

New Scientist

WEEKLY July 1 - 7, 2017

THINKING OUTSIDE THE BOX AI learns to multitask

DAMBUSTERS

When rivers get blocked,
who you gonna call?

FROM CELLS TO STARLINGS

The universal laws that
govern how life moves

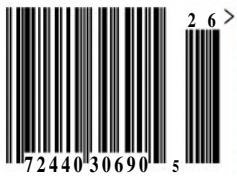
SEEING THE LIGHT

Artificial iris behaves
like a real eye

THE MANY AGES OF YOU

You're younger – and older – than you think

No 3132 US\$6.99 CAN\$6.99



Science and technology news

www.newscientist.com

US jobs in science

FERTILITY ROADBLOCK Traffic noise makes it harder to conceive

Intellectual indulgence

Subscribe and save up to 76%

Visit newscientist.com/9942 or call
1-888-822-3242 and quote 9942



NewScientist
FEEDING MINDS FOR 60 YEARS

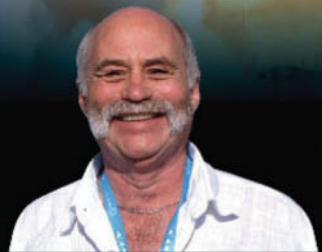


Space flight: A history

A two-week, action-packed tour in the US with astronomy and space experts

DEPARTURE:

25 SEPTEMBER 2017



Nigel
Henbest

》 VISIT THE TRINITY SITE

Join a small group *New Scientist* readers and local experts on 7 October at the Trinity site in New Mexico, the desolate spot where the first atomic bomb was tested. Seldom open to the public, it will be a rare opportunity to get close to some of the key science behind space flight engineering.

》 AN APPOINTMENT WITH APOLLO 11

Gaze at the Apollo 11 capsule as you enter the Smithsonian Air and Space Museum before studying the Viking lander and the Gemini and Mercury capsules. Venture into the Spaceport Operations Center at Virgin Spaceport America and interact with crewmembers. Explore the US Space and Rocket Center where the Saturn V Moon Rocket is displayed.

》 QUIZ AN ASTRONAUT

Chat with an astronaut at the NASA Kennedy Space Center and enjoy expert talks from astronomer and astronaut-in-training Nigel Henbest. You'll also have time to soak up the local atmosphere in Washington DC, Orlando, New Orleans and Houston.

WHAT'S INCLUDED

- 》 All hotels and internal flights*
- 》 Lectures and talks from space and astronomy experts
- 》 Entry to museums and tours, including VIP experiences

14 nights from £5045 per person

FIND OUT MORE ABOUT THIS UNFORGETTABLE TRIP

Call now on +44 (0)203 3089 917 or visit newscientist.com/travel/spaceflight



* BAGGAGE COSTS ARE NOT INCLUDED ON INTERNAL FLIGHTS

CONTENTS

News

8

The purpose of consciousness

Being conscious lets us learn rapidly in a quickly changing world



On the cover

28

The many ages of you

You're younger – and older – than you think

Cover image

Francesco Bongiomi

- 36 **Dambusters**
When rivers get blocked
- 32 **From cells to starlings**
The universal laws that govern how life moves
- 12 **Seeing the light**
Artificial iris seems real
- 16 **Think outside the box**
AI learns to multitask
- 12 **Fertility roadblock**
Traffic noise makes it harder to conceive



Features

36

Dambusters

When rivers get blocked, who you gonna call?



JAMES STILLINGS

Coming next week...

Ethics special

Ten thorny questions thrown up by science

Flame resistance

How to wrest back control from wildfires



When you have finished with
this magazine please recycle it.

Volume 235 No 3132

Leaders

- 5 Drone warfare strikes back. Dams can show the way to a better relationship with nature

News

UPFRONT

Male mice may distort drug development. US healthcare bill. Google's quantum supremacy

NEWS & TECHNOLOGY

Planet size pattern. Chimps aren't as strong as we thought. Bridge for endangered pumas. Monkeys with gut trouble eat mud. Seismic blasts kill plankton. Amputees control computer by moving missing arms. Traffic noise delays pregnancy. Artificial iris. Teaching AI to spot sites of slavery. Quake threatens Italian shrimp. Google's multitasking AI. Egg shape explained

IN BRIEF

Suitcase wobbles. Uranus's magnetic field. Gut "taste" cells. Deep-living amphibian

Analysis

- 22 **Drone terrorism** Can we counter the threat from weaponised consumer drones?

COMMENT

How Jeff Bezos can best spend his fortune. Hunting pledge damaged UK prime minister

INSIGHT

Don't blame selfies for the rise of botox

Aperture

- 26 The beautiful secret structure of charcoal

Features

- 28 **The many ages of you** (see above left)

- 32 **From cells to starlings** The universal laws that govern how life moves

- 36 **Dambusters** (see left)

40 PEOPLE

Mary Somerville, pioneer of science communication

Culture

- 42 **Good behaviour?** Young people are struggling with their digital identities

- 44 **Right under the skin** Tattoos are not just artworks, they are performances too

Regulars

- 52 **LETTERS** Belly gratification

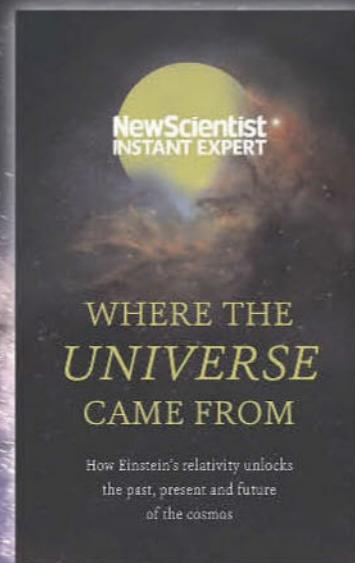
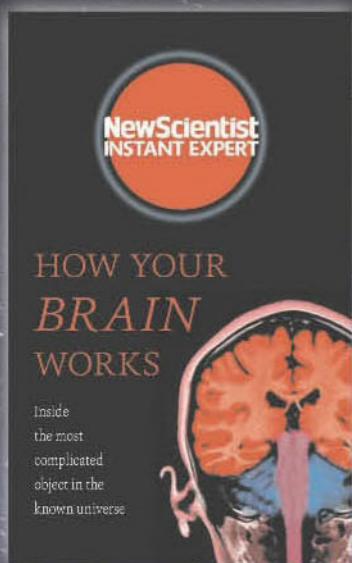
- 55 **OLD SCIENTIST** Julys past

- 56 **FEEDBACK** Space-based hosiery

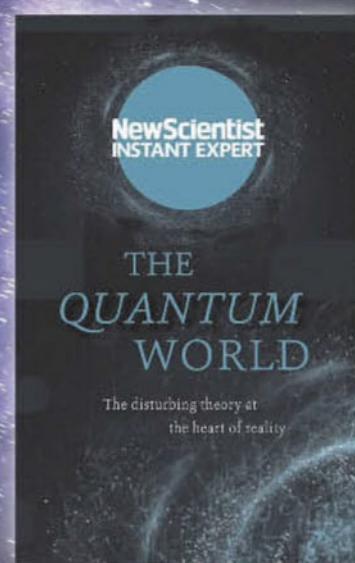
- 57 **THE LAST WORD** Silver linings?

INTRODUCING THE New Scientist INSTANT EXPERT SERIES

DEFINITIVE, ENGAGING AND ACCESSIBLE GUIDES TO
THE MOST IMPORTANT SUBJECTS IN SCIENCE.



MARCH 2017



APRIL 2017



NewScientist

LOCATIONS

USA
45 Prospect St
Cambridge, MA 02139
Tel +1 781 734 8773

UK
110 High Holborn,
London, WC1V 6EU
Tel +44 (0) 20 7611 1200

Australia
Level 11, Suite 3,
100 Walker Street,
North Sydney, NSW 2060
Tel +61 2 9422 8559

SUBSCRIPTION SERVICE

For our latest subscription offers, visit
newscientist.com/subscribe

Customer and subscription services are also available by:

Telephone 1-888-822-3242
Email subscribe@newscientist.com
Web newscientist.com/subscribe
Mail New Scientist, PO Box 3806,
Chesterfield, MO 63006-9953 USA
One year subscription (51 issues) \$154

CONTACTS

Contact us
newscientist.com/contact

Who's who
newscientist.com/people

General & media enquiries
enquiries@newscientist.com

Editorial
Tel +1 781 734 8773
news@newscientist.com
features@newscientist.com
opinion@newscientist.com

Picture desk
Tel +44 (0) 20 7611 1268

Display advertising
Tel +1 781 734 8773
displaysales@newscientist.com

Recruitment advertising
Tel +1 781 734 8773
nssales@newscientist.com

Newsstand
Tel 212 237 7987
Distributed by Time/Warner Retail
Sales and Marketing, 260 Cherry Hill
Road, Parsippany, NJ 07054

Syndication
Tribune Content Agency
Tel 800 637 4082
tca-artidesales@tribpub.com

New Scientist Live
Tel +44 (0) 20 7611 1273
live@newscientist.com

© 2017 New Scientist Ltd, England.

New Scientist ISSN 0262 4079 is published weekly except for the last week in December by New Scientist Ltd, England.

New Scientist (Online) ISSN 2059 5387

New Scientist at Reed Business Information 360 Park Avenue South, 12th floor, New York, NY 10010.

Periodicals postage paid at New York, NY and other mailing offices

Postmaster: Send address changes to New Scientist, PO Box 3806, Chesterfield, MO 63006-9953, USA.

Registered at the Post Office as a newspaper and printed in USA by Fry Communications Inc, Mechanicsburg, PA 17055



YAHYA ARHAB/REX/SHUTTERSTOCK

Drone warfare strikes back

High-tech weaponry eventually becomes available to all

SHORTLY after 9/11, the US deployed a new form of high-tech warfare: sending drones into foreign airspace to kill terror suspects. At first the strikes were restricted to Afghanistan, but soon they were extended into Pakistan, Yemen and Somalia. The strategy has been escalated by presidents Obama and Trump.

Initially the US had a virtual monopoly on drone technology, but commentators pointed out that this would only be temporary. Legal scholars also warned that the strikes were of dubious international legality. The implication was clear: if the US could strike with impunity, what was there to stop others from doing the same?

That threat has yet to come to pass. But China and Russia are both reportedly in possession of combat drones and there are fears that the development of cheaper models will lead to global proliferation.

That latter danger now appears imminent, with a company in Ukraine developing combat drones at a fraction of the cost of a US Predator drone (see page 22). Meanwhile, ISIS fighters in Iraq are customising commercial drones to drop grenades. It isn't inconceivable that this tactic could be used on the streets of Paris, London or Brussels.

Some may say that reporting on such possibilities is irresponsible, because it risks seeding ideas into

the minds of would-be terrorists. But the drone genie is out of the bottle; ISIS videos already show weaponised drones being used on the battlefield. It is better to be open about the threat so as to stimulate discussion about how to combat it – including action on the dissemination of extremist material by social media outlets.

The aftermath of 9/11 saw the revival of the CIA term "blowback", referring to the unintended consequences of covert military action. The current wave of terrorist attacks in the West is fuelled, in part, by perceived injustices of Western foreign policy, including drone strikes. The blowback is on – or maybe just over – the horizon. ■

Dams in distress

EVIDENCE of the Anthropocene is all around us. Even if humans were wiped out tomorrow, future scientists couldn't fail to notice planet-wide changes: a surge of greenhouse gases, a mass extinction event, a layer of plastic in ocean sediments, and more.

One signal of the Anthropocene that often goes unremarked is our drastic replumbing of the planet's fresh water. Our future

scientists would note alterations in sediment flows, the sinking of deltas and, possibly, the remains of huge artificial structures across many of the world's great rivers. Over the past century we have built dams at a staggering rate.

Dams bring benefits to humans but can be extremely damaging to nature. In recent years many have been demolished in order to alleviate the problems. But the

cost is prohibitive, and new dams continue to be built. And so an alternative approach – making dams work with nature – is on the rise (see page 36).

This is part of an emerging "good Anthropocene" movement, which accepts that we cannot restore nature to a pristine state but must instead become better stewards of change. Dams offer an opportunity to show that we can live in better harmony with nature – and open the floodgates for more of the same. ■



Easy target?

Quantum incoming

GOOGLE is the leader of the pack when it comes to quantum computing. The firm is testing a 20-qubit processor – its most powerful quantum chip yet – and is on target for a working 49-qubit chip by the end of this year.

“Google aims to be the first with a quantum computer beyond the abilities of ordinary computers”

Qubits, or quantum bits, can be both 0 and 1 at the same time, making them potentially more powerful than classical bits.

If everything goes to plan, the 49-qubit chip will make Google the first to build a quantum computer capable of solving certain problems beyond the abilities of normal computers. Google set itself this goal, known as quantum supremacy, in a paper published last July.

Alan Ho, an engineer in Google's quantum AI lab, revealed the company's progress at a quantum computing conference in Munich, Germany, last week. His team is

working with a 20-qubit system that has a “2-qubit fidelity” of 99.5 per cent – a measure of how error-prone the processor is, with a higher rating equating to fewer errors.

For quantum supremacy, Google will need to build a 49-qubit system with a 2-qubit fidelity of at least 99.7 per cent. Ho is confident his team will succeed by the end of this year. Until now, the company's best public effort was a 9-qubit computer built in 2015. The big challenge now is scaling up these systems and reducing their error rates.

ADAM GAULT/GETTY



Male mice skew findings

Parliament’s email hack

THE UK parliament was hit by a cyberattack on 23 June that compromised the email accounts of up to 90 people. The hacked accounts were using weak passwords that didn't conform to the recommended parliamentary security standards, a House of Commons spokesperson said in a statement.

During the “sustained and determined cyberattack”, hackers repeatedly attempted to access an email network used by members of both houses of parliament, including the prime minister and other government ministers.

There is no evidence at the moment linking the attack to Russia or any other state, contrary to speculation, says Dave Palmer, director of technology at security firm Darktrace in London. It

would take weeks of detailed analysis before any such links could be established, he says.

Hackers may have started with a list of parliamentary email addresses and then tried to access the accounts with software that runs through obvious and commonly used passwords. “This has the hallmarks of someone just doing it to show they can, or of someone doing it for fun,” says Palmer.

But he says the attack is a “wake-up call” that should prompt parliament to look closely at the state of its cybersecurity. Simple measures like multifactor authentication – requiring confirmation by app or text message before logging in – would make it harder for hackers to gain access to email accounts.

US ‘healthcare’

US SENATE leaders are attempting to replace Obama's Affordable Care Act with a bill that could leave millions more people without health insurance.

The Better Care Reconciliation Act proposes rolling back taxes for the wealthiest Americans, and reducing funding for Medicaid, which insures millions of Americans on low incomes. The bill would eliminate the requirement for all Americans to be covered by health insurance, let states opt out of covering

essential services like maternity care, and ban individuals from using tax credits for healthcare plans that cover abortion other than in extreme circumstances.

For the bill to pass, 50 of the 52 Republican senators will need to vote in its favour – which may not happen following the publication of a Congressional Budget Office report that says it would increase the number of people without health insurance by 22 million by 2026. When *New Scientist* went to press, several Republican senators had said they wouldn't support the bill in its current form.

Sex bias in drugs

WOMEN miss out on optimum medical treatment because most preclinical drug research is done in male animals. So suggests a new study that reveals many previously unknown differences between male and female mice.

Over three-quarters of drug evaluation studies use only male animals because of concerns that female hormone cycles will affect results. The common assumption is that what works for males

60 SECONDS

will work for females too.

However, Natasha Karp at the Wellcome Trust Sanger Institute in Hinxton, UK, and her team cast doubt on this. Comparing 234 physical traits in lab mice, they found sex differences for 57 per cent of quantifiable traits – like cholesterol levels and bone mass – and for 10 per cent of qualitative ones, like head shape (*Nature Communications*, doi.org/b824).

Karp says these nuances mean that drugs optimised for male animals may be less effective in females, while drugs that work better in females may never reach clinical trials.

RNAi crop approved

FOR the first time, a crop that produces an RNAi-based pesticide has got the green light.

The US Environmental Protection Agency has approved a genetically modified corn known as SmartStax Pro. In addition to producing two *Bt* toxins to kill any western corn rootworm larvae that try to eat it, the plant produces a piece of RNA that shuts down a specific gene inside the larvae, killing them.

