went wrong and an acknowledgment of responsibility, followed by a declaration of repentance, an offer of repair and a request for forgiveness.

The most crucial of these are to acknowledge responsibility and make an offer of repair, with the request for forgiveness seen as the most dispensable. It is simple really, says Edwin Battistella, a linguist at Southern Oregon University and author of *Sorry About That*. "It's what your mother told you to do when you did something wrong: look the person in the eye, name what you did wrong, be sincere, and explain how you're going to make some restitution."

This has made me rethink my own behaviour. I'm no longer going to worry about saying sorry too much. But learning about the different types of apology has made me more conscious of the way I use them. From now on, I will reserve my heartfelt apologies for occasions when I have caused someone suffering and feel genuine remorse. And for when I want to borrow a stranger's phone. ■



SOURCE: YOUTGOV

Moya Sarner is a freelance writer based in London

He blinded us with seance

"Clairvoyant" con man **Henry Slade** electrified Europe's scientific community and took some high-profile scientists for a reputation-destroying ride



CHRONICLE / ALAMY STOCK PHOTO

IT WAS nothing short of astonishing. In 1877, word began to spread that a team of internationally renowned scientists had witnessed empirical proof of a fourth spatial dimension populated by the souls of the dead.

The luminaries, at the University of Leipzig in Germany, included Wilhelm Weber, inventor of the electromagnetic telegraph, psychophysics pioneer Gustav Fechner, Johann Zöllner, the university's chair of astrophysics, and Wilhelm Wundt, who would later be dubbed the "father of experimental psychology".

How did they come to believe what we might now think of as "alternative facts", controversial even then? They had been persuaded by an American con man, a self-proclaimed spirit medium called "Dr" Henry Slade. His ability to convince and confound showed up the fractious state of science in the 19th century. Even Charles Darwin and Alfred Russel Wallace, pioneers of the theory of evolution, were pulled into Slade's orbit – albeit in opposite ways.

The apparent proof of Slade's abilities, and therefore of the supernatural, involved a series of 30 seances. They were held in Leipzig over the winter of 1877 and spring of 1878 with the university's best and brightest in attendance. Zöllner quickly wrote them up in the book *Transcendental Physics*, and although he described them as "experiments", in truth they were chaotic affairs. Slade claimed to have no direct control over his powers, so while he often failed to provide the scientists with the intended results, something incredible usually happened.

Slade first impressed the Leipzig luminaries by deflecting a compass needle with only a wave of his bare hand. Later, as the men sat in a circle holding hands, objects in the room winked into and out of existence. Impossible knots appeared in lengths of cord. Lights flickered. Other times, rapping noises and music could be heard. Books and furniture might be flung about by mysterious forces. During one sitting, a bed screen behind Slade cracked in half, a feat the physicists estimated would have required the strength of two horses. Then, the words "It was not our intention to do harm" mysteriously appeared on a slate that the scientists had cleaned themselves and would swear that Slade had not even touched.

Looking back, it can feel easy to dismiss Zöllner's experiments as products of

Magician John Neville Maskeyne took to the stand to denounce Slade as a fraud

gullibility and accomplished trickery, but researchers are still discovering ways that magic tricks and illusions can confound human perception and reasoning. And Slade was a persuasive man. Once described by a reporter as having “a winning smile, and might be called handsome”, he was a showman and a conjurer – like an 18th-century Derren Brown, but with a luxuriant moustache and no scruples. Slade had seized a golden opportunity, with spiritualism in its ascendancy in the late 1800s and combining an alternative Christian movement with emerging scientific and pseudoscientific concepts. High-profile proponents, including Arthur Conan Doyle, pointed to advances in the science of invisible forces such as electricity and magnetism to argue that mediums could provide empirical evidence of a soul’s survival beyond death. One might imagine that Conan Doyle’s signature character, Sherlock Holmes, would have disagreed.

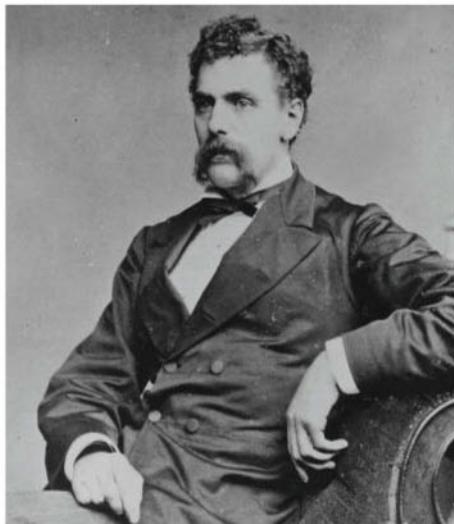
Slade’s rise to fame began before his trip to Leipzig, when he decided to embark on a world tour of psychic demonstrations accompanied, he claimed, by the spirit of his deceased wife, Alcinda. During his performances, he would receive communications from “Allie”, and other souls, as written messages that mysteriously appeared on slates.