On paper at least, such RNA interference (RNAi) is the perfect pesticide: it kills the target species while leaving others untouched. But it only works in some insects. In large animals like humans, RNAs, and proteins like the *Bt* toxins, get destroyed in the gut. We already eat gene-silencing RNAs, because many organisms produce them in their cells.

It could still be a few years before farmers in the US start growing the maize, made by agrochemical firms Monsanto and Dow. "We're still awaiting import approval from several countries, which is why we're looking at an end-of-decade commercial launch," says Jeffrey Neu of Monsanto. The company is also developing RNAi-based sprays to protect crops against pests and even to alter crop traits.

Ozone hitch

THE healing of the ozone layer could be delayed for decades – ironically by rising emissions of a gas used to make "ozone-friendly" chemicals for air conditioners and refrigerators.

While emissions of ozone-destroying CFCs are being curbed under the 30-year-old Montreal Protocol, emissions of another gas called dichloromethane are rising fast, says Ryan Hossaini of Lancaster University in the UK.

Dichloromethane is used to make a hydrofluorocarbon called HFC-32, often used as a

replacement for CFCs. It can escape into the atmosphere, but because it breaks down rapidly, the chlorine it contains was assumed not to spread into stratosphere where it can destroy ozone.

This is turning out not to be the case, though. Hossaini's model suggests that unless action is taken to stop dichloromethane emissions rising as fast as they are now, they will delay the repair of the Antarctic ozone hole.

Originally expected to fill by 2065, the hole might not heal until at least 2095 (*Nature Communications*, DOI: 10.1038/ncomms15962).

Look on the bright side

The brightest light on Earth is one billion times more intense than the sun's surface. Researchers have created the brightest laser ever, and found that its dazzling glow can distort an object's apparent colour or even its shape. High-energy X-rays, byproducts of this unusual scattering, could help take quick images of tiny tumours (*Nature Photonics*, doi.org/b82m).

Solar panel woes

Carbon pollutants from human activity can build up on solar panels, causing a 25 per cent drop in performance in some places. Cleaning the panels more often might reduce the problem – but can damage panels (*Environmental Science & Technology Letters*, doi.org/b82n).

Extinction shock

Fossils suggest that one-third of the oceans' large animals disappeared between 2 and 3 million years ago, possibly due to changing sea currents. This newly identified extinction included the Megalodon, one of the largest ever marine predators (*Nature Ecology & Evolution*, doi.org/b82p).

Google's giant fine

Google has been handed a record €2.42 billion fine after the European Commission ruled it has been illegally promoting its own shopping comparison service ahead of others. If Google doesn't end these practices within 90 days, it will face further fines of up to \$14 million per day.

Try this for your brain

The US National Academies of Science, Engineering and Medicine has reviewed evidence on ways to fend off cognitive decline and Alzheimer's-type dementia. They didn't find much conclusive evidence, but suggest that managing high blood pressure, exercising more and cognitive training all might help.

Double SpaceX rocket launch

SpaceX just did a double-header. Two of the firm's Falcon 9 rockets launched within 49 hours of each other, one from NASA's Kennedy Space Center in Florida and one from the Vandenberg Air Force Base in California. That's a first for SpaceX, and provides a proof of concept for efficiently reusing future rockets.

The launches, on 23 and 25 June, marked the second and third time that Elon Musk's space-flight company reused rocket boosters that had already been to space, landed and been refurbished. After successfully releasing their payloads into orbit, each booster returned to Earth and safely landed on a drone ship. Now they will be checked for damage, and possibly refurbished

and launched a third time – a feat that SpaceX has yet to attempt.

The 23 June launch (pictured) lifted Bulgaria's first communications satellite into orbit. The 25 June launch carried 10 communications satellites for the company Iridium, marking the second of seven planned batches that will make up its global satellite constellation.

Afterwards, Musk tweeted that his aim is to relaunch a booster within 24 hours of it landing back on Earth, with no intermediate servicing necessary. Launching a satellite aboard a SpaceX rocket is already \$300 million cheaper than with other launch-vehicle providers, and consistent, quick reuse could drive down prices further.

SPACEX



Space at the double

The point of consciousness

Our very awareness may have evolved to aid us in a changing world



PETER MARLOW/MAGNUM

Attention aids success

Anil Ananthaswamy

TO UNDERSTAND consciousness, we need to know why it exists in the first place. New experimental evidence suggests it may have evolved to help us learn and adapt to changing circumstances far more rapidly and effectively.

We used to think consciousness was a uniquely human trait, but neuroscientists now believe we share it with many other animals, including birds and octopuses. While plants and arguably certain animals like jellyfish seem able to respond to the world around them without conscious awareness, many other animals consciously experience and perceive their environment.

In the 19th century, Thomas Henry Huxley and others argued that such consciousness is an “epiphenomenon” – a mere side effect of the brain’s workings.

More recently, it has been suggested that consciousness lets us synthesise external information so that, for example, we experience the sight and sound of a passing car as a unified perception, even though light and sound travel at different speeds.

But ever more experiments are revealing that a surprising number of behaviours don’t need conscious attention, says Eoin Travers at the School of Advanced Study, University of London. Once you have learned to ride a bicycle, you can do it without being consciously aware of cycling in the same way as you had to be when learning. Studies have also shown that you don’t need to be aware of a “stop” sign to comply – subliminally perceiving it can be enough to halt an action.

To see what differences there might be between conscious and

unconscious perception, Travers and colleagues have been testing how well we learn when given wrong or misleading cues.

In the first experiment, volunteers gazed at a plus sign that appeared at the centre of a computer screen. About three-quarters of a second later, the sign was replaced by an arrow pointing left or right. The arrow lingered

“The capacity for rapid, effective learning would almost certainly have been selected for by evolution”

either for 33 milliseconds, so it could only be perceived unconsciously, or for 400 milliseconds, so that it entered conscious awareness. Finally, an X appeared to one side and the volunteers pressed a button to indicate whether it was on the left or right side of the screen.

Each volunteer sat through 200 trials with conscious arrow cues and 200 with subliminal ones. Each of these was further split into 100 rounds in which the cues pointed mostly in the correct direction, and 100 in which they were mostly wrong.

The team found that even when subliminal cues were largely incorrect, the participants were usually duped into pressing the wrong button. But when cues reached conscious awareness, the participants learned when to disregard them.

In a second experiment, the team varied the percentage of times that both conscious and unconscious cues were incorrect, and tracked participants’ eye movements to see how this affected their speed at homing in on the target.

When the cue was unconscious, the participants took longer to push the button because they couldn’t help but look in the direction of the arrow, even when it was wrong 88 per cent of the time. Because they were unable to adapt to the situation, they then had to find the target’s real location each time (*PsyArXiv*, bit.ly/2udT6uD). “Consciousness facilitates rapidly adjusting your behaviour in response to changes in the world,” says Travers.

“This is brilliant research,” says Thomas Metzinger at the University of Mainz in Germany. “The capacity for rapid, effective learning would almost certainly be something that evolution would have selected and maintained.”

The study suggests that this capacity requires conscious awareness. This gives researchers a clue to a theory of consciousness in which it really does have a causal effect, says Metzinger. ■

In this section

- Bridge for endangered pumas, page 10
- Traffic noise delays pregnancy, page 12
- Can we counter weaponised consumer drones?, page 22

Planets around other stars fit a strange pattern

EXOPLANETARY systems are like peas in a pod, whatever type of star the planets orbit. This challenges our ideas about how such systems form.

A team led by Lauren Weiss at the University of Montreal in Canada has looked at 909 planets discovered by the Kepler space telescope in 355 systems. All planets in a given system seem to be close in size and similarly spaced in their orbits when compared with planets in other systems. "We see this pattern happening again and again," says Weiss – regardless of what kind of star these planets are orbiting (arxiv.org/abs/1706.06204).

That's not what we'd expect, given how we think star systems are born: that stars form from a cloud of gas and dust, pulling it into a thick disc as they rotate. Denser clusters of gas and dust within the disc condense into planets, suggesting there should be a link between planets and their star.

The team thinks something other than stellar mass must influence how protoplanetary discs give rise to planets, such as the total mass of the disc, the solid mass within the disc or what happens to the disc after a planet's initial formation.

"There's probably something related to the physics of the disc that the planets are forming in that is determining how big the planets grow and how far apart from each other they end up," says Weiss. "But this idea has yet to be tested."

It's also possible that these patterns are just a fluke created by our limited data. Kepler can only find planets with short orbital periods – those that crossed in front of their star during the four years of the spacecraft's mission. That's like only looking at Mercury, Venus, Earth and Mars in our own system.

So can we really build theories on Kepler's limited observations? "That's the question that keeps me and many other people up at night!" says Weiss. Mika McKinnon ■



Chimps do not merit their super-strong reputation

CHIMPANZEES do have stronger muscles than us – but they are not nearly as powerful as many people think.

"There's this idea out there that chimpanzees are superhuman strong," says Matthew O'Neill at the University of Arizona. Yet his team's experiments and computer models show that a chimp muscle is only about a third stronger than a human one of the same size.

This result tallies well with the few tests earlier researchers have carried out. The team's review of these published studies suggests that when it comes to pulling and jumping, chimps are about 1.5 times as strong as humans relative to their body mass. But because they are lighter than the average person, humans can outperform them in absolute terms, says O'Neill.

"If you have a chimpanzee pull a weight or jump on a force plate, the performance of chimps and humans is actually fairly similar. In most cases, the humans outperform the chimps."

The team's findings suggest that other apes have comparable muscle strength to chimpanzees.

"Humans are the odd ones," O'Neill says.

His group has been studying the evolution of upright walking. To create an accurate computer model of how chimps walk, the team needed to find out whether their muscles really are exceptionally strong. So they removed small samples of leg muscle from three chimps

A 1923 study claimed that one chimpanzee could pull nine times its own body weight

under general anaesthetic and measured the strength of individual fibres, which are single muscle cells.

The same procedure is used to study human muscles. "It's pretty commonly used in human exercise research," says O'Neill.

Comparing the chimp results with the earlier human studies revealed that, contrary to the claims of several other studies, there is nothing special about chimp muscle. "Chimpanzee muscle is really no different than human muscle in terms of the force that individual fibres

exert," says O'Neill.

So why, on a kilo-for-kilo basis, are chimps slightly stronger than humans? The team went on to look at the muscle of chimps that had died of natural causes. This allowed them to take samples from muscles in 35 different parts of the body rather than just the one spot in living chimps.

Fast-twitch fibres

They found that two-thirds of chimpanzee muscle consists of fast-twitch fibres, whereas more than half of human fibres are slow-twitch. Fast-twitch fibres are more powerful, but use more energy and fatigue faster. "The chimps differ quite considerably from humans," says O'Neill. "Humans have a real predominance of slow-twitch fibres across their skeletal muscle, on average."

Another factor, O'Neill found, is that chimps have longer fibres on average, which also enhances their strength (PNAS, DOI: 10.1073/pnas.1619071114).

This adds to the evidence that walking is much more energy intensive for chimps than people. The results fit neatly with the idea that early humans evolved to use their muscles many times before fatigue sets in, so they could walk or run long distances. It seems that we sacrificed some strength for greater endurance.

Another study published a decade ago found that our jaw muscles are particularly weak, which may have helped our brains grow larger.

Quite how the myth that chimps are incredibly strong came about is not clear, says O'Neill. But it may have been fuelled by a 1923 study that claimed one chimp could pull nine times its own body weight. Later studies suggest they can only pull two to four times their weight.

"But I'm sure there are a lot of other things that come into it. Chimpanzees are big animals and they can be intimidating when they want to be." Michael Le Page ■

How do LA's pumas cross the road?

Adam Popescu

HOLLYWOOD would be hard-pressed to conjure up characters trapped in such a perilous position.

There are about a dozen pumas living in the Santa Monica mountain range, which bisects Los Angeles. They are trapped on an island of habitat, surrounded on all sides by freeways on which hundreds of thousands of cars roar past every day. But an ambitious plan to build a \$60 million wildlife crossing may soon change this.

A dozen pumas – also known as mountain lions or cougars (*Puma concolor*) – have been killed attempting crossings since 2002. Only one cat born in the Santa Monica mountains has successfully left the area. Dubbed P-22, that young male is now living under the Hollywood sign in Griffith Park, an oasis of 4300 acres of chaparral habitat in the middle of the city.

An adult male puma's home range can extend over about 500 square kilometres, and the Santa Monica mountains cover 700 square kilometres. But with

southern Californians frequently building homes in canyons next to puma habitat, interspecies conflict is now common.

Big cats have lived among humans in this area for hundreds of years. Even so, deaths from snakes and bees far outnumber those caused by pumas, of which less than two dozen have been recorded since 1890. Yet some locals remain spooked.

Last November, tensions flared after livestock were killed in rural

Malibu, Los Angeles County. The California Department of Fish and Wildlife approved a permit to shoot an offending cat, thought to be the resident 70-kilogram male, P-45. However, Victoria Vaughn-Perling, whose 10 alpacas were slaughtered there, stood down in the face of public outcry.

Still, encroachment and the lure of easy meals means that lions continue killing livestock.

"Eight weeks ago, over a three-week period, the lion, or lions, killed all 144 of my neighbour's stock," says resident Wendell Phillips – adding that 41 were slaughtered in a single night.

The National Park Service (NPS) says the cats can't be relocated. Prime territory does

exist elsewhere, but it's home to resident populations, and dropping in an outsider would be tantamount to a death sentence.

The key to keeping the species alive, says NPS biologist Jeff Sikich, hinges on habitat connectivity. When they are free to roam, the pumas aren't as tempted by livestock.

To help these cats cross major roads to find mates and territory, there is a plan to build a \$60 million wildlife crossing. Crossings have been constructed in places such as Montana and Africa, but never over a five-lane highway of this size and vehicle volume. It's ambitious, but good for other species such as coyotes and deer, too.

So far, \$3 million has been raised. The California Department of Transportation is nearing the review phase for environmental compliance, having donated \$200,000 to the environmental impact study.

"Our fundraising target by the end of the year is \$10 million," says Beth Pratt-Bergstrom, California director for the National Wildlife Federation. She's so enraptured with these animals that she has tattooed P-22 on her bicep and leads hikes to trace the cats' paths. "That money gets the project shovel ready and then we go. This will be built in early 2022, and the mountain lions will be crossing soon after." ■



NATIONAL PARK SERVICE

Holed up in LA

Mud may help monkey avoid stomach aches

ARE there merits to munching mud? Some monkeys seem to go out of their way to add it to their standard diet of leaves, fruits and insects. In Amazonian Peru, one primate species seems to use mud medicinally, possibly to prevent stomach upsets.

Why some monkeys eat mud has been much debated – they might use it to kill parasites, for example, or to

get minerals lacking in their diet.

"Many previous reports involved just a few sightings, or come from accidental encounters," explains Dara Adams at the Ohio State University in Columbus, who led the study. "We were really focused on answering this question, and that seems to have made the difference."

The team studied Rylands' bald-faced saki monkey (*Pithecia rylandsi*), which lives in the rainforest canopy. The sakis' treetop lifestyle means they don't get their mud from the ground, but from the nest casings of tree-living termites.

"They ate mound casing – they weren't focusing on the termites. They even ate inactive mounds," says team member Jennifer Rehg from Southern Illinois University Edwardsville.

But why termite mounds? "The important thing is that this isn't just any mud, it's termite-processed mud," says team member Minalini Watsa at Washington University in St Louis,

'A large part of a saki's diet is seeds from unripe fruit, which are packed with toxic chemicals'

Missouri. Analysis showed that the mud can absorb cations – positively charged particles – so could mop up potentially toxic metal ones from other substances in the monkeys' diet (*Primates*, doi.org/b82k).

"This was key," says Adams. "A large part of a saki's diet is seeds from unripe fruit, and these are packed with toxic chemicals."

The region's other major seed eaters – macaws and parrots – fly to clay-rich soils on riverside cliffs for stomach-calming intestinal mudbaths. Sakis have found a solution closer to their homes. Adrian Barnett ■

Oil exploration airguns are killing plankton

SOUND is literally the death knell for some zooplankton. The blasts made by airguns searching for oil reserves under the ocean floor can kill swathes of the tiny animals.

Since the 1960s, companies have employed airguns to probe the sea floor for oil deposits. The devices release compressed air into the water, creating bursts of sound. The way the acoustic waves bounce back from the ocean floor gives information about whether petroleum is present.

Previous research has shown that airguns cause behavioural changes and hearing loss in whales, dolphins and giant squid, impairing their ability to find food and communicate. Now, Robert McCauley at Curtin University in Western Australia and his colleagues have shown that the noise also kills zooplankton.

The team surveyed zooplankton populations before, and 1 hour after, setting off an airgun near the south-east coast of Tasmania in Australia. They found that the sound burst created a 2-kilometre-wide "hole" in the zooplankton population. Within this area, zooplankton abundance dropped by two-thirds and the number of dead zooplankton more than doubled (*Nature Ecology & Evolution*, doi.org/b8zk).

It's unclear how and why the zooplankton died so rapidly. The sound waves may have shaken and damaged the delicate "hairs" they use for sensing the environment, says McCauley, but that would have long-term effects like making it harder to swim, find food and avoid predators.

Until now, many thought plankton were safe from airguns, because they are too small to reflect the long sound wavelengths they emit, says Lindy Weilgart at Dalhousie University in Halifax, Canada. "But vibrations - being shaken - may come more into play than pressure waves," she says.

The team will now research how the declines in plankton populations affect other marine creatures. Alice Klein ■



THOMAS VICTOR / AGENCE FRANCE PRESSE / GETTY IMAGES

Active imagination

Amputees 'move' lost arms to control computer

PEOPLE who have had amputations can control a virtual avatar using their imagination alone, thanks to a system that translates neuron activity into computer signals.

Brain-computer interfaces have been advancing rapidly, raising hopes that such technology can help people overcome disabilities such as paralysis or lost limbs.

But it has been unclear how well this might work for people who have had limbs removed some time ago, as the brain areas that previously controlled these may become less active or repurposed over time.

Ori Cohen at IDC Herzliya, in Israel, and colleagues have developed a system that uses an fMRI scanner to read the brain signals associated with imagining a movement. To see if the system could work a while after someone has had a limb removed, the team recruited three volunteers who had had an arm removed between 18 months and two years earlier, and four people who had not had an amputation.

While lying in the fMRI scanner, the volunteers were shown an avatar on a screen with a path ahead of it, and instructed to move the avatar along this path by imagining moving their feet to go forward and their hands to turn left or right. The people who had had arm amputations were able to do this just as well with

"The results show that the amputees are still using the missing arm in their brain"

their missing hand as they were with their intact hand. Their overall performance was almost as good as that of the people who had not had an amputation.

"Although the amputees' performance is a little bit behind the control group, the big picture shows they are almost the same level, and still using the missing arm in their brain," says Cohen, who presented the research at the IEEE EMBS Conference on Neural Engineering in Shanghai, China, last month.

While the findings show that the brain retains the ability to control a lost limb for a year or more, it only gives a hint of whether this might be maintained for much longer periods. "Two years from the amputation is not really long term," says Dario Farina, a neural interface researcher at Imperial College London.

The system requires a person to be inside a brain scanner, so it would not be possible to use it outside a lab. But Cohen thinks that a new technology called functional near-infrared spectroscopy will make it possible to read the same brain signals with portable devices. This may lead to new ways for people who have had limbs removed to control prosthetic devices.

But Farina doesn't think such a system is likely to be very useful for amputees. "There are alternative techniques that are far superior for prosthetic control," he says. The fMRI interface only distinguished between four commands: forward, stop, left and right. By contrast, prosthetic controllers that work by detecting muscle signals at the stump of the severed limb can distinguish more commands, respond more quickly, and allow the user to control the force or speed.

Farina says Cohen's system could be more useful for locked-in patients, who have no means of communicating except via brain signals. "For other types of patients, this is a good performance, which is promising," he says.

Last year, a woman with amyotrophic lateral sclerosis became the first locked-in person to use a brain-computer interface to communicate in her own home, but this involved invasive surgery that placed electrodes on the surface of her brain. A system that scans brain signals instead would do away with the need for surgery.

Sam Wong ■

Traffic noise may delay pregnancy

Inga Vesper

LIVING near a noisy road seems to have an unwelcome effect on couples who are hoping to start a family, increasing the likelihood that it will take them between six and 12 months to get pregnant.

That's according to an analysis of 65,000 women living in Denmark. Jeppe Schultz Christensen of the Danish Cancer Society Research Center in Copenhagen and his team made this discovery by analysing data from the Danish National Birth Cohort, a project that ran from 1996 to 2002. They selected women who had tried to get pregnant during the project for whom traffic noise data was available for where they lived.

Previous research has suggested that 80 per cent of women who are actively trying to get pregnant usually do so within six menstrual cycles. As many as 30 per cent conceive within the first month.

But Christensen's team found that for every 10 decibels of extra traffic noise around a woman's home, the chance of it taking six months or longer increased by 5 to 8 per cent (*Environment International*, doi.org/b8xx).

This link persisted even when factors like poverty levels and

nitrogen oxide pollution were taken into account. However, the team's statistical analysis showed that this association did not hold for women who took more than 12 months to get pregnant – perhaps because other factors may have affected these couples' fertility.

"Road traffic noise may affect reproductive health," says Christensen. But it is not clear whether traffic noise is influencing the fertility of women or their partners – or both. Previous research has found a link between sleep disturbance and decreased

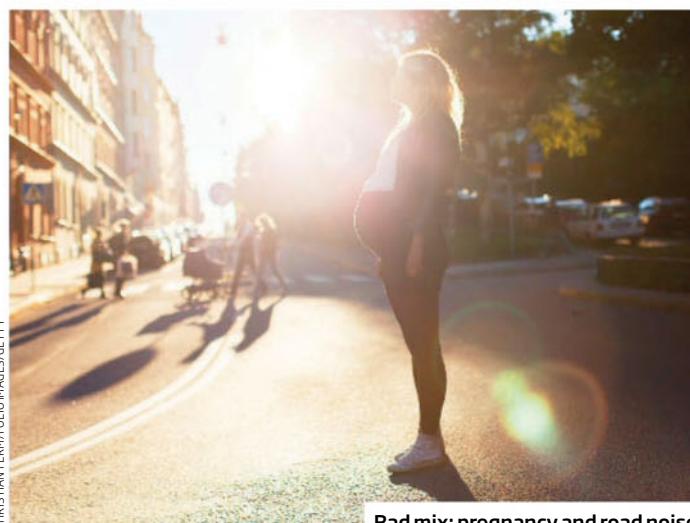
fertility in women, as well as lower quality of semen in men. A 2013 study showed that consistent exposure to aircraft traffic noise activates a system in the brain that is known to disrupt the rhythm of ovulation.

Rachel Smith of Imperial College London says the link between traffic noise and health is worrying. Because traffic noise is common, even a small effect on health might have a large impact across a population, she says.

Since the cohort project ended in 2002, Europe's roads have become even noisier. In the UK alone, an extra 2 million cars hit the roads between 2011 and 2015.

Christensen says the link between traffic noise and fertility needs to be investigated further before drawing up any recommendations for couples hoping to get pregnant. But Smith suggests that anyone who is worried could try to choose bedrooms away from the road, and close windows at night.

Marie Pedersen at the University of Copenhagen says traffic issues should be tackled through better town planning and alternative transport. "It is a matter for urban planners and politicians," she says. ■



CHRISTIAN FERM/ALAMY IMAGES/GETTY

Bad mix: pregnancy and road noise

Synthetic iris knows its way around light

AN ARTIFICIAL iris that automatically opens and closes in response to light, just like the ones in your eyes, could improve cameras and, eventually, help repair damaged human eyes.

The iris is the coloured part of your eye and controls the pupil, the hole that lets light inside the eyeball. In bright light, the iris contracts to shrink the pupil, protecting the sensitive retina which sends visual signals to the brain. In the dark, the iris opens to let in more light.

The aperture of a camera performs the same function, but normally

requires an external control. Now Arri Priimägi at Tampere University of Technology in Finland and his colleagues have created one that works by itself.

They started with a thin disc 14 millimetres across and bearing 12 radial petals cut through its middle without reaching the edge. The disc was made of a polymerised liquid crystal elastomer, a rubbery material that alters shape in response to heat.

In dark conditions, each petal bends and curls outward, leaving a round pupil-like hole in the middle. To make the iris respond to light, the researchers added a red dye to the liquid-crystal mixture.

When blue or green light hits the dye, it heats up, triggering the petals to

curl back down and close the aperture (*Advanced Materials*, doi.org/b8xr).

"We shine light on the material and it changes its shape," says Priimägi. He hopes it can tackle a problem with artificial irises used to treat certain eye problems – that they cannot change the size of the pupil, and

"With a set pupil size suited to bright sunlight, patients with today's artificial irises lose vision in the dark"

are essentially fixed contact lenses. With a set pupil size suited to bright sunlight, patients lose much of their vision in the dark.

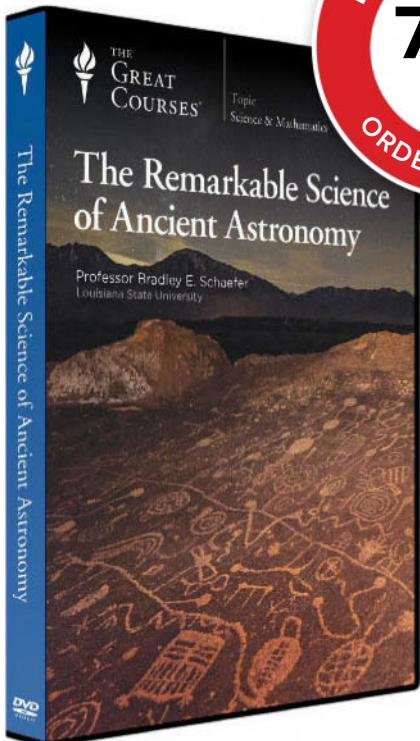
Priimägi says the device is not quite ready to be implanted in a human eye because it doesn't have fine enough

control over pupil size and only responds to fairly strong light. "This is the first step – maybe we can go there one day," he says.

"This is great, but applications will come down to the details," says Jeremy Lerner, president of LightForm, a US imaging instrumentation company. "It depends on how fast it closes, how much light it lets through, and at what wavelengths."

The artificial iris can close in seconds, but that will need to be sped up to the millisecond level for many applications, such as in sensitive cameras that could be ruined by being suddenly pointed at a bright object.

It may also need to close more tightly – at present, it still lets around 10 per cent of the light through when fully shut. Leah Crane ■



What Did the Ancient Astronomers Get Right?

In a world without artificial lights, the night sky is ablaze with stars, whose patterns tell stories you have heard since childhood. Experience this ancient outlook with noted astrophysicist and historian of astronomy Professor Bradley Schaefer of Louisiana State University. Dr. Schaefer takes you back in time and around the world to see the sky from many perspectives, exploring the close relationship that people thousands of years ago had with the sky.

The Remarkable Science of Ancient Astronomy also covers notable sites and phenomena, such as Stonehenge, the Great Pyramid, the Star of Bethlehem, the origin of constellations, Polynesian sky navigation, ancient calendars, and more. Using only their eyes and simple instruments, ancient astronomers got many things right, and their meticulous records and insights laid the foundation for modern science.

Offer expires 07/16/17

**THEGREATCOURSES.COM/6NSUSA
1-800-832-2412**

The Remarkable Science of Ancient Astronomy

Taught by Professor Bradley E. Schaefer
LOUISIANA STATE UNIVERSITY

LECTURE TITLES

1. Stonehenge and Archaeoastronomy
2. The Real Stonehenge
3. Alignments at Maes Howe and Newgrange
4. Astronomy of Egypt's Great Pyramid
5. Chaco Canyon and Anasazi Astronomy
6. Ancient Cosmologies and Worldviews
7. Meteorite Worship and Start of the Iron Age
8. Eclipses, Comets, and Omens
9. The Star of Bethlehem
10. Origins of Western Constellations
11. Chinese and Other Non-Western Constellations
12. Origins and Influence of Astrology
13. Tracking Planet Positions and Conjunctions
14. Ancient Timekeeping and Calendars
15. The Lunar Crescent and the Islamic Calendar
16. Ancient Navigation: Polynesian to Viking
17. Breakthroughs of Early Greek Astronomy
18. The Genius of Hipparchus
19. Revealing the Antikythera Mechanism
20. How the Antikythera Mechanism Worked
21. Achievements and Legacy of Ptolemy
22. Star Catalogs from around the World
23. How Ancient Astronomy Ended
24. Ancient Astronomy and Modern Astrophysics

The Remarkable Science of Ancient Astronomy
Course no. 1866 | 24 lectures (30 minutes/lecture)

SAVE UP TO \$190

DVD ~~\$269.95~~ NOW \$79.95

Video Download ~~\$234.95~~ NOW \$59.95

+\$10 Shipping & Processing (DVD only)

and Lifetime Satisfaction Guarantee

Priority Code: 141601

For over 25 years, The Great Courses has brought the world's foremost educators to millions who want to go deeper into the subjects that matter most. No exams. No homework. Just a world of knowledge available anytime, anywhere. Download or stream to your laptop or PC, or use our free apps for iPad, iPhone, Android, Kindle Fire, or Roku. Over 600 courses available at www.TheGreatCourses.com.



Brick kilns can be slavery sites

ASIF HASSAN/AFP/Getty Images

Teaching AI to find forced labour camps

Matt Reynolds

ONLINE volunteers are helping to track slavery from space. A new crowdsourcing project aims to identify brick-making kilns in South Asia – frequently the site of forced labour – in satellite images (see below).

This data will then be used to train machine learning algorithms to automatically recognise brick kilns in satellite imagery. If computers can pinpoint the location of such possible slavery sites, then the coordinates could be passed to local charities to investigate, says Kevin Bales, the project leader, at the University of Nottingham, UK.

South Asian brick kilns are notorious as modern-day slavery

sites. There are an estimated 5 million people working in brick kilns in South Asia, and of those nearly 70 per cent are thought to be working there under duress – often to pay off financial debts.

However, no one is quite sure how many of these kilns there are in the so-called “Brick Belt”, a region that stretches across parts of Pakistan, India and Nepal. Some estimates put the figure at 20,000, but it may be as high as 50,000.

Bales is hoping that his machine learning approach will produce a more accurate figure and help organisations on the ground know where to direct their anti-slavery efforts.

It's great to have a tool for identifying possible forced labour sites, says Sasha Jesperson at St Mary's University in London. But it is just a start – to really find out how many people are being enslaved in the brick kiln industry, investigators still need to visit every site and work out exactly what's going on there, she says.

Kilns are often hidden in patches of cleared forest, which makes them hard to detect on the ground. But from space they're much easier to spot. From above,

the kilns appear as round and usually pale structures, which makes them stand out in satellite images. They're often clustered together, with several appearing in the same photo.

So far, volunteers have identified over 4000 potential slavery sites across 400 satellite images taken via Google Earth. Once these have been checked several times by volunteers, Bales plans to use these images to teach the machine learning algorithm what kilns look like, so that it can learn to recognise them in images automatically.

Bales is also developing a similar approach for identifying open-pit mines in countries such as the Democratic Republic of the Congo, which are also often sites of forced labour.

But he thinks his machine learning algorithms might have a trickier time categorising open-pit mines, which often look like big holes in the ground and can be harder to spot.

“A lot of slavery is visible from space,” says Bales. But image recognition techniques could

If computers can pinpoint slavery sites, the coordinates can be passed on for investigation”

also help track down slavery that's invisible to satellites. TraffickCam, a database set up by the social action group Exchange Initiative, uses image recognition to identify victims of sex trafficking.

Travellers to hotels are asked to upload an image of the inside of their hotel room, and these can then be compared with photos of the sex workers posted online by the sex traffickers.

Because such photos are frequently taken in hotel rooms, investigators may be able to use the TraffickCam database to pinpoint the location of a particular photograph and rescue trafficked individuals. More than 150,000 hotel rooms in the US have been documented in this way. ■

Italy's drying lakes put shrimp at risk

AN ANCIENT shrimp found only in a single small lake tucked away in the mountains of central Italy could soon disappear, as a combined result of climate change and an earthquake that hit the area last year.

The fairy shrimp (*Chirocephalus marchesonii*) has evolved from a species native to the Himalayan region. Its ancestors are thought to have reached the Apennine range in Italy during the last ice age, after their eggs latched onto the feet of migratory birds.

“Over the millennia, the shrimp has adapted to the specific environment of Lake Pilato,” says Maria Gaetana Barelli of the Sibillini Park authority, which helps look after part of the Central Apennines. The species is unique among freshwater shrimp in the area for its Asian origins.