At his first stop, in London, he narrowly escaped being imprisoned for fraud. The trial in the autumn of 1876 drew huge crowds and international media attention. And because spiritualism co-opted the language of scientific revolutions, its rise led to schisms not only in the general population, but also the scientific community. Darwin himself contributed the legal fees necessary to bring charges against Slade, whereas Wallace – who had been taken in by Slade’s performances – spoke in his defence (a decision that did little for his reputation).

No miracle

Magician John Neville Maskelyne was called to the stand to show that Slade’s miracles could be reproduced by way of magic tricks. Slade declined to demonstrate his powers in the courtroom; Alcinda considered the proceedings “undignified”, apparently. Slade’s attorney, Mr Munton, managed to get Maskelyne’s testimony dismissed, arguing that just because the magician could produce effects that looked like the miracles, it didn’t follow that Slade himself used trickery.

Late in the trial, Munton invited the judge to consider Slade in the light of other scientific revolutionaries – if the court convicted Slade



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A talent for persuasion helped Henry Slade win over leading scientists

for claiming to speak to the dead, then they were akin to the church officials who had imprisoned Galileo for asserting that Earth orbited the sun. “What is laughed at today,” he warned, “might be very differently regarded tomorrow”. The judge wasn’t buying it, and sentenced Slade to hard labour and three months’ imprisonment for using “subtle craft, means, or device, by palmistry or otherwise, to deceive and impose on any of his majesty’s subjects”. But luckily for Slade, the conviction was overturned on a technicality, and he fled to continental Europe before he could be retried. This is where he encountered budding spiritualist Zöllner and his colleagues.

Zöllner came to believe that Slade’s miracles represented empirical evidence of an otherwise unobservable fourth spatial dimension. He theorised in *Transcendental Physics* that souls of the dead resided in this dimension, where they were unbound by our usual laws of three-dimensional space. In this way, he accounted for many of Slade’s “miracles”: for example, the vanishing objects didn’t really vanish, but were simply rotated into the fourth dimension. It was an elegant physical explanation, but entirely reliant on Zöllner’s belief that Slade was an honest gentleman.

Of all the scientists who witnessed Slade in action during his time in Leipzig, only one would publicly accuse him of dishonesty – one of the university’s newest faculty members, Wilhelm Wundt. Following the publication of Zöllner’s preliminary conclusions, Wundt wrote a piece that appeared in *Popular Science Monthly* called “Spiritualism as a Scientific

Question”, which criticised spiritualist interpretation of the seances and proposed that they might better be attributed to “jugglery” or sleight of hand.

Whereas Zöllner had argued that scientists were the best people to assess Slade because they were trained physical observers, Wundt proposed they might not be the most qualified to detect deception. When Slade deflected the compass needle with his hand, the scientists immediately began to consider the implications in terms of “molecular currents”. Non-scientists, Wundt wrote, “would scarcely have neglected to examine the coat-sleeves of the medium” looking for magnets. Zöllner countered with a blistering letter addressed to Wundt, in which he suggested that Wundt be imprisoned for slander and hypothesised that the magnetic forces surrounding Slade might have scrambled Wundt’s brain.

Wundt was not imprisoned, and nor was Zöllner’s work with Slade ever embraced by the wider scientific establishment. Zöllner would subsequently collapse over his breakfast, dying of a stroke at the age of 47. Today, if he’s remembered at all, it is for his contributions to optical illusions and not, as he had hoped, for solving the mystery of eternal life.

“One theory was that objects didn’t vanish, they rotated into the fourth dimension”

Following Zöllner’s death, Wundt took over his university budget to establish what would become the world’s first officially recognised laboratory of experimental psychology.

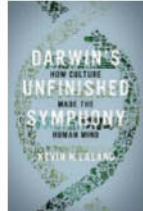
And what of Slade’s legacy? In 1885, an investigative commission comprising magicians and scientists from the University of Pennsylvania would interview the surviving witnesses and even assess Slade himself. They concluded that his demonstrations were “so closely resembling fraud as to be indistinguishable from it”. Slade continued to travel and practice, even briefly returning to England under an alias, but he would never again achieve the acclaim or notoriety that he’d had in London and Leipzig. Later in his life, his affinity with spirits got the better of him as he descended into alcoholism. He died in a sanatorium in Michigan in 1905. Four days later, *The New York Times* ran a story that noted Slade had not yet returned from the dead. ■

By Matthew Tompkins

A series of fortunate events

We accept that culture drove our extraordinary success as a species, but exactly how? **Mark Pagel** explores a compelling new account

Darwin's Unfinished Symphony: How culture made the human mind by Kevin Laland, Princeton University Press



Homo sapiens is the only species with a history. In the mere 200,000 years of our existence, we have gone from upright apes with a few hand-axes and spears to a species that spread from Africa to occupy nearly every habitat on Earth, building a world replete with technologies most of us don't even understand.

By comparison, our close genetic cousins, chimpanzees, still sit on the ground cracking nuts with stones, as they have for millions of years. History for other animals really is, as British historian Arnold Toynbee said, "just one damn thing after another" – and the same "thing" at that.