Barelli is concerned that the crustacean may go extinct if the small lake it inhabits undergoes significant environmental changes.

Last year, the region experienced a major earthquake that affected the groundwater system. “The water levels in the basin are abnormally low this year,” says Alessandro Rossetti of the Sibillini Park authority. Depending on the nature of the damage, the lake might ultimately dry out.

The shrimp can survive long dry spells because it buries its eggs under the lake bed, where they can remain intact for more than a year until conditions are right to hatch.

Even so, Barelli is worried. “My concern is that this year, because the water is already so low, the individuals present in the lake might not have the time to mature sexually and lay their eggs before the basin dries out.”

The shrimp isn't the only species under threat. In a valley not far from Lake Pilato, another shrimp, *Chirocephalus sibyllae*, depends on the regular seasonal cycle of a pond it inhabits. Again, its survival is tied to water availability when it matures and lays eggs. Lou Del Bello ■



GOOGLE EARTH

THE WORLD'S
MOST EXCITING FESTIVAL
OF IDEAS RETURNS

New Scientist Live

TURN TO PAGE 45
TO SEE OUR EXCLUSIVE
SHOW PREVIEW

28 September – 1 October 2017 ExCeL London

BOOK NOW AT

newscientistlive.com

SPONSORED BY



BEST
CONSUMER
SHOW



AWARDS

SHOW
OF THE
YEAR



BEST
CONSUMER
LAUNCH

Google AI reveals its wide repertoire

Matt Reynolds

DEEP-LEARNING systems tend to be one-trick wonders: great at the task they were trained to do, but pretty awful at everything else. Now a neural network from Google suggests that AI can be multitalented after all.

Most deep-learning systems are built to solve specific problems, such as recognising animals in photos of the Serengeti, or translating between languages. But if you take, for instance, an image-recognition algorithm and retrain it to do a completely different task, such as recognising speech, it usually becomes worse at its original job.

Humans don't have that issue. We use our knowledge of one problem to solve new tasks, and don't usually forget how to use a skill when we start learning another. Google's neural network takes a tiny step in this direction, by simultaneously learning to solve a range of different problems without specialising in any one area.

The neural network from Google Brain – one of the search giant's deep-learning teams –

is able to perform eight tasks, including image and speech recognition, translation and sentence analysis. Called MultiModel, the system is made up of a central neural network surrounded by subnetworks that specialise in specific tasks relating to understanding audio, images or text.

Although MultiModel broke no records for the tasks it attempted, its performance was consistently high across the board. With an

accuracy score of 86 per cent, its image-recognition abilities, for example, were only 9 per cent worse than the best specialised algorithms – and matched the best algorithms in use five years ago (arxiv.org/abs/1706.05137).

MultiModel also showed other benefits. Deep-learning systems usually need to be trained on large amounts of data to perform a task well. But MultiModel seems to have come up with a neat way of sidestepping that, by learning from data relating to a completely different task.

The network's ability to parse the grammar of sentences, for example, improved when it was trained on a database of images, even though that database

had nothing to do with sentence-parsing.

For problems where the network already had large amounts of data, its performance stayed roughly the same when it learned from other tasks.

Sebastian Ruder at the Insight Centre for Data Analytics in Dublin, Ireland, is impressed with Google's approach. If a neural network can use its knowledge of one task to help it solve a completely different problem, it could get better at tasks that are hard to learn because of a lack of useful data. "It takes us closer on the way to artificial general intelligence," he says.

The approach could also be useful for building artificially intelligent robots that can learn as they move through the world, Ruder says. The world is full of unorganised audio, images and text, which a system that learns from lots of different types of data might be better equipped to understand than highly specialised machines.

Google has released the MultiModel code as part of its TensorFlow open-source project, giving other engineers a chance to experiment with the neural network and put it to the test.

The network's complexity, however, might make it difficult for researchers to work out just how it acquires its multitasking skills, says Ruder. ■



Too skilled to pigeonhole

Flying style might shape birds' eggs

EGGS are eggs, but some are round while others are long and pointy – and we may finally know why. It might all be to do with the way a bird flies.

Mary Caswell Stoddard of Princeton University and colleagues analysed the shape of almost 50,000 eggs from around 1400 species in museum collections. They quantified the egg shapes according to ellipticity – length

relative to width – and asymmetry, the extent to which one end is pointier and the other rounder.

The researchers compared egg shape with data about each bird species, but found no correlation with clutch size, environmental factors or nest characteristics. However, one measurement did correlate with egg shape: the hand-wing index, a measure of the shape of the wing.

Birds with a large hand-wing index tend to be better fliers and also tend to have elliptical or asymmetric eggs. This might be because the demands of flying favour light, streamlined

bodies. To maximise the volume of an egg that has to fit through a narrow pelvis and oviduct, it must be longer. By contrast, flightless birds are more likely to have spherical eggs (*Science*, DOI: 10.1126/science.aaj1945).

But this link has yet to be proven. "At best this is correlational, not causative," says L. Mahadevan at Harvard University, who co-authored the study.

"To maximise the volume of an egg that has to fit through a narrow pelvis it must be longer"

"They've done a great job of taking these anecdotal studies and putting them into a proper framework," says Steve Portugal at Royal Holloway, University of London.

But the study raises many further questions, he says. For example, why is a symmetrical egg advantageous for birds that don't have high-intensity flight? Perhaps this minimises the shell material needed for the same volume.

The team now plans to study how the egg develops as it moves through the oviduct to look at the mechanisms that directly shape the egg. Sam Wong ■

Land of fire and ice

An amazing seven-day tour of the majestic landscape of Iceland. Discover how fire and ice shape the scenery and get a chance to see the Northern Lights

GEOTHERMAL POWERS

HVERAGERDI AND KRÝSUVÍK

Discover the might of the planet as you marvel at the sights, sounds and smells of erupting geysers and bubbling pools of mud. Soothe away your cares in the warm, mineral-rich waters of the Blue Lagoon in the middle of a black lava field. Enjoy food cooked by Earth's heat and visit the innovative greenhouses where tomatoes grow even in deepest winter.

ICE AND FIRE

BORGARFJORDUR AND SNAEFELLSNES PENINSULA

Drive across Europe's second largest glacier in an eight-wheel truck, and see shades of blue you never knew existed in Langjökull ice cave. Hike across the awe-inspiring Sólheimajökull glacier to discover how ice shapes the landscape. See how an eruption 8000 years ago sculpted beautiful shapes in Vatnshellir lava cave. Visit ice-capped volcano Eyjafjallajö.

MAGICAL LANDSCAPES

GOLDEN CIRCLE AND SOUTH SHORE

Our tour takes in Iceland's "Golden Circle", including the UNESCO-listed Thingvellir National Park, where the tectonic plates of Europe and North America separate to create a dramatic rift valley. Steeped in legend, Iceland's South Shore is famous for its sheer cliffs, picturesque villages and volcanic black sand overlooked by towering glaciers.

WHAT'S INCLUDED:

- ▶ Six nights' accommodation, including breakfast
- ▶ Private coach
- ▶ Local expert guides
- ▶ All entrance fees

DEPARTURE DATES:

18 OCT 2017, 15 NOV 2017

SEVEN DAYS

FROM £1790 PER PERSON

FIND OUT MORE

Call +44 020 3308 9763 or visit newscientist.com/travel/iceland

The science of the Renaissance

Discover the great scientific minds and discoveries of the age on an eight-day cultural adventure across Florence, Pisa and Bologna

7 NIGHTS FROM £1,795 PER PERSON

DEPARTURES:

30 NOVEMBER 2017, 1 MARCH 2018, 15 NOVEMBER 2018

Join a group of like-minded, inquisitive *New Scientist* readers on an enlightening eight-day tour of Florence, Pisa and Bologna.

Led by art and architecture expert Andrew Spira, you will wander through echoing churches, study extraordinary museum collections and visit hidden Renaissance buildings. On this distinctive trip, you'll also enjoy a special lecture from *New Scientist's* editor-at-large, Jeremy Webb.

From the Ptolemaic planetarium in the dome of the Old Sacristy, San Lorenzo, to Bologna's Anatomical Theatre, you will be guided through the astronomic, architectural, medical and mathematic discoveries of the period.

The trip includes three evening lectures from our experts and four-star hotels throughout. The itinerary has been curated by *New Scientist* and is packed with insight.

WHAT'S INCLUDED

- Return flights with British Airways from London
- All hotels and transfers
- Entry to museums and tours
- Expert guide throughout
- Evening lectures from:



Andrew Spira

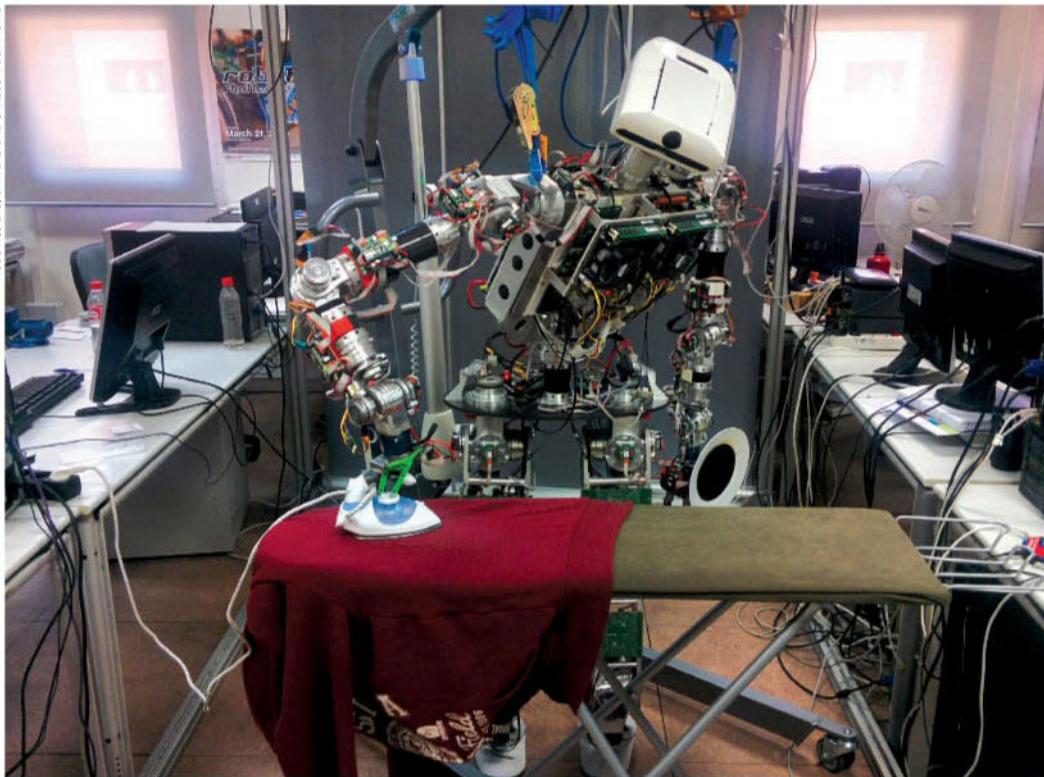


Jeremy Webb

START PLANNING YOUR TRIP

Call now on +44 (0)20 7251 0045

or visit newscientist.com/travel/renaissance



Robot butler irons your clothes so you don't have to

IF WE'RE lucky, robots might steal our household chores before they steal our jobs. Next on the list could be ironing, now mastered by a humanoid robot called TEO.

When a human places an item of clothing on an ironing board in front of TEO, it uses a camera built into its head to create a high-resolution 3D representation of the garment and the ironing board.

The robot then detects creases by calculating a "wrinkliness local descriptor". This means coming up with a number between 0 and 1 for each point on the garment, where 0 represents a sharp edge and 1 a flat spot. TEO

knows that creases fit somewhere between these two extremes, as the only truly sharp edges are the boundaries of the ironing board.

After TEO has all the wrinkles in its sights, it slowly lowers the iron on to the garment and then executes an ironing trajectory calculated to smooth out each crease. Once that's done, the robot repeats the manoeuvre for good measure.

"TEO is built to do what humans do as humans do it," says Juan Victores at Carlos III University of Madrid. He and his colleagues want the robot to tackle other domestic tasks, like helping out in the kitchen. Their ultimate goal is for TEO to learn how to perform a task just by watching people with no technical expertise carry it out (arxiv.org/abs/1706.05340).

Gut 'taste' cells sound the alarm bell

EVER needed to hurry to the toilet after eating a meal? Blame the special "taste" buds that line your intestine.

Little is known about these enterochromaffin cells, which produce 90 per cent of the body's serotonin – a chemical mostly known for regulating mood, appetite and sleep in the brain.

To find out why these gut cells release such large amounts of a

brain chemical, David Julius at the University of California, San Francisco, and his team have been studying mini-intestines grown from mouse cells in the lab.

They have discovered that enterochromaffin cells have receptors for sensing dietary irritants – such as allyl isothiocyanate found in cabbage – and stress hormones such as adrenaline. When exposed to

these substances, the gut cells pump out serotonin, which activates intestinal nerve endings that connect back to the brain (*Cell*, doi.org/b8xg).

The brain responds by speeding up bowel movements, or inducing diarrhoea or vomiting in extreme cases. "It might also give you a general sense of discomfort as a way of letting you know you've got some kind of inflammatory episode going on in there," says Julius.

Case of the wobbly luggage solved

IF YOU'RE late for your flight, and your suitcase starts wobbling, don't slow down. Luggage is less likely to topple over if you walk faster, a study has found.

Sylvain Courrech du Pont at Paris Diderot University and his colleagues used a tiny model suitcase on a treadmill to find out why two-wheeled cases flip over.

They discovered that if a suitcase runs over a bump, the whole thing tilts and begins to rock from one wheel to the other.

If the bump is small it doesn't tilt far and eventually rights itself. A large bump makes the case rock more violently from one wheel to the other until it falls over. But if you speed up, it wobbles faster so doesn't have time to tilt as far and comes back down on both wheels. "If it's not wobbling, it's better to walk slower, but if it starts then it's bad to slow down," says Courrech du Pont (*Proceedings of the Royal Society of London A*, doi.org/b8xf).

Cigarette butts keep nest tick-free

IS THIS a cigarette habit with some benefits? Urban house finches (*Carpodacus mexicanus*) seem to harness the toxic chemicals in cigarette butts to drive out nest parasites.

Constantino Macías García at the National Autonomous University of Mexico and his colleagues had already noticed that the birds add fibres from the butts to their nests. Now their experiments have shown that the birds add significantly more of the fibres if their nests are infested with ticks (*Journal of Avian Biology*, doi.org/b8zg).

Nicotine has anti-parasite properties, and the finches seem to know this. However, earlier work suggests butts can cause genetic damage in chicks.

Weird amphibian sets depth record

HERE be dragons. In a limestone cave at the bottom of a lake 113 metres below the surface of Croatia, biologists have discovered an amphibious salamander known as an olm - a creature once believed to be a baby dragon.

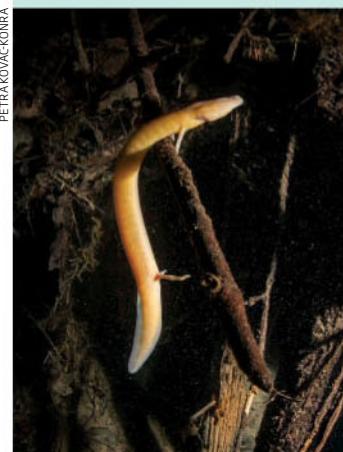
"This was the deepest finding of the olm ever recorded," says team leader Petra Kovač-Konrad.

Proteus anguinus is dubbed the "human fish" because of its pinkish pale skin. With its slow lifestyle this blind animal can live for up to a century. Little is known about olms, and it is a race against time to find out more as the salamanders' underground habitat is being contaminated by pollution from human activities on the surface.

Cave divers have found five new olm habitats in the past six years as part of the project run by Croatian association Hyla. The lake where the creature was seen at record depth, Zagorska pec, is of particular interest as, unusually, several specimens have turned up there.

"Study of the olms in greater depths is extremely important, especially when done by divers focused on conservation," says biologist Gregor Aljančič, head of the Tular cave laboratory. He suspects deeper olms will be found.

"Our previous findings indicate that *Proteus* can withstand significant pressure," he says.



PETRA KOVÁČ-KONRAD

Uranus's crooked, messy magnetic field might open and shut

URANUS has the weirdest magnetic field in our solar system, and it just got weirder.

Most of the planets in our solar system rotate around similar axes, spinning in the same plane as their orbit. Their magnetic fields are aligned with these axes.

Uranus is different. It rotates on its side and the axis of its magnetic field is tilted too, at a 59-degree angle from the rotational axis. The magnetic field is also off-centre, originating about a third of the way towards the planet's south pole.

All of this makes Uranus's magnetosphere – its protective magnetic bubble – a total mess. "It is changing in all sorts of directions," says Carol Paty at the Georgia Institute of Technology in Atlanta.

Paty created a model of the planet's magnetosphere and its interactions with the solar wind, a stream of charged particles blown out by the sun. The magnetic field acts as a barrier to the solar wind: when the two are moving in the same direction, the solar wind slides off it. But Paty found that

when this wind blows towards Uranus at the right angle, the planet's magnetic field lines up with the solar wind's and lets particles through.

This process sometimes occurs near Earth's poles and can lead to intensified auroras. On Uranus, Paty found that it should happen every Uranus day (roughly 17 Earth hours), switching the magnetosphere's protection on and off. This could lead to an intensified aurora there as well (*Journal of Geophysical Research: Space Physics*, doi.org/b8xj).

Pumas put off food by human voices

DOES talk radio put you off your dinner? Pumas in California can sympathise. The animals abandoned their kills and fled when played presenters' voices.

Justine Smith at the University of California, Santa Cruz, and her colleagues set up motion sensors, speakers and cameras at sites of fresh puma kills in the Santa Cruz mountains. When a puma came to feed, the speakers played either a talk radio clip or the call of a Pacific tree frog as a control.

In 29 trials on 17 pumas, the cats fled in 83 per cent of tests when human voices were played, and only once in response to the frog sound. The pumas took longer to return to their kill if they heard a human voice, and halved their feeding time compared with when they heard a frog (*Proceedings of the Royal Society B*, doi.org/b8xk).

"We weren't particularly surprised by the result, but a little bit by the magnitude," says Smith.

This fear response may be bad news for the pumas' prey. "For a large carnivore which kills bigger prey, reducing feeding means they have to go and kill again because they're not getting all the energy from their kill," says Smith.



VASILY PINDURIN/GETTY

Radio runs on sweat power alone

BATTERY gone flat? Don't sweat it – or perhaps you should do.

Sweat alone has been used to power a radio for two days, thanks to a flexible patch measuring just a couple of centimetres. This square is a biofuel cell that sticks to the skin and contains sweat-fuelled enzymes that replace the precious metals normally used in batteries (*Energy and Environmental Science*, doi.org/b8xh).

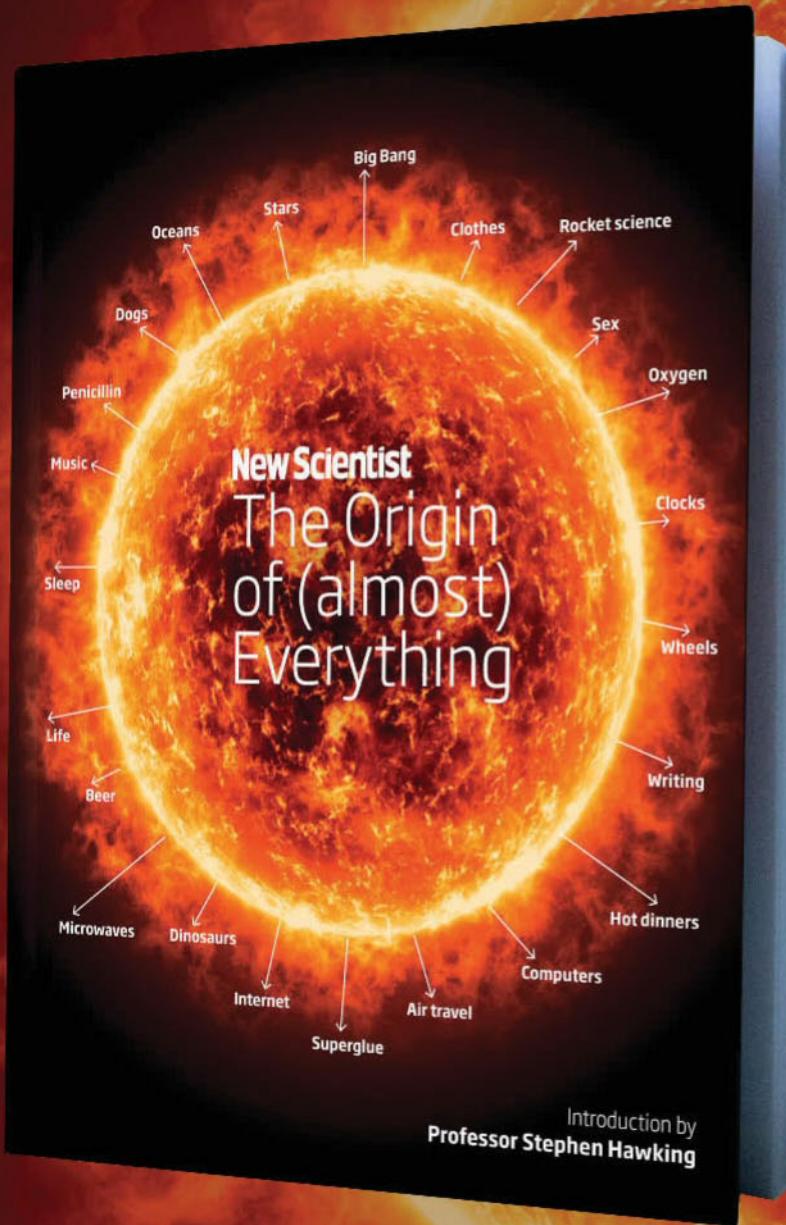
"If you were out for a run, you would be able to power a mobile device," says Joseph Wang at the University of California, San Diego,

one of the team that worked on the technology.

Successfully powering a radio shows how far biofuel cells have advanced in recent times, but unsurprisingly, sweat radio isn't the main goal. Instead, researchers are looking at how such cells can be used to track human health.

The enzymes in this biofuel cell are powered by the lactate in sweat, which is also an indicator of how efficiently a person's muscles are working. Future cells could use this to give readings on an athlete's performance during exercise.

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



And where does belly-button fluff come from?
Find the answers in our latest book. On sale now.



Introduction by **Professor Stephen Hawking**

**New
Scientist**



PHOTOGRAPH: ARIS MESSINIS/AFP/GETTY IMAGES

Consumer drones are being used against ISIS

Terror from above

ISIS is using weaponised consumer drones on the battlefield. How do we counter this new threat, asks **Christian Borys**

DRONE warfare, once the sole pursuit of the US military, is being democratised.

Islamic State (ISIS) has deployed consumer drones carrying grenades in the battle for the Iraqi city of Mosul, creating the most daunting problem US Special Operations Command troops faced in Iraq during 2016, according to their commander Raymond Thomas.

Groups around the world are taking advantage of the increasing accessibility of drone technology to build and deploy them as weapons (see “Home-grown drones”, right). And it’s not hard to imagine them being used in an

attack in the West; the bomber responsible for the May attack on a concert in Manchester used parts purchased locally and may have been trained in Libya.

To combat the risks, the US government is looking for broad legal powers to hack and destroy drones on US soil. So do drones carrying bombs really represent a credible next step in the evolving terrorist threat? And are existing countermeasures effective, or should other countries follow in the US’s footsteps?

In theory, the idea of drone terrorism should be like that of tank terrorism – far beyond a terror cell’s capabilities. But

while the US (along with its ally Israel) effectively held a monopoly on weaponised drones just five years ago, almost anyone can now build drones for combat, says Ulrike Franke at the

“Unlike just five years ago, almost anyone can now build and deploy drones for combat”

University of Oxford – and their evolution is being accelerated by the rise of weapons start-ups in conflict zones.

At the vanguard of these efforts is Matrix UAV in Ukraine, which is working on the world’s first

drone capable of firing anti-tank missiles. Operating from a decrepit Soviet-era building, the group’s offices are only slightly hidden away from the bustle of downtown Kiev. With a wingspan of roughly 1 metre, the drone isn’t slick like the Predator drone used by the US. But appearances are deceptive: it will be capable of taking out an armoured vehicle.

Flush with cash after an anonymous Ukrainian businessman invested in the group, Matrix UAV plans to have a working prototype test-firing the missiles within four months. CEO Yury Kasyanov, a former journalist and advertising executive, is hoping to export the drones to governments around the world for \$100,000 each.

That’s extraordinarily cheap compared with the price of Western-made military combat drones, which range between \$6 and \$14 million. It’s made possible by a massive fall in the

cost of consumer drones and cheap labour in Ukraine.

But if they can do it, so can others. In the hands of insurgents, a drone like this would offer the ability to sneak up on opposing forces and attack mechanised infantry, tanks, buildings and troops from the sky.

It would be a significant step up from the flying improvised explosive devices (IEDs) being used by ISIS in Iraq. As the Iraqi military began its push to take back ISIS-held Mosul last year, its troops were targeted by off-the-shelf drones with grenades strapped to them.

"Combatants weren't expecting that they'd have small bombs from these small drones raining on their necks," says Veli-Pekka Kivimäki, a Finnish military defence analyst.

Diversion tactics

Iraqi forces have now adopted the same tactic in retaliation (pictured, left and right).

Kivimäki believes these drones can play two significant roles on the battlefield. "The small drones have been used to eliminate key personnel, something that a sniper might do in an ordinary 20th-century army," he says, pointing to an ISIS propaganda video showing a drone dropping a grenade on a tank, killing a partially exposed soldier. They are also used to create a diversion, such as dropping a grenade into a group of soldiers before a suicide bomber strikes in the confusion.

And now, according to Thomas ISIS is using drones in an "almost swarm level capability" – deploying multiple fliers to the battlefield that can act and move as one.

Although there is no evidence that ISIS is developing combat drones as ambitious as the one being built by Matrix UAV, even the small, home-made weaponised drones are difficult to defend against. So what can governments do?

On the battlefield, even basic drones are proving to be such a problem that militaries are going to absurd lengths to shoot them down. In March, the BBC reported that a US ally had used a \$3 million "Patriot" missile to shoot down a

The French air force is deploying eagles trained from birth to take out drones

\$200 quadcopter drone.

That's why the hunt is on for an alternative take-down method. One possibility is the Drone Defender produced by Battelle, a military contractor based in Ohio.

The device has a range of 400 metres and looks like a rifle with a radio mast for a barrel. It was first spotted on the battlefield in Iraq in 2016. It operates by shooting a directed radio pulse, disabling the operator's control of the drone or disrupting its link to GPS satellites, causing it to fall out of the sky.

Since the first sighting, images of US troops and their allies armed with Drone Defenders have flooded onto social media. Franke says that there is now a rush to



Grenades can be dropped from drones

develop similar anti-drone systems, with about 10 per cent of R&D on military drone tech being pumped into countering them.

But these systems aren't without problems, says Franke. "You can't really use any of these in central London or at airports because they interfere with communications," she says.

This explains the rise of strange alternatives, like the French air force training eagles to take out drones. However, eagles aren't a much better option, according to one European military contractor

who asked to remain anonymous.

"First of all, they're expensive," he says. "On top of that, they take forever to train, and you can't use one to take out a swarm of drones. You'd need multiple eagles in that scenario. More importantly, ISIS has started using bigger drones than an eagle isn't strong enough or fast enough to take out."

Considering the complexity and ubiquity of the threat, it seems a smart move by the Trump administration to establish a set of laws by which the US government can rein in or destroy drones on US soil. According to a draft bill seen by *The New York Times* in May, the US government fears current surveillance and aviation laws could make such countermeasures illegal, hence the need for new legislation.

But as with all weapons and anti-weapons systems, it is an arms race, meaning we have to be prepared to counter an ever-evolving threat.

"In that regard, drones could eventually be used for assassinations," says Franke. "For example, a couple of years ago, there was a picture of German Chancellor Angela Merkel sitting on a panel and the German Pirate party, an opponent, flew a drone right up to her. Now when I look at this picture, I just think of how easily a group like ISIS could do the same with a weaponised drone or flying IED." ■

HOME-GROWN DRONES

Azerbaijan has previously relied on Israeli hardware for use in the Nagorno-Karabakh conflict with neighbouring Armenia, but now the small nation is producing its own miniature attack drone.

The drone, known as Impact, is derived from one made by Israeli firm Aeronautics. Weighing 20 kilograms with a wingspan of more than 3 metres, it can be carried in a backpack and assembled in just 10 minutes. It is equipped with a warhead developed by the Azerbaijan Ministry of Defence's Research Institute to defeat armoured vehicles, like tanks, by flying into them.

The best way to stop a small drone like this is to jam the signals between it and the human controller (see main story), but the makers claim that, unlike most drones, Impact can

navigate even when radio signals are blocked. In an interview with AzeriDefence.com in May, defence minister Yamar Jamalov claimed that Impact can operate autonomously when the radio link with the operator is lost, seeking out and destroying tanks from 100 kilometres away.

Imported drones can be expensive, and the Azeris have only acquired them in small numbers. Impact should be cheaper. In 2016 Jamalov said Azerbaijan will produce "hundreds" of the drones.

The move shows that small players can produce fleets of attack drones. It also suggests that jamming, seen as the easiest counter to small drones, could drive the development of "killer robots" capable of deciding which targets to attack without human supervision. David Hambling

How to spend it

Tech titan Jeff Bezos wants to splash his cash to make the world a better place. It's harder than it sounds, warns **David Auerbach**

JEFF BEZOS has turned to Twitter for advice on how to use his wealth for the greater good. Philanthropy is not a frivolous task, and Bezos, the founder of Amazon who is on track to become the world's richest person, is right to seek guidance.

Philanthropy is difficult, more so than entrepreneurship because it lacks the concrete metrics of profit and loss. Philanthropists have both the luxury and the burden of thinking big.

Giving most often succeeds when it supports existing, healthy structures. Investments made by the likes of Bill Gates and Ed Scott (dubbed Silicon Valley's "most effective global giver") into fighting AIDS, polio, malaria and tuberculosis have made a big difference. This is not just because they focused on the issues, but because structures like the World Health Organization and US



Centers for Disease Control are already effective and able to allocate extra resources well.

When structures are dysfunctional – often the case with education or urban economic development – results are less certain. Much of Mark Zuckerberg's investment to reform Newark public schools went to waste because money alone could not mitigate the rot of local and state governance, lack of expertise, and a glut of overpriced consultants and ed-tech snake oil.

Bezos has spoken of "helping people in the here and now... at the intersection of urgent need and lasting impact". This means tackling the trickier problems – education and crumbling urban infrastructure – in addition to health and emergency relief.

So how can he try to avoid the pitfalls? Bezos's philanthropy will be most powerful if it plays to his

Held at bay

At least our declining foxes have been spared the hounds, says **Stephen Harris**

TALK of resuming fox hunting is over for now after this idea was ditched by the UK's enfeebled Tory government last week.

It was always an odd manifesto promise. After all, fox hunting is not a high priority for most voters – the vast majority oppose lifting the ban. This feeling has grown and now includes 84 per

cent of rural voters. Traditionally, though, animal welfare has not been a big decider of how people actually vote.

A small group of Tories still counted on this being the case and got prime minister Theresa May to promise a free vote on bringing back hunting: despite assertions this was all about controlling fox

numbers and lamb losses, it was really about keeping a small pro-hunt rural vote on board.

It proved toxic, losing May votes and possibly her majority; animal welfare is important, especially to young voters.

The reprieve is welcome. The backdrop is the rapid decline in British foxes despite the 12-year hunting ban. The well-regarded British Trust for Ornithology estimated a 34 per cent fall between 1996 and 2014.

"This reprieve is welcome. The backdrop is foxes in rapid decline despite the 12-year hunting ban"

Why is less clear. Studies show that changes in fox numbers in Scotland from the 1960s to 1980s were related to food availability, not "pest control". Rabbits are an important food for foxes: as UK rabbit numbers have fallen to less than half, this may be the reason.

In any event, the classic "pest control" argument for hunting has had no teeth for some time. For example, there was no hunting for nearly a year during the 2001 foot and mouth outbreak when other forms of fox control were also curtailed. Yet fox numbers did not rise. Economic gains to farmers from predation on rabbits have also been shown.

and Amazon's existing strengths, beginning in the US.