Our achievements pose a challenge to Darwin. His great theory of evolution by natural selection provides a sophisticated view of how species adapt to their environments. But how are we to explain the existence of petrol engines, cameras, pasta machines, yo-yos, religion and the arts? Even if we concoct stories to explain how these artefacts might improve our survival, why have only humans produced them?

These questions make up, in Kevin Laland's eyes, the "unfinished symphony" of his

new book. He wants to know exactly what it was about humans that set us on a trajectory of cumulative and accelerating technological innovation, the limits of which we are still exploring.

We know it must have been small in genetic terms because we share around 98 per cent of our protein-coding gene sequences with chimpanzees, and more than 99 per cent with the hapless and extinct Neanderthals. And yet

"The history of technology is not one of great leaps of insight but small, often accidental modifications"

there seems to be an unbridgeable gap between our evolutionary potential and theirs. Indeed, there seems to be a gap between us and all other species.

The usual human conceit is that we are simply more intelligent: our big brains allow us to figure things out. But this view is exaggerated. Looking at the evolution of technology, it did not happen with great leaps of insight, but small and often accidental modifications to existing ideas. Thomas Edison's notebooks show he tried thousands of materials, including platinum and bamboo, before alighting on a carbon fibre as the filament for his light bulb; Henry Ford didn't invent the assembly line; even Isaac Newton acknowledged that he stood on the shoulders of giants.

Laland, who is a behavioural and evolutionary biologist at the

University of St Andrews, UK, organised a tournament in which 100 computer programs competed over many rounds of interactions to survive in an ever-changing environment.

Programs could combine strategies of copying and innovation in whatever ways they liked. Startlingly, the winning program almost exclusively copied others. The program that relied almost entirely on innovation finished close to last.

Our view of ourselves as progressing through a series of light-bulb moments of inspiration is being replaced with the idea that what our species is really good at is imitation. We can search among a sea of what might be little more than random ideas others have tried, picking the ones that seem to work best. It is a form of survival of the fittest ideas that mimics biological evolution, but because ideas can quickly spread from one mind to another, the pace of our cultural evolution vastly outstrips the plodding rate of most genetic change.

However, there is more to this story. Copying is fraught with errors. If left uncorrected, those errors will accumulate on top of other errors, and this will eventually bring the cultural evolutionary train to a halt, at least for things more complicated than those you might be able to learn on your own. This is a fair description of most other animals' technologies – chimpanzees, for example, probably rediscover the art of

ELLIOTT ERWITT/MAGNUM PHOTOS

nut cracking every generation, perhaps benefiting only from having their attention called to it from watching others. Lacking a mechanism to reduce copying errors, the chimpanzees are stuck at this level of sophistication.

Our solution, in Laland's view, was to teach. Teaching can transmit new information, but it is also an error-correction mechanism that allows more sophisticated practices and technologies to be passed on and accumulate.

Some animals do display rudimentary forms of teaching – such as when adult meerkats disable the stinger on a scorpion to allow their offspring to experiment with it at low risk –





New York Met museum: The origins of human art are still mysterious

have yielded a species that is curiously in and out of its time. Remarkably, our ancient allegiance to our group has been able to scale up as our increasingly sophisticated cultures grew in size from the small societies we evolved in, to the larger, modern groupings of villages, towns, cities and even nations with millions of people. The emotion of watching your nation triumph over another in a sporting contest is an atavism from an earlier age, and it allows us to live relatively peacefully and productively alongside people who are effectively strangers with a shared identity.

That same atavism must now confront a globalised world (also a product of cumulative culture) in which we routinely mix and live alongside people whose cultural roots and identities may be distant from our own. In spite of the tensions this can cause, when measured across the world, human societies are becoming more, rather than less, peaceful, continuing a trajectory that began at least 10,000 years ago when humans began to live in larger groups.

The simple and yet unexpected story of our species' success shows how *H. sapiens* gives up the secrets of its success slowly and only after painstakingly detailed work by academics. Laland's book shows how those evolutionary biologists, anthropologists and social scientists are currently leading the way in unlocking those secrets. *Darwin's Unfinished Symphony* is accessible to the general reader and well researched. It is an enjoyable and valuable place to begin or to top up your understanding of our enigmatic existence. ■

but only humans practise the systematic teaching of complex actions. Laland even suggests that our human capacity for language evolved not for the economic and social reasons many others suggest, but as an aid to teaching: language arose as something akin to an aural DNA.

It's surprising how little was needed to accelerate our development: who would have thought that the ability to copy others could get us so far? What's more, the cultural environment this cognitive shift produced has fostered other adaptations. There is a growing recognition that, compared with other species, humans are less a product of their genes than our genes are a

product of living in the presence of the cultures we have created.

If Laland is right, language provides a striking example. Another is psychology and social behaviour that is uniquely centred around group living. Around 70,000 years ago, our

"Language may have evolved as an aid to teaching: as something akin to an aural DNA"

capacity for culture propelled us out of Africa by allowing us to acquire the knowledge and technologies necessary for survival in new environments.