Above all, Amazon knows how to get stuff to people. It has enhanced, supplemented, and sometimes replaced existing shipping infrastructure, as well as experimenting with new forms of delivery. The company's move into bricks-and-mortar stores with its purchase of Whole Foods will give it a significant physical footprint within communities, one that is likely to grow.

If Bezos can combine Amazon's shipping infrastructure with community-based efforts to distribute knowledge (skills training, apprenticeships, job matching) and access resources (community centres), he may actually be well placed to ease the deprivation that creates apathy and despair in his own nation.

Some see the new Silicon Valley philanthropy as a poor substitute for government and NGOs. This may well be true, but given the sclerotic US government and the uneasy populism racking Europe, it would be foolhardy to reject such philanthropy out of hand. Rather, we should encourage it even as we police it. ■

David Auerbach is a technology writer based in New York and a fellow at the New America Foundation

Sadly, evidence seems to play a minor role in the debate. A hard core of Tories remain committed to a resumption and, according to animal welfare groups, fox hunts routinely flout the law under the guise of "trail hunting".

Fox hunting is far from being consigned to history. But, if the political pundits have got it right, it looks as if its most prominent political supporter of late will soon find herself hounded to the point of exhaustion, cornered and torn apart. ■

Stephen Harris is a retired professor of environmental sciences and a world expert on foxes

INSIGHT Cosmetic procedures



CHRISTIAN VIERIG/GETTY IMAGES

Do my sunnies look big in this?

Selfie culture not to blame for rise of botox

Clare Wilson

ANOTHER day, another moral panic over what the youth of today are getting up to. This time it's because an appearance-obsessed selfie culture is apparently driving them to cosmetic procedures, such as getting botox injections, dermal and lip fillers and skin lightening - after all, doesn't every girl want to look like Kim Kardashian?

The claims come from a report on ethical concerns around cosmetic procedures by the Nuffield Council on Bioethics, a UK think tank.

The report makes it clear that regulations for these procedures need a face lift. Although plastic surgeons in the UK are regulated by the doctors' watchdog the General Medical Council, non-surgical cosmetic procedures can be provided by anyone, anywhere. Training courses and qualifications in the field do exist, but they aren't obligatory. As a result, plumping lip fillers, for instance, are often provided in beauty salons or even by those working out of their homes.

And yet, there is a whiff of people looking down their non-enhanced

noses. At a press conference last week, the authors of the report cited instances of people in their mid-teens seeking such procedures and claimed some practitioners were willing to provide them. But they had no figures on how often this happened.

The authors laid the blame on social media sites like Instagram and Snapchat, where appearance is all. They also cited TV programmes like *The Only Way is Essex*, in which the protagonists talk openly about their cosmetic procedures, and apps that let you simulate plastic surgery, some of

"This is part of the knee-jerk reaction to any problems affecting children - blame the internet"

which are aimed at children.

But there is no evidence that social media is to blame. It's hard not to suspect that this response is part of the knee-jerk, broad-brush reaction to any problems affecting children and teenagers, which is to blame everything on smartphones and the internet.

In fact, there seem to be few societal ills that haven't been laid at

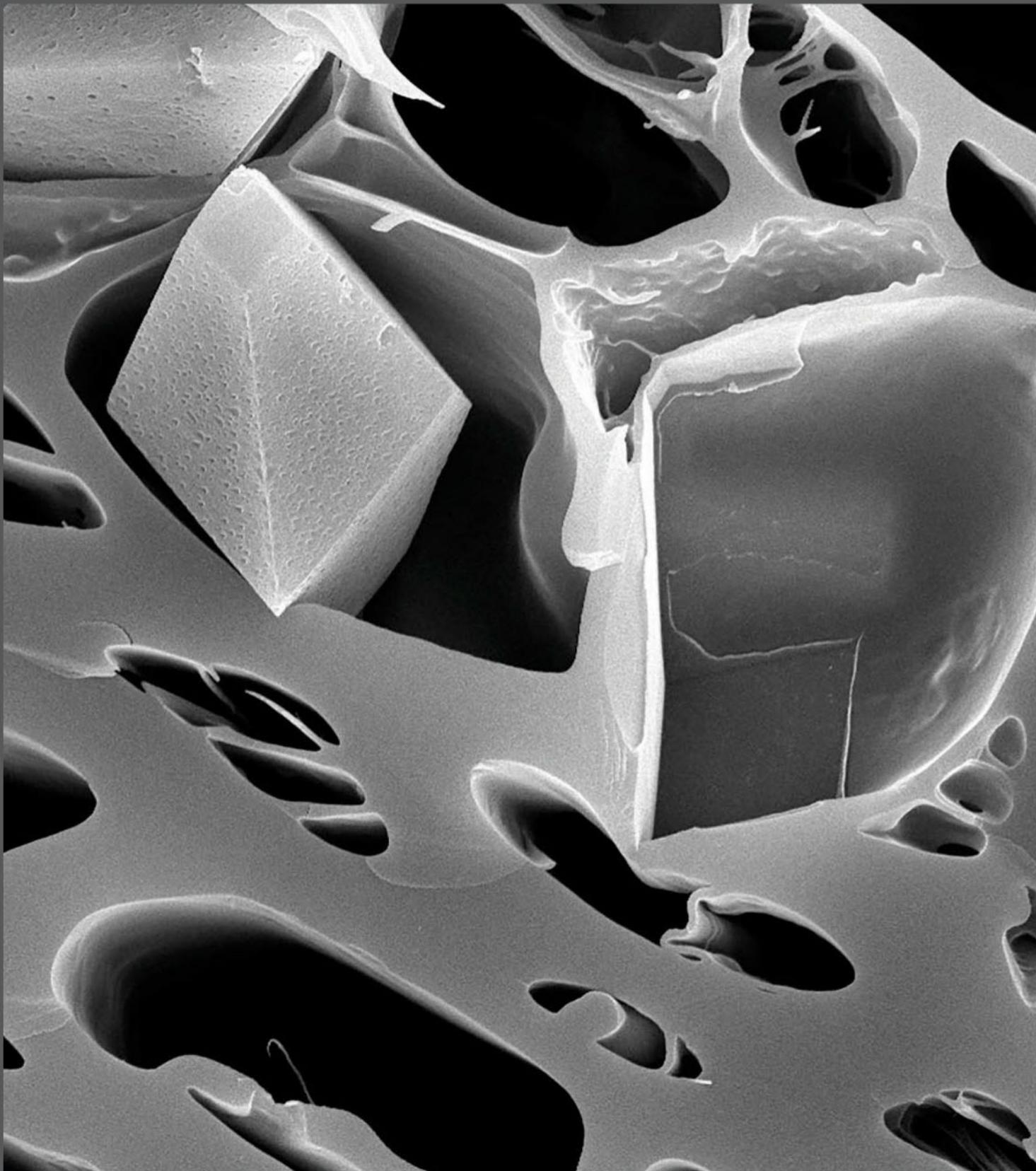
the door of the internet at one time or another. It has been charged with leading to violence, bullying, sleep deprivation, eating disorders, porn addiction and impotence. According to one recent claim, giving your child a smartphone is basically like giving them a gram of cocaine.

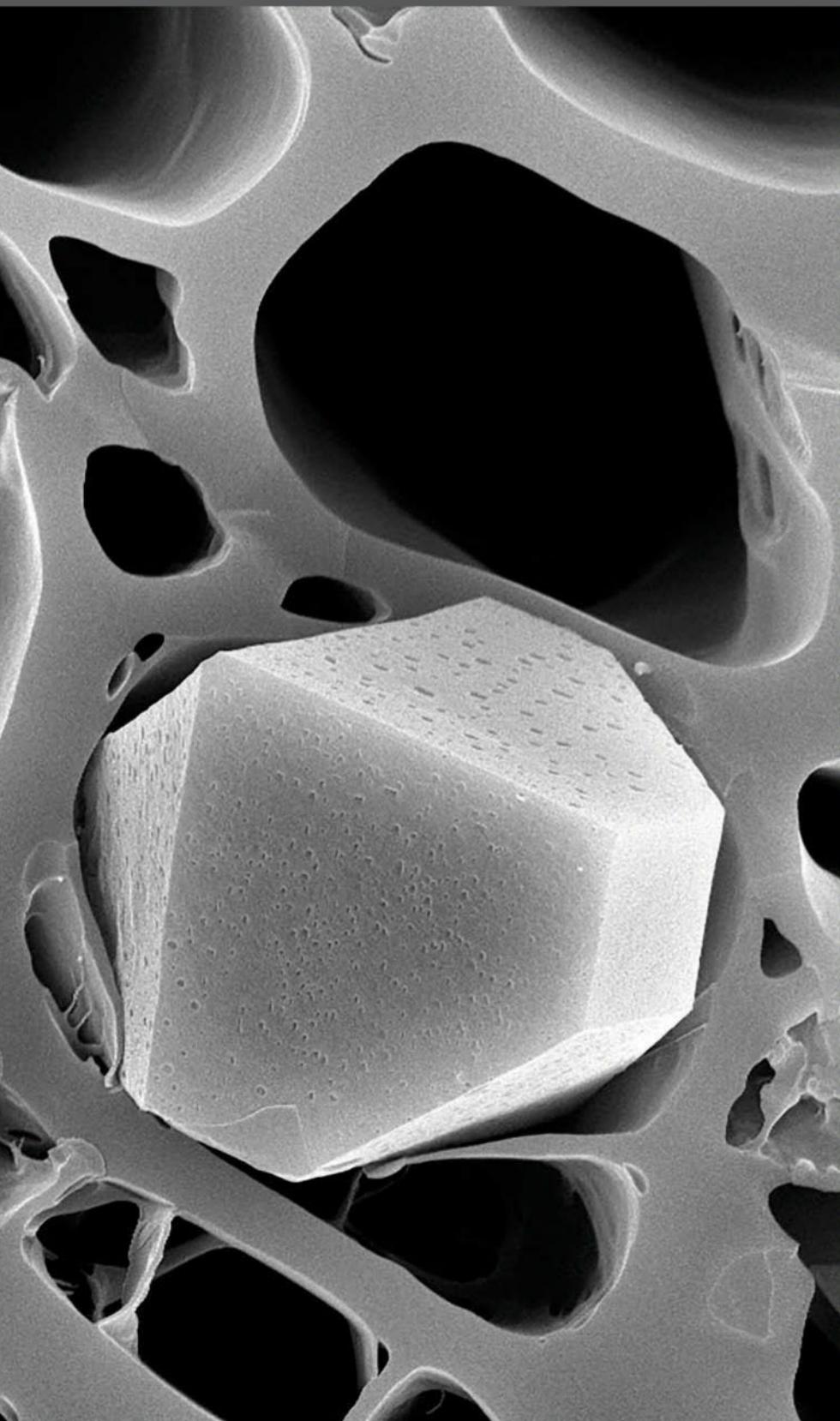
The Nuffield report does have some good recommendations, including that cosmetic procedures should be offered only by people who are properly qualified, and any products used, like dermal and lip fillers, should have regulatory approval. Fillers are a particular problem - more than two-thirds of plastic surgeons have seen people seeking help to correct bad results from these procedures, such as lumps and scars.

A ban on providing any cosmetic procedure to under-18s without a doctor's referral would also seem sensible, even if there are only a few cases - we already have such bans on tanning salons and tattoos.

But these problems are not the fault of social media sites - they are failures of government regulation of a £3.6-billion-a-year industry. It is contradictory to castigate app stores for hosting cosmetic procedure apps aimed at children when it isn't yet illegal to actually carry out these procedures on those children. So let's solve the real problem by going after the people offering these treatments, rather than blaming the culture of the teens that they prey on. ■

APERTURE





Ripe for burning

NO, IT ISN'T Swiss cheese, but a fuel source that warms many impoverished homes. This is charcoal, magnified 4000 times under a scanning electron microscope. Nestling within its cavities are crystals of calcium oxalate, a sign that the tree it was made from grew in calcium-rich soil.

In such conditions, trees take up calcium but cannot use it all, so store it in these crystals. "It's a beautiful decorative addition but it's no use to the plant," says Caroline Cartwright of the British Museum in London.

As part of the British Museum's Tropical Fuelwoods project - a collaboration with the Royal Botanic Gardens in London and Brazil's North-east Plants Association - Cartwright has been using electron microscopy to see which trees make the best charcoal. The specimen pictured was made from mimosa trees from Pernambuco in north-eastern Brazil, a poor region where charcoal is often used as a domestic fuel.

Cartwright has been making charcoal from different trees at a range of temperatures to see how the wood's cellular structure stands up to heat. The better it keeps its structure, the longer the charcoal can warm a family home. Clare Wilson

Photographer

Caroline Cartwright

The Trustees of the British Museum

Our bodies may be ageing faster or slower than our birthdays suggest. **Helen Thomson** explores what your real age reveals about the time you've got left

How old are you really?

AGE is a peculiar concept. We tend to think of it as the number of birthdays we have celebrated – our chronological age. But this is just one indicator of the passage of time. We also have a biological age, a measure of how quickly the cells in our body are deteriorating compared with the general population. And these two figures don't always match up.

Just take a look around: we all know people who look young for their age, or folks who seem prematurely wizened. Even in an individual, different parts of the body can age at different speeds. By examining how chronological age lines up with biological age across the population, researchers are starting to pin down how these two measures should sync up – and what it means for how long we have left when they don't.

In recent years, studies have shown that our biological age is often a more reliable indicator of future health than our actual age. It could help us identify or even prevent disease by tracking the pace at which we're getting older. It may even allow us to slow – or reverse – the ageing process.

I became interested in my biological age after discovering in my 20s that my ovaries were ageing prematurely. Yet now, at 33, I am still often asked for identification when buying alcohol, suggesting my face is holding up pretty well. It made me wonder about other aspects of my biological age, and whether knowing more might help me to live a longer, healthier life. So, I set out to answer the question: How old am I really?

Ageing is the progressive loss of function accompanied by decreasing fertility and

increasing mortality, according to Thomas Kirkwood from the Institute for Ageing at the University of Newcastle, UK. Surprisingly, it's not universal across species. The *Turritopsis dohrnii*, or "immortal jellyfish", can revert to a larval state and turn back into an adult indefinitely, for instance. We don't have that luxury. According to the UK Office for National Statistics, I can expect to live to 83.

The most widely cited theory of ageing is that telomeres, genetic caps on the ends of chromosomes, grow shorter each time a cell divides – like a wick burning on a candle. Once these are used up, the cell withers and dies. But a new idea gaining ground suggests ageing is instead a byproduct of how energy intensive it is for our bodies to continuously repair faults that occur in our DNA as cells divide. "It doesn't make evolutionary sense to maintain that process for ever," says Kirkwood. Indeed, several animal studies have shown that genes that affect lifespan do so by altering cells' repair mechanisms. Little by little, faults build up in cells and tissues and cause us to deteriorate.

This is where biological age comes in – it attempts to identify how far along we are in this process. It's not a simple task, because no one measure of cellular ageing gives a clear picture. As Kirkwood says, "Attempts to measure biological age have been bedeviled by the difficulty of taking into account the many different biological processes at work."

Still, a growing number of researchers have taken up the challenge. Before seeking them out, however, I began to wonder whether I could be in for a nasty surprise. When Daniel Belsky and his team at Duke ➤

How old is my brain?

Just like the rest of our body, the brain can sometimes age quicker than we do (see main story). Now researchers at Imperial College London have a way to find out how old the brain really is. James Cole and colleagues trained a computer algorithm to estimate age based on brain images from 2001 healthy people, then tested it on a new group of people to see how old their brains seemed to be.

They found that people whose brain age was older than their chronological age had poorer lung function, slower walking speed and an increased risk of death. Those with older brains also performed worse on tests of logic and pattern recognition.

What makes the brain age prematurely? High blood pressure, smoking and high cholesterol seem to accelerate brain ageing, possibly by affecting the blood vessels that carry oxygen and essential nutrients. Long-term stress has also been shown to speed up memory loss in older adults. And shift work has a big impact: more than 10 years of shift work can accelerate brain age by around 6.5 years.

Exercise seems to be key to mitigating these harms. The brains of elderly people who regularly exercise look 10 years younger than those who don't.



University in North Carolina studied 18 different markers of cellular ageing – including blood pressure and cardiovascular function – in almost 1000 adults, they found that some were ageing far faster or slower than their birth certificates would suggest. One 38-year-old had a biological age of 28; another's was 61.

So if I have an accelerated biological age, does it mean I'm less likely to make it to 83? Studying humans until they die takes a long time, so the causal relationship is tricky to pin down. But an increasing number of studies suggest this is a fair assumption. Belsky's team found that 38-year-olds with an older biological age fared worse on physical and mental tests, for instance. And when James Timmons and colleagues at King's College London examined expression of 150 genes associated with ageing, they found that biological age was more closely tied to risk of diseases such as Alzheimer's and osteoporosis than chronological age.

Braced for a rocky ride, I started the hunt for my real age by looking in the mirror. In 2015, Jing-Dong Jackie Han and colleagues at the Chinese Academy of Sciences in Shanghai analysed 3D images of more than 300 faces of people between 17 and 77 years old, and

created an algorithm to predict age. When they used it on a new group of faces, they found that people born the same year differ by six years in facial age on average, and that these differences increase after 40. (See "Written in your face", below.)

"Some molecular changes in the body can be reflected on the face," says Han. High levels of low-density cholesterol (the "bad" kind) are associated with puffier cheeks and pouches under the eyes, for instance. Dark circles under the eyes can result from poor kidney

"The result was a win for me: I apparently have the face of a 25-year-old"

function or blood circulation. The message is that if we look older than we should, it could be a sign of underlying disease.

The algorithm was developed using a population of Han Chinese people and so far has only been tested in four Caucasians. So, as a white woman, I had my face analysed by a similar algorithm designed by anti-ageing company Youth Laboratories in Russia. The result was a win for me: I apparently have the face of a 25-year-old.

Next it was time to draw some blood. Using 32 different parameters that reflect disease risk, a team at the company Insilico Medicine developed a deep-learning algorithm to predict age. After training it on more than 60,000 blood samples of known chronological age, they used it to accurately predict age from new samples to within 6.2 years. The team found that people whose blood age was higher than their actual number of years were more likely to have health problems. The algorithm is free to use, so after I had my blood taken by Medichecks in London, I plugged in my details at www.aging.ai. Reassuringly, it shaved off a couple of years, estimating my real age to be 31.

Another method for measuring biological age is to look at how complex carbohydrates called glycans are attached to molecules in the body, a process called glycosylation. Gordan Lauc and colleagues at the University of Zagreb in Croatia recently discovered that glycosylation of an antibody called immunoglobulin G changes as we get older, and that this can be used to predict chronological age. When Lauc's team compared 5117 people's "glycan age" with known markers for health deterioration, such as insulin, glucose, BMI and cholesterol, they found that those who scored poorly on these markers also had an older glycan age.

"Your glycan age seems to reflect how much inflammation is occurring in the body," says Lauc. Prolonged inflammation can make cells deteriorate faster, so having an accelerated glycan age could be used as an early warning signal that your health is at risk, he says.

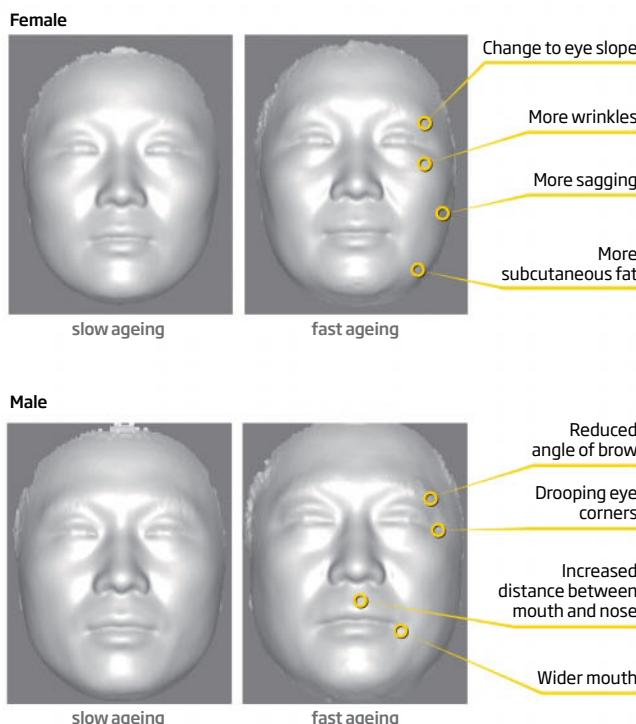
Lauc and Tim Spector, a genetic epidemiologist at King's College London, founded GlycanAge – a company that tests people's glycan levels – and kindly tested mine for free. It turns out my glycan age is just 20, a whopping 13 years younger than I am.

With a new spring in my step, I moved on to what is now considered the most accurate way to measure human ageing: an intrinsic "epigenetic" clock present in all our cells. Epigenetics refers to the process by which chemical tags called methyl groups are added to or removed from DNA, which in turn influences which genes are switched on or off. Some changes in methylation patterns over time can be used to estimate age.

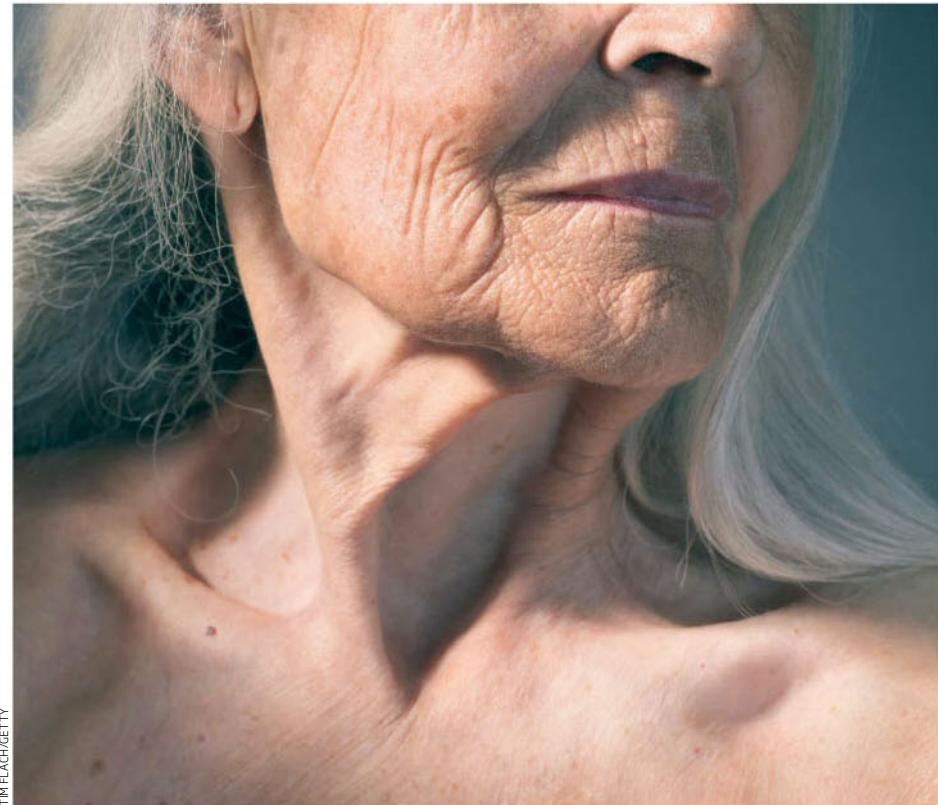
The father of this technique is Steve Horvath at the University of California, Los Angeles. In 2011, looking at methylation patterns in blood samples, Horvath and colleagues were able to predict chronological age to within five years. He has since analysed

Written in your face

After taking 3D images of 300 faces, Jing-Dong Jackie Han and colleagues at the Chinese Academy of Sciences, Shanghai, created composite images of people of the same chronological age (about 45) but markedly different facial ages. Older looking faces are characterised by more wrinkles, wider mouths and several other factors (see right). For most of these things, men and women are equally affected. But there are two notable differences. As men get older, their noses protrude more – something that may have to do with the effect of testosterone on cartilage growth. For women, the buildup of a certain kind of cholesterol can make the face appear more "fleshy", particularly in the cheeks and under the eyes.



SOURCE: JING-DONG JACKIE HAN, CHINESE ACADEMY OF SCIENCES SHANGHAI



TIM FLACH/GETTY

data from more than 13,000 samples and identified methylation patterns to estimate a healthy person's age to within 2.9 years. "The age estimate is so accurate it continues to amaze me," says Horvath. (Unfortunately, for the purposes of my investigation, at \$900 a pop, I decided to give this test a miss.)

Horvath is also interested in discrepancies between our chronological age and epigenetic clock, which diverge most drastically in cancer tissue. Trey Ideker, a medical researcher at the University of California, San Diego, and his colleagues discovered that the epigenetic age of kidney, breast, skin and lung cancer tissue can be almost 40 per cent older than the person it came from.

A recent study by Horvath and his team suggests that breast tissue from healthy women aged 21 appears 17 years older than their blood, which tends to correlate closely with their chronological age. This difference decreases as we get older; for women aged 55 years, breast tissue appears around eight years older than blood. By identifying what the normal differences are, researchers hope to flag outliers. "Ultimately, we want to be able to collect data from a particular organ, or from a surrogate tissue and say, 'wow, this woman has breast tissue that is 20 years older than it

should be, so she needs to be monitored more closely for breast cancer,'" says Horvath.

Beyond monitoring and aiding diagnoses for diseases, can any of these measures give us a better idea of how much life we have left? There is an association between our epigenetic clock and our time to death, but it's not very accurate – yet.

In his analyses, Horvath found an association between accelerated epigenetic ageing – an older epigenetic age compared with your real age – and time to death.

"It sounds like science fiction... but in theory it's possible to reset the clock"

Around 5 per cent of the people he studied had an accelerated epigenetic age. Their risk of death in the next decade was about 50 per cent higher than those whose epigenetic age lined up with their actual years.

If our epigenetic clock is ticking down to our death, is there anything we can do to intervene? Horvath has started studying the epigenetic age of induced pluripotent stem cells (iPSC), which are adult cells that can be pushed to revert to an embryonic-like state,

from which they are capable of turning into most types of cells in the body.

The epigenetic age of iPSCs is zero. Transforming normal body cells into stem cells would be an "extreme rejuvenation procedure", Horvath says. You wouldn't want to do it to all of your cells, but perhaps it's a strategy that could be modified to intervene with the ageing process. "It sounds like science fiction, but conceptually it's possible," he says. "All epigenetic marks are reversible so in theory it's possible to reset the clock."

Turn back time

Another promising, if speculative, plan might be to freeze blood stem cells when you are young so that you can use them to reconstitute your immune system when you are old.

Short of miraculous anti-ageing treatments, understanding more about biological age can still improve our health. People told their heart age – measured using parameters such as blood pressure and cholesterol – are better able to lower their risk of cardiovascular problems compared with people given standard information about heart health, for instance. (My heart, I learned, is 28 years old.)

There are not yet any placebo-controlled trials to determine whether certain lifestyle interventions can reduce biological age, and so risk of early death. But Horvath did find that the epigenetic clock is accelerated in the livers of obese people, and ticks more slowly for those who regularly consume fish and vegetables, and only drink in moderation.

Unsurprisingly, exercise also seems to help. In a trial of more than 57,000 middle-aged people, those whose fitness levels resembled a younger person's were less likely to die in the following decade or so. Fitness-associated biological age was a stronger predictor of survival than chronological age.

And we may get more conclusive results soon: Spector is about to begin a trial to see if an intensive exercise and diet regime can reduce glycan age. Han is planning a similar trial to see if exercise can influence facial age.

There is still a long way to go before we can pinpoint the exact ways to reverse ageing. But for now, I'm relieved to know that most of my body is younger than my years would suggest and, in the not too distant future, knowing my biological age could hold the key to preventing disease or even postponing death. I'll happily celebrate turning 34 in the knowledge that my age really is just a number. ■

Helen Thomson is a consultant for *New Scientist*



**FIND
MORE
FREE
MAGAZINES**

FREEMAGS.CC

Find the flow

What are the rules that govern how living things flow?
Kate Ravilius tracks down a new law of nature

DAVIDE MARENDOZZO watches as the synchronised swimmers rhythmically precess around the edges of the pool. He's in charge here; he founded this troop and directs their every move. He'll have them practising like this as long as he likes.

Even though he's a hard taskmaster, the swimmers aren't complaining – but then bacteria rarely do. For that's what Marenduzzo is playing with, and it's no swimming gala they are competing at. All that training is in aid of a quest to uncover new laws of physics.

Marenduzzo is one of a number of scientists seeking laws that govern fluids teeming with living things. It might be sperm cells on their way to an egg, a fleet of bacteria off to stir up trouble in your guts or a flock of birds heading for their wintering grounds.

The idea that these disparate types of flowing life could obey universal laws of nature seems almost untenable. Yet Marenduzzo and others are uncovering some of the first hints that they might.

Turning those hints into a fully fledged theory won't be easy, but the reward would be amazing. Technologies like self-pumping fluids could be possible and doctors might find they can understand, predict and maybe control the flow of cells – providing a powerful novel approach to medicine.

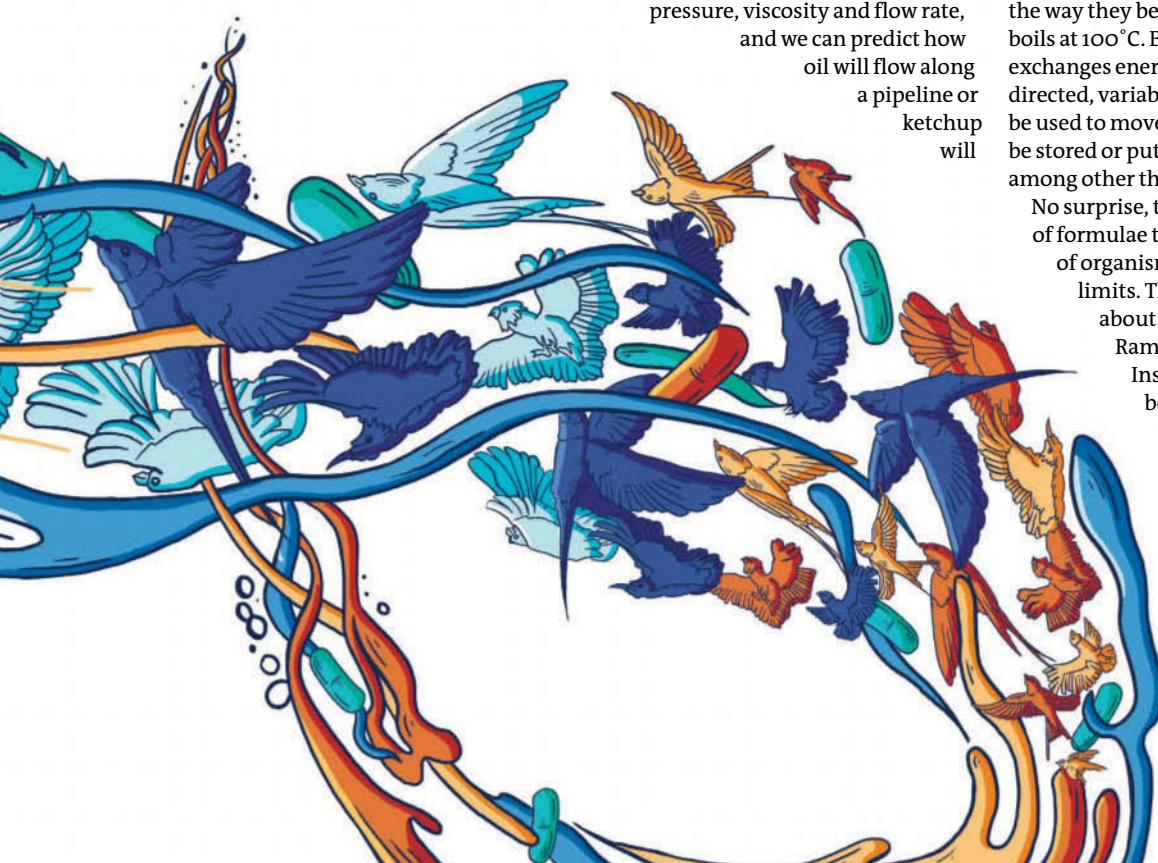
When it comes to understanding the flow of fluids like air or water, our footing is reasonably solid. The equations of fluid dynamics can predict the flow of gases and liquids, at least until they become turbulent. Measure a few basic parameters such as pressure, viscosity and flow rate, and we can predict how oil will flow along a pipeline or ketchup will

ooze from its bottle. These laws are dependable: any time you take off in an aeroplane, you can be sure the crafted flow of air around the wings will keep you aloft.