Humans eventually occupied nearly every environment on

Earth in small tribal societies with their own languages, customs and beliefs. So important were our groups to our survival that we developed a tendency to treat other members almost as honorary relatives: we came to risk our well-being and even our lives for our tribes, for example, when going to war. No other species does these things, apart from the social insects – the ants, bees and wasps – whose unusual reproductive systems mean that the members of a hive or nest are brothers and sisters.

Our cultural adaptations have equipped us for the modern world, but have also left legacies. Today, the advance of culture and the changes it has wrought in us

Mark Pagel is an evolutionary biologist at Reading University, UK, a fellow of the Royal Society and author of *Wired for Culture: Origins of the human social mind*

All in the body

Can dance help us grasp abstruse science? **Simon Ings** explores

8 Minutes, Alexander Whitley
Dance Company, Sadler's Wells,
London, 27 and 28 June

IN A basement studio in south London, seven dancers are interpreting some recent solar research from the Rutherford Appleton Laboratory in Oxfordshire. They are tackling the electromagnetic properties of the sun's surface, and have got themselves, literally, into a knot. "Something about your grip here is stopping her moving," frets choreographer Alexander Whitley. "Can we get his hips to go the other way?"

Bit by bit, a roiling form emerges. Imagine a chain, folded in on itself, stretching and reforming. Its movements are coherent and precise, but wildly asymmetrical. This is no tidy, courtly dance. At one point the chain abruptly unwinds. The relief is palpable as the dancers exploit their few seconds of freedom. Very quickly, the chain kinks and folds in on itself again: a folding problem intensely claustrophobic to watch, never mind perform.

Whitley formed his dance company in 2014, and *8 Minutes* will be its debut on London's Sadler's Wells main stage at the end of June. It is named after the time it takes for light from the sun to reach Earth. "If you imagine travelling this distance at the speed of light, and you subtract all the relativistic effects, it's quite bizarre," muses Hugh Mortimer, Whitley's collaborator and a researcher at Rutherford.

Mortimer designed climate change-detecting spectrometers

for the Sentinel-3 satellite, and a sea-surface temperature monitor currently operating from the Queen Mary 2 liner. He hopes to build space-based instruments that analyse the atmospheres of exoplanets. But quite another fascination drew him into collaboration with Whitley's dance company: the way the most abstruse science can be explained through ordinary experience.

He continues his thought experiment: "For 6 minutes, you'd be sitting in darkness. By the 7th minute you would notice a point of light looming larger: that's the Earth. You'd arrive at the moon, pass by Earth, and a few seconds later you'd pass the orbit of the moon again. And the point is, passing the moon and the Earth and the moon again a few seconds later would feel intuitively right. It would feel ordinary."

However difficult an idea, someone, somewhere must be able to grasp it, or it's not an "idea"

in any real sense. How, then, are we to grasp concepts as alien to our day-to-day experience as electromagnetism and the speed of light? It's a question that has cropped up before in these pages, although seldom through the medium of dance. In 1988, for example, computer scientist Tony Hey wrote about his lunch with US physicist Richard Feynman,

"Bit by bit, a roiling form emerges. Imagine a chain, folded in on itself, stretching and reforming"

who explained particle spin "using the belt from his trousers" (*New Scientist*, 30 June 1988, p 75).

As for Whitley, he says: "We grasp quite advanced concepts first and foremost through movement. That forms a semantic template for the complex thinking we develop when we acquire language. Right, left, up, down, front, back – also the idea of containment, the concept

of an inside and an outside – these ideas come through our bodies."

This is especially true in children, he argues, because they don't yet have fully developed rational capabilities. "I think there's strong potential for using movement to give them a different understanding of and engagement with scientific ideas," Whitley says.

Mortimer discovered the truth of this idea for himself quite recently: "Alexander runs a creative learning project for 9 and 10-year-olds based on our collaboration. Sitting in on some sessions, I found myself thinking about solar-dynamic processes in a new and clearer way."

Will the audience at the work's premiere leave understanding more about the sun? From what I saw, I'm optimistic. They won't have words, or figures, for what they'll have seen, but they will have been afforded a glimpse into the sheer dynamism and complexity of our nearest star. ■



A knotty problem, as dancers interpret solar research



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A photograph of a woman with curly hair, wearing a purple shirt and black leggings, jogging on a paved path in a park. In the background, there are trees and several children playing, including one in a red shirt who is jumping. The scene is bright and suggests a healthy, active environment.

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EDITOR'S PICK

Fusion funding depends on a bold statement

From Nigel Bennett, Marple Bridge, Greater Manchester, UK

You quote physicist Thomas Klinger saying that lack of progress on nuclear fusion for power generation is simply down to a lack of funding (13 May, p 38). The current budget of €18 billion (€16 billion) for ITER, the 35-nation tokamak fusion experiment at

Cadarache, France, is paltry compared, for example, with the £56 billion for the High Speed 2 railway north from London or the current estimated lifetime cost of a replacement for the UK's Trident nuclear missile submarines of £167 billion.

But the main reason that fusion remains trapped in the lab is politics. Officials at the UK's Department for Business, Energy and Industrial Strategy have told me that they view fusion in the same light as perpetual motion and brief ministers accordingly. Fusion needs a political endorsement like that given to the Apollo moon programme by US president John F. Kennedy on 25 May 1961, promising to land an American on the moon by the end of the decade. Without that, NASA would merely have pursued more rocket experiments.

What's the point of consciousness?

From Eric M. Van, Watertown, Massachusetts, US
Neuroscientists vying to find credible consciousness indicators in simpler organisms may be overlooking the most direct way to do so (13 May, p 28). Our brains are massively parallel information processing systems, largely organised in discrete modules. The most salient information from these is somehow selected and integrated into a stream that controls most of our behaviour. We experience this stream as "consciousness". So to find consciousness in other species, we must seek sufficiently modular brain organisation.

The brain calculates optimum behaviour by tagging information as positive or negative for reproductive success.

So philosopher Jesse Prinz and evolutionary biologist Bjørn Grinde are correct to regard this "hedonic valuation" as crucial. But such valuation has to be more fundamental and hence older than consciousness – which is advantageous when the valuation process becomes distributed and hence needs to be summed across the entire brain.

The other proposed indicator that clearly fits this structural conception of consciousness is selective attention. Once a brain starts ignoring some information, it's headed down the path towards consciousness. Once it is doing so in multiple brain modules, it has almost certainly arrived there.

From Derek Bolton, Birchgrove, New South Wales, Australia
Neurologist Benjamin Libet showed that our conscious awareness usually lags around

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"We found the Higgs? We can take its picture off milk cartons and telephone poles now?"

Jane Jorgensen catches up with news about the famous boson and its role in the first moments of the universe (10 June, p 30)

half a second behind reality. Try this: glance at your watch and note how long it takes for the seconds count to change. It will seem to take from half to one-and-a-half seconds, not the nought to one second we know it should. When we switch our gaze, the half-second delay is overridden, then the perceived "frame" freezes while it is re-established.

It follows that it is possible to play tennis or have a conversation only because most of what we do is preconscious. When I run into friends, I do not see them stare at me for half a second before showing recognition.

Might the delay be the time it takes for all our sensory inputs to be synchronised into a consistent narrative? But why is that useful? How can we detect whether other animals do it? And is it necessary for any of the consciousness-related behaviour the article lists?

*From John Harris,
Richmond, North Yorkshire, UK*
Philosopher Jesse Prinz says "consciousness looks like it's largely about perception and emotion." One view of emotions is that they have two key functions: to select from a pool of potential behaviours and to sequence those behaviours in a way that aids survival. Behaviours are obviously modified by learning, but are still set in an emotional context. A conflict between emotions could be disastrous for survival: it is better for the animal to behave decisively. That is only possible if one emotion is dominant at any one time. I believe consciousness has evolved to ensure that this normally happens.

There is clear experimental evidence that remembering is more efficient and successful if the recall task is set in similar emotional circumstances to the

original experience. If dreams do involve the consolidation of memory, it seems logical that this consolidation has to happen in an emotional context and is only possible in a conscious-like state.

Do game theorists not have any friends?

From Brian Horton, West Launceston, Tasmania, Australia
I was intrigued by the suggestion that society as a whole would be more efficient if we never lent our friends tools or other things they need (3 June, p 7). We should, apparently, hire out these goods instead, charging our friends a fee.

The problem with the idea is made clear in the caveat that it assumes "this choice solely comes down to cost". The authors of the study neglected to allow for the fact that charging our friends a fee would soon mean we have no

friends, so we would all end up buying things we rarely need because no one would lend us anything. This is not the economic optimum for society as a whole, because our choices in interacting with our friends are not based solely on cost.

If space-time is granular then it is 'stiff'

From Steven Hall, Leigh, Greater Manchester, UK
Joshua Sokol reports the idea that the granularity of space-time acts as a form of friction, shedding energy into the stitching of space (27 May, p 28). I suggest it has another effect: to make space-time "stiff".

It limits how curved space-time can become: a radius of curvature less than the grain size is not possible. In other words, at very small scales, the gravitational

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field cannot be stronger than a maximum value. This would mean that if you put more and more mass into a small volume, there comes a point when this mass is not "visible" through its effect on gravity.

Athenian 'democracy' was nothing of the sort

*From Pam Manfield,
The Narth, Monmouthshire, UK*
Campbell Wallace proposes the "sortition" solution adopted to pick legislators by lot in ancient Athens (Letters, 20 May). But this didn't pick from "the whole community". It excluded women, most people not born in Athens, people with disabilities and, at times, others who lacked property or wealth.

But sortition of some sort still sounds better than our current system, in which big money and poor information or the insulting of opponents can influence voters. Brexit is an ideal example.

I have long advocated a lottery for the UK's House of Lords, with people having to commit to five years' regular attendance with no

other employment. The same for the Commons would surely be no worse than the deal we have now.

The right to bear arms in full and unabridged

*From Peter Gardner,
Blawith, Cumbria, UK*

Carrie Arnold describes the scale of gun-related deaths in the US (6 May, p 22). Not only is it horrific, it is ridiculous and unnecessary.

The finger of blame usually points at the Second Amendment to the US Constitution, which, according to gun defenders, enshrines the right of citizens to keep and bear arms. But this is at best a misunderstanding, at worst a deliberate misrepresentation that ignores the full wording of that amendment: "A well regulated Militia, being necessary to the security of a free State, the right of the people to keep and bear Arms, shall not be infringed."

That right is clearly not absolute; it is conditional. Indeed, John Paul Stevens, an associate justice of the Supreme Court from 1975 to 2010, suggested the addition of five words to the

amendment: "when serving in the militia". Until a sufficient body of concerned US citizens and politicians come to accept this conditional interpretation, the senseless slaughter will continue.

Beware non-nuclear electromagnetic arms

*From Chris deSilva,
Dianella, Western Australia*

Jeffrey Lewis dismisses the use of atomic bombs in space for an electromagnetic pulse (EMP) attack (13 May, p 24). It is possible, though, to use conventional explosives to create intense EMPs for localised attacks. These "flux compression generators" have existed since the 1940s. Placed close to critical installations, they could have catastrophic effects.

First do no harm; and last do no harm

*From Sam Edge,
Ringwood, Hampshire, UK*

Anna Nowogrodzki suggests that the choice of drugs used for executions should be made by seeking "medical advice" (6 May,

p 24). Someone who advises others on how best to kill people without their consent is not offering medical advice. Any medical professional who does so should be stripped of their status.

An economic upside for Donald Trump's Wall

*From Derek Morris,
Harpenden, Hertfordshire, UK*

Your review of *Borderwall As Architecture* (13 May, p 44) failed to note that the building of Trump's Wall may well lead to a boom in shipbuilding in Mexico.

Winning words

The gongs keep on coming. Our longest-serving reporter, Andy Coghlan, was honoured with a lifetime achievement award by the Association of British Science Writers; our newest reporter, Tim Revell, was named as one of "30 to watch" by MHP's Young Journalist Awards; freelancer Josh Sokol won the American Astronomical Society's Jonathan Eberhart Planetary Sciences Journalism Award for his feature "Hidden Depths", published on 13 August last year; congratulations are also due to Daniel Cossins who commissioned and edited that article.

TOM GAULD

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For the record

- Dark energy researcher Alejandro Perez works at Aix-Marseille University in France (27 May, p 28).
- In fact, 9 per cent of candidates in the UK's recent parliamentary election had a degree in science, technology, engineering or mathematics; and automation was mentioned in 31 parliamentary debates in the past year (27 May, p 23).

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SIGNAL BOOST

Offering your projects a helping hand



An eye to independence

A DIAGNOSIS of motor neurone disease (MND) can be devastating for individuals and their families. It gradually robs people of their muscular functions, including their ability to communicate, such a central feature of human existence.

One ray of hope is that, for reasons not yet understood, MND doesn't usually affect eye movement. A few communications options already exploit this, but they rely on other people holding up screens or using a letter board. So our firm, LusoVu, has been working to find a way for people with MND to use augmented reality (AR) glasses to communicate independently.

The development was triggered by the father of our chief executive officer, Ivo Vieira, being diagnosed with a form of MND called amyotrophic lateral sclerosis. Our parent company, LusoSpace, had studied the possibility of astronauts using AR on behalf of the European Space Agency and developed a pair of AR glasses in 2008. Vieira spotted the potential these held for people with MND, as well as other illnesses and disabilities, and so we set up LusoVu to develop them further.

Our EyeSpeak system is based on a pair of Epson AR glasses that project a screen and virtual keyboard on the inside of the lenses. To this has been added a unit incorporating a microphone, speakers and a microprocessor-controlled camera. The camera tracks eye movement to see which letter of the keyboard the user is looking at, spelling out words. The system comes with a standard synthesised voice or the user's voice based on previous recordings. Wearers can also use the glasses to browse the internet, while still seeing the world around them.

EyeSpeak could have other applications too. We're striving to develop the ultimate AR headset, one with a large field of view and thin lenses, which is as light, comfortable and elegant as a normal pair of glasses. This will greatly benefit the next generation of EyeSpeak users, but such development isn't cheap. The initial prototypes were funded through a Kickstarter campaign. We are now looking for support to move forward with our AR development. **Rui Semide, CMO, LusoVu**

To find out more about our AR development and how you can help, contact us at rui.semide@lusovu.com

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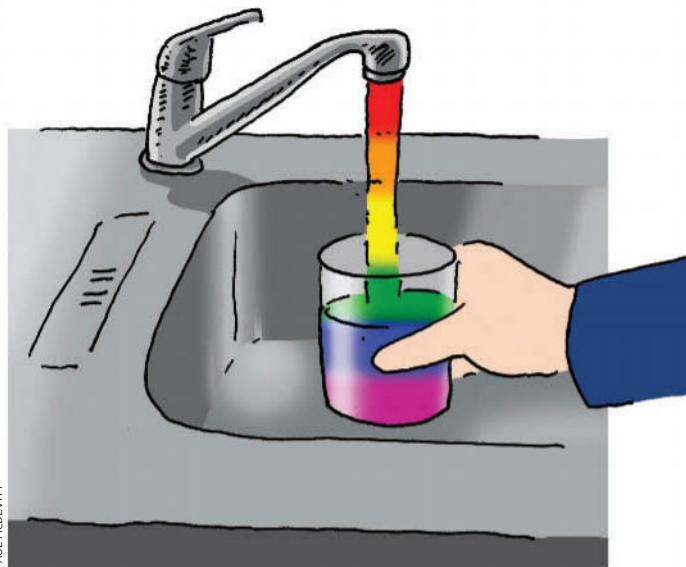
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PAUL MCDEVITT

THE first rule of politics is to give the answer you want reported, regardless of the question asked. So we can only speculate as to the inner monologue of the UK Liberal Democrat candidate Susan King. When asked for her thoughts on her party leader's views on homosexuality, she managed to tell the *Shropshire Star* her theory that chemicals in the water supply are turning people gay.

"There are a lot of feminising hormones getting into the environment and that has to be taken into consideration. It's affecting people's sexuality basically," she told journalists during the webchat, quickly adding that people "are at liberty to interpret how they want to live themselves".

The Telford candidate said her views were the result of "lots of research" into water quality, although citations were not provided. Feedback isn't sure how feminising hormones could alter sexuality - and indeed there's no evidence that they can - but we do think any impact on women has been overlooked. Are they immune, or will this souped-up water turn them into wonder women?

Mike Batten passes on news from his local free paper circulated in Nottinghamshire: "Young farmers in Clitheroe are preparing to celebrate their 70th anniversary."

LAST week, we discussed the soaring aspirations of South Suffolk UK Independence Party candidate Aidan Powlesland, who wants £1.2 billion to build his constituents spaceships for interstellar travel (10 June). If successful, perhaps he should consider getting a "Metro Galactic" print offered through Kickstarter.

Based on Harry Beck's revolutionary diagram of the London Underground, the Metro Galactic boasts that each constellation in the night sky is represented with "perfect accuracy" on a map, connected by nine (as-yet non-existent) interstellar metro lines. This of course makes it superior to Beck's map, which sacrificed geographical accuracy to present commuters with a clear topology for navigating the Underground network.

Creator Cillian Joseph McMinn says his goal is to "wildly reimagine traditional products and design". We have to say, drawing sky-spanning constellations as single points

with "perfect accuracy" inside a network of non-existent transport lines certainly takes some wild imagination.

WHAT, if anything, can be done to prevent further terrorist attacks in the UK? There is a dearth of sensible ideas but no shortage of suggestions from the nation's politicians and columnists. UK prime minister Theresa May characterised last week's atrocity as an attack on the UK's liberal values, and suggested the nation could more expeditiously resolve this conflict by further abandoning those very same values (10 June, p 7).

May called for more to be done to make online communications less secure, echoing predecessor David Cameron's sentiment that there should be no form of communication that the government cannot intercept.

While this strategy would effectively destroy the safe operation of the UK's digital infrastructure, it does mean we can look forward to an end to religious strife, as gods of all denominations would be sidelined by an all-knowing state. At the pearly gates, British citizens could anticipate being met by a minister clutching their internet search history and a disapproving glare.

MEANWHILE, *Daily Mail* columnist and doctor Max Pemberton identified a hitherto overlooked strand connecting several terrorists. "Was he a psychopath? Was he evil?" Pemberton wrote of Salman Abedi, who detonated a shrapnel-filled bomb at a concert attended by young children in Manchester last month, killing 22. "I do not know," he concludes. "But I do know that, according to his friends, Abedi was a frequent and heavy cannabis smoker."

The *Mail* is known for campaigning for harsh punishments, but this is the first time we've seen them expecting terrorists to be stoned.

AND *Daily Mail* columnist Katie Hopkins, recently reported to the police for hate speech, called for

hate preachers to be expelled from the country. And she joined her colleague Richard Littlejohn in calling for internment camps to lock up everyone suspected of doing wrong, although neither could explain what should happen next, short of inventing a Sorting Hat to divide good citizens from bad ones.

FINALLY, Janey Stephenson at *The Independent* newspaper sought to avoid generalising the actions of a few terrorists with the wider community of Muslims or people with mental health issues, and instead made an even broader generalisation that the common factor was that they were male.

This is a correlation that may boast strong statistical significance, if little predictive value. Nonetheless, Feedback can only hope the any further rise in toxic masculinity will be neutralised by the feminising toxins in our water supply. Finally, a practical solution!



THANKS to Derek Woodroffe who writes in with another example of troublesome truncation. He reports that the automated Twitter feed for the *Naked Scientists* podcast reports that "Panspermia is the belief that life originated in space, and Milton Wainright from The University of Sheffield."

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.

Offal way to die

The Last Word has told us that lions prefer to eat the fat and organs of their prey rather than the muscle. Apparently, muscle tissue is relatively poor in energy and vitamins (for lions, at least), and lions are able to make glucose in the liver from protein, so do not need carbohydrates. What, then, are the equivalents in humans? And if, when civilisation crashes, I finally manage to catch a stray cat or dog, which parts should I eat first, and why?

(Continued)

■ An earlier answer was a little misleading and perpetuated a common myth about the Inuit and their traditional diet. The idea that the Inuit enjoyed peerless health on an all-meat diet has been defying evidence for decades. They obviously survived, but their rates of stroke were higher than the average for Western populations and, as their diet changed and westernised, their rates of ischaemic heart disease dropped.

As for protein, if meat is too lean and that's all you eat, then you will die. This is sometimes called "rabbit starvation" because it was discovered among people who were trying, of necessity, to survive only on rabbits. But the outcome will be the same for any other similarly lean meat. Australia's National Health and Medical Research Council has cited survey data in which not a single person getting more than 30 per cent of their calories from

protein was meeting their recommended intake of vitamins or minerals.

Humans can indeed survive on all manner of unhealthy diets, but any implication that they are beneficial should be dismissed.

*Geoff Russell
St Morris, South Australia*

Cloning to the rescue

Having cloned sheep and who knows what else, wouldn't it be a good idea for scientists to begin cloning the world's endangered species? Is there any reason not to?

■ Cloning technology has improved dramatically since 1996 when Dolly the sheep became the first mammal to originate from a somatic cell (any cell of a living organism other than the reproductive cells). We now have a better understanding of nuclear reprogramming, a process that gives a cell the capacity to generate all the different types of cells that make up the organism – called totipotency. As a result, many species have been successfully cloned, including those of amphibians, fish, insects and mammals. But cloning is still inefficient, with a maximum of 5 per cent of cloned embryos developing into healthy offspring.

There have been several attempts at cloning endangered or even extinct species, such as the gaur and the Pyrenean ibex. These have been largely

unsuccessful. Generally, hundreds of embryos have to be created, of which only a handful can be implanted. And of those, only a couple are born, but these often die soon after birth.

The problem in most cases is sexual isolation, which is part of the speciation process, in which one species eventually evolves into two separate ones. These become incapable of reproducing with each other because their reproductive cells are no longer compatible or the embryo of one species cannot be carried by a mother of the other. Both issues affect cloning.

One species where cloning has been successful is the African wildcat. Although wild, this species is still genetically close enough to the domestic tabby for interspecies embryo transfer to be slightly more efficient. More importantly, cloned animals were then able to mate and reproduce among themselves.

But the main problem with cloning remains: it eliminates genetic diversity. The whole point is to reproduce an exact copy of an individual, such as a champion racehorse. Most higher organisms, however, reproduce sexually, which leads to the offspring bearing a combination of characteristics from both parents. This genetic mix and match allows species to adapt to their environment and reduces negative traits or diseases within the population. A diverse genetic pool is essential for a species to survive in the wild.

So although cloning might help preserve some species in critical times, the best way to avoid their extinction is to protect their environment and stop senseless poaching of wild animals.

*Alena Pance
Wellcome Trust Sanger Institute
Cambridge, UK*

This week's questions

THE ART OF TIMING

Why are the dates when we switch between summer and winter times (for example, swapping between Greenwich Mean Time and British Summer Time in the UK) placed so asymmetrically around the solstices?

*Chris Daniel
Colwyn Bay, Conwy, UK*

SANDCASTLES IN THE AIR

It seems ubiquitous at beaches for children to build sandcastles. Is this behaviour global? Is it innate or learned? Did the children of nomadic, hunter-gatherer groups also build mounds in the sand?

*Simon Iveson
University of Newcastle
New South Wales, Australia*

WINDING UP

Most of the discussion around climate change naturally revolves around temperature, but have wind speeds increased and become more variable? It seems to me that they have.

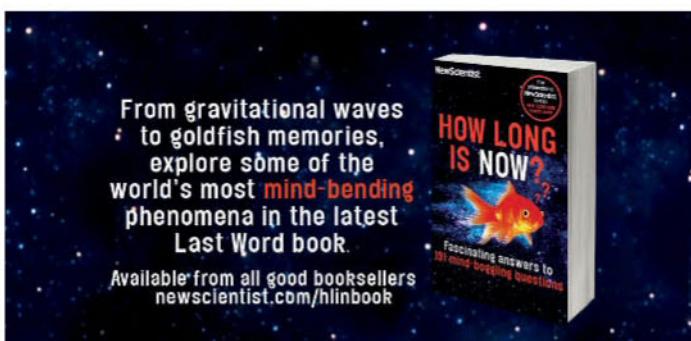
*David Joyner
Preston, Lancashire, UK*

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Professor Dame Carol Robinson

2015 Laureate for United Kingdom

By Brigitte Lacombe



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