All that is true only as long as the fluid is made from inanimate molecules – add in something alive and the ordinary equations go out the window. The living thing and the fluid each affect the flow of the other, with the overall result impossible to predict. "You get this incredibly complicated turbulent flow, driven by the movement of the living things," says Hermes Gadêlha, a mathematician at the University of York, UK.

The heart of the problem is energy. When the molecules in a liquid absorb energy, they move faster until a predictable point at which they change phase. That means they alter the way they behave entirely, like when water boils at 100°C. But a hallmark of life is that it exchanges energy with its environment in a directed, variable fashion. The energy might be used to move around, but it might equally be stored or put into power metabolism, among other things.

No surprise, then, that finding a neat set of formulae to explain the flow of all sorts of organisms was long considered off limits. That only began to change about 15 years ago when Sriram Ramaswamy, now at the Indian Institute of Science in Bangalore, began to think about materials that are the tiniest step away from being inanimate. Imagine, for example, something that has no senses or metabolism, but can use energy to propel itself. Work out rules for these so-called non-equilibrium systems, thought Ramaswamy, and we would at least have a start.



Ramaswamy is an expert on liquid crystals – materials used in some display screens – which can flow like a liquid but only in restricted ways. So he wondered if it would be possible to tweak the established equations we have for describing liquid crystal flow for the simplest possible non-equilibrium systems. He and his then PhD student Aditi Simha had a go. The equations they came up with predicted that as the concentration of the particles in non-equilibrium systems increased, they would start to align into a flowing state.

By 2007, those predictions had aroused interest from experimentalists who joined Ramaswamy to put them to the test. They placed thousands of copper rods, each the size of a grain of rice, into a vibrating container and took photographs every 15 seconds. The

whirlpool idea using a chemical to suppress the activity of the protein filaments. As they added more chemicals, the rotation of the nucleus drastically slowed and became less smooth. That proved the filaments were driving the flow, and the speed and pattern of the rotation fitted the same tweaked liquid crystal equations that had worked for the rods.

By now, Ramaswamy had started something. More researchers began pitching in, trying to predict how various biochemical bits and bobs flowed. Some started to call the field “active matter”, reflecting the fact that the components didn’t just respond passively to energy but used it in directed ways. But the real goal was to develop laws that would apply to whole living things.

Graduate to that league, and the active parts of the fluid become really unpredictable. To get started, we needed to break the problem down and first understand how one living thing influences the fluid flow around it. Take *Chlamydomonas reinhardtii*, a microscopic green alga. This single-celled critter has two tentacle-like flagella that it uses to swim with a breaststroke motion. But it’s a wonder it gets anywhere at all. “For things this tiny, their world is dominated by viscous forces. For them, water feels like honey does to us,” says Dmitri Pushkin, a mathematician at the University of York.

Recent studies have shown in fine detail how the algae overcome the viscosity by twisting their bodies as they swim. Armed with that knowledge, Pushkin wanted to look at how the algae affect the way the fluid flows around them. He and his team added thousands of microscopic polystyrene beads to a tank of the cells and then took photographs 500 times a second. If the fluid

“Add something living to a liquid and fluid dynamics is out the window”

vibrations imparted a little energy to each rod, enabling it to move around. The rods lay flat, because the container was less high than they were long. At low densities, the rods moved around randomly as expected. But at higher densities, the rods began to align into flowing clusters that were jammed together in some places and more sparse in others (see photo, below right). The rods moved in an organised manner without the need for any controller. “We showed that motile but non-sentient things can produce flocking characteristics,” says Ramaswamy.

The whole thing was reminiscent of a phase change: at a certain, predictable density, the copper rods changed their behaviour fundamentally and began to flock almost like birds. It was the first sign that predicting aspects of how living things flow might be possible. Of course, copper rods aren’t that interesting in themselves – which is why Ramaswamy wanted to see if the rules applied to something closer to life.

He decided to investigate inside connective tissue cells called fibroblasts. A curious fact about them is that their nucleus slowly rotates, although we didn’t know how or why. Ramaswamy and Simha conjectured that protein filaments in the cell, driven by molecular motors, might be moving together and whipping the cell’s cytoplasm into a whirlpool that the nucleus rides. It’s a system that’s a step up in complexity from the copper rods.

The duo and their colleagues tested their



were inanimate, you would expect the beads to be randomly buffeted by the water molecules, a process called diffusion. Pushkin expected that the movement of the algae might make the beads spread out a bit faster than that – perhaps 10 times faster.

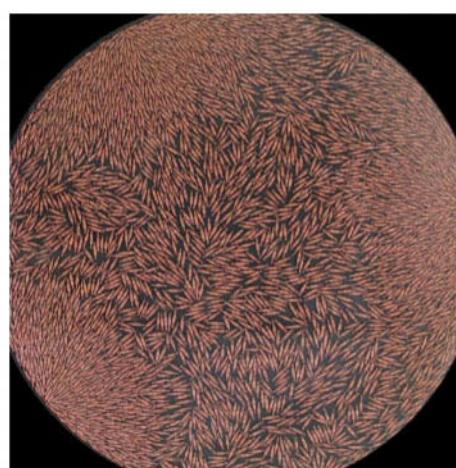
In the zone

When the results came in, the beads actually dispersed about 500 times faster than diffusion would allow. Pushkin thought the experiment must be faulty, so he reran it several times. He realised that although most of beads followed loop-like patterns, surfing the currents created by the flagella, about one in five was caught in a dead zone in front of the swimming cells and carried long distances. “It is quite a rare occurrence,” says Pushkin. “But the effect it has is enormous.”

That dead zone might prove to have been evolutionarily important. The flagella-breaststroke technique is common in algae, perhaps because having morsels of food trapped in the dead zone makes it easier for the cells to eat.

Pushkin’s work is also edging us towards equations for describing how the algae affect the fluid. Taking the equations that describe diffusion, Pushkin added a term to describe the dead-spot effect and produced a formula that could predict the patterns of fluid flow around the cell.

That equation is a far cry from a fully fledged description of active matter. Still, we’re already beginning to see how these



VIJAY NARAYAN



The laws of living flow - if they exist - would govern everything from sperm (below) to starlings

STEVE KNELL/NATUREPL.COM

sorts of things could be handy in real life.

That much is apparent just down the corridor from Pushkin's lab, where Gadélha is studying sperm. We know that the little swimmers swish their tails 20 times a second to move themselves along, but again it is a mystery how they get anywhere, because the fluid feels so thick to them. Gadélha has been documenting the sperm movements with greater precision than ever before and feeding the information into a computer to model the patterns of fluid flow around them. He plans to use those models to improve the way we assess fertility.

Male fertility is normally measured by counting sperm and assessing their swimming ability by monitoring the path their head follows. But using that method, "it's really hard to determine whether someone is going to have trouble or not", says Gadélha. His model would instead identify the sperm that are best at powering through the fluid, which he thinks will be more accurate.

However, if we want laws that explain the whole shebang – fluid and multiple cells at once – the maths Gadélha and Pushkin are working on isn't enough. It only describes the effects of one cell on its surrounding fluid. In reality, cells often move in swarms, and it's their collective motion that affects the overall flow. That's why Marenduzzo is watching his synchronised swimmers.

He began with an experiment reminiscent of Ramaswamy's jiggling copper rods. In 2011, Marenduzzo and his colleague Wilson Poon, both at the University of Edinburgh, UK,

showed that when they increased the concentration of a soup of *E. coli* beyond a certain threshold, the bacteria suddenly began to cluster. Once again, it was a bit like a phase change. "Once some bacteria slow down, they start to accumulate, which leads to more bacteria slowing down and accumulating," says Marenduzzo. Curiously, the clusters always rotated, as if doing laps.

This got Marenduzzo and others wondering if, once we have understood these flows, we could put them to work. One way to get started is to capitalise on the fact that *E. coli* instinctively avoid light. Marenduzzo did some computer simulations that suggested it would be possible to use light beams to herd

How they work is still uncertain, but these are self-pumping fluids

the bacteria into small areas, whereupon they would become concentrated and start to swirl.

In an unpublished experiment, Roberto Di Leonardo at the Sapienza University of Rome has made this real. He took *E. coli* that have been genetically modified to respond to particular wavelengths of light and herded them into pockets on a custom-built, microscopic Ferris wheel, which rotates as they push.

Arrays of these rotors might one day be tools in medicine. Di Leonardo imagines capsules equipped with arrays of these motors, some to propel them through the bloodstream and

others to pump out a payload of drugs when they find biomolecular cues signalling disease.

That is a while off, but the motors could soon be used in microfluidic chips. These tiny devices are etched with even tinier channels. Water flows very neatly when confined in these channels, meaning several chemical reactions can be done one after another in a minuscule space. Such chips are used as simple kits for checking water quality or diagnosing disease. "But currently we have to find ways of pumping fluid around the chip," says Di Leonardo. He reckons the bacterial pumps might be the perfect solution, because they can be engineered to self-regulate, adjusting the pressure they pump at for different tasks.

Despite these advances, those hunting the laws of living flows still have a long way to go. It's not clear whether any of the equations so far developed could apply to multicellular life.

But the rules of active matter don't have to be used to describe natural things – there is also a world of synthetic active matter to be explored.

Marenduzzo and his colleagues have a research programme to design new classes of active materials built from synthetic components. The idea is to create materials that will flow in response to stimuli in programmed ways, for example, repairing themselves by backfilling after a fracture.

It's early days, but the potential was illustrated in a recent breakthrough from the lab of Zvonimir Dogic at Brandeis University in Waltham, Massachusetts. His team had previously combined fibre-like biomolecules called microtubules, a protein called kinesin that walks along them and a fuel molecule. The resulting material united natural components in an unnatural way and flowed by itself in intricate whorls.

A few months ago, Dogic showed the same material can be used to drive water through a microscopic pipe. He doped water with 0.1 per cent of the mixture and injected it into doughnut-shaped tubes. In tubes with a rectangular cross section, the motion was random, but in roughly square tubes, the water was driven round coherently. By cutting microscopic notches in the tube, the researchers could also control the direction of the flow, which was about as rapid as typical microfluidic devices and persisted for at least a metre. "We still need to pin down the theory," says Dogic. "But essentially we've invented self-pumping fluids." ■

Kate Ravilious is a science writer based in York, UK. For videos of the flows described in this article, go to newscientist.com/issues/3132

BETWEEN the still waters of Lake Gruyère, held back by the Rossens dam, and the pretty town of Fribourg, the Sarine river winds lazily through western Switzerland. It's a picture of bucolic tranquility. One day last September, though, it was anything but. Suddenly, great torrents of white water came rushing from the base of the dam. With spectators crowding vantage points and a drone capturing footage from above, it looked for all the world like a catastrophic engineering failure. In fact, it was quite the reverse.

This stretch of the Sarine hadn't run free since it was dammed for hydropower more than half a century ago, restricting its capricious flows to a predictable near-trickle. It is a story repeated around the world, with nearly half of the planet's major river systems choked by dams. They bring important benefits, not least renewable energy, but come with a high ecological cost. Where people once marvelled at these triumphs of engineering, many have come to see dams as an environmental liability. But what if all that concrete could be part of the solution?

That's what the scientists behind the artificial flood released on the Sarine are attempting to find out. They want to unleash regular designer deluges, carefully calibrated to restore the river's natural rhythms. The idea is to give us the best of both worlds: to keep our dams without destroying the ecosystems they exploit. The results are just beginning to dribble in, but they offer hope that dammed rivers may not be damned forever.

We have built a staggering number of dams: on average, a dam 15 metres tall or higher has been constructed each day for the last 130 years. Europe now has about 7000, the US roughly 9200. Counting smaller structures, the total rises to more than 800,000 worldwide.

This dam-building bonanza has delivered on its promise to provide clean energy, a boon as we try to break our addiction to fossil fuels, plus fresh water for drinking and irrigation. The Hoover dam in the US (pictured right), for example, generates about 4 billion kilowatt-hours of electricity per year – enough to serve 1.3 million people – and can store up to 9.2 trillion gallons of water. But none of this is much good for rivers, or the ecosystems they support.

Dams have helped make riverine ecosystems some of the most vulnerable on the planet. These habitats are losing species much faster than their terrestrial or marine counterparts, and their bellwethers – freshwater fish, including Europe's eight species of sturgeon and the European eel – are disappearing

Damned if you do...

They give us green energy but destroy precious river ecosystems. What can we do about dams, asks Terri Cook

at alarming rates. Some 39 per cent of freshwater fish in North America are now considered imperilled, and the numbers are nearly as high across the countries of the European Union.

That isn't all down to dams, of course, but they are a big part of it. Most obviously, migratory fish can no longer make it up blocked rivers to reach their spawning grounds. There can be few more visceral reminders of the disruption dams cause than the sight of salmon paddling in vain against a looming concrete wall.

But the issues with dams go deeper. Every river has its own personality, defined primarily by the rhythms of its flows – the daily, seasonal and annual shifts in timing and volume as the river thunders or trickles from source to sea. Collectively, these rhythms shape the habitats created by rivers and in turn the flora and fauna that live in and around them, says Julian Olden, an ecologist at the University of Washington in Seattle.

Dams break this natural variability.

Depending on the type of hydropower plant, reservoir water is released in a constant flow to produce a steady source of electricity, or at a rate that varies in response to peaks in demand. Either way, dams keep more than just water behind the wall: they trap sand and mud, too. Downstream, this can force the river to scour existing sediment from its bed and banks as it tries to regain its natural equilibrium, transforming the shape and roughness of the channel, and making life tough for fish trying to spawn on the riverbed. The blockage can also drastically reduce the delivery of the organic material and nutrients vital for sustaining the base of any river's food web.

It really is a case of "damned if you do," says Olden. As we have come to understand this dilemma, more and more people have asked whether the renewable energy and other benefits dams bring are really worth it, given the damage they do. Increasingly, in the West at least, the answer is no.

So what can we do? One solution is to



JAMEY STILLINGS

"The idea is to recreate the natural rhythms of rivers through controlled deluges"

remove the dams and let the rivers run free again. In the US alone, more than 1000 dams have been demolished in the past 70 years, with half removed in the last decade. Although most were small structures that had outlived their intended purpose, in some cases authorities have seen fit to demolish major dams, including two megastructures on the Elwha river in Washington state. Just days after the second came tumbling down in 2014, native fish, including chinook and coho salmon, ventured back upstream. But although studies show that rivers tend to respond quickly when dams are dismantled, it isn't often a viable option.

Concrete solution

One problem is that it can be extremely expensive. Taking down the Elwha dams cost \$26.9 million, and the restoration project as a whole is expected to exceed \$320 million. The US government was prepared to stump up only because it was a special case: the vast majority of the river lies within a national park, and the dam had failed a safety inspection, potentially leaving the Lower Elwha Klallam tribe downstream in harm's way. Add the fact that people still want the water and renewable power, and you can see why there is precious little political will to decommission most major dams.

Ecologists aren't giving up that easily.

Instead they have come up with a clever solution: using the dams themselves as conservation tools. Their big idea is to recreate the natural rhythms of free-flowing rivers through controlled deluges – and it is already being put to the test.

The most spectacular example was the huge pulse of water released in 2014 from the Morelos dam, on the Colorado river at the border between the US and Mexico (see "Just add water", opposite). But like almost every other artificial flood release so far, it was a one-off. You can't possibly recreate the myriad differences in flow, temperature and sediment delivery of a free-flowing river with one release, says Olden.

To really figure out whether artificial floods can restore a river's habitat, we need repeated inundations. Here the challenges run deep. There must be enough water stored in the reservoir, for starters. Then you need to get permission from the dam's managers to conduct the releases at times that would make sense not economically, but ecologically, according to records of the river before it was dammed or observations of the natural rhythms of similar rivers. All of this explains why, despite ecologists and water managers managing to push through large artificial flooding experiments at more than 100 dams in 20 countries, the vast majority have been one-offs. "Long-term environmental flow programmes are a rare breed," says Olden.

Switzerland's Spöl river is the place where the idea of repeated floods was first put to the test. Its sparkling waters flow from the Swiss-Italian border through a deep limestone gorge before joining a tributary of the Danube. But despite its path through the Swiss National Park, the Spöl was dammed at two sites for hydropower in the 1960s – and when the dam gates closed, the ecosystem suffered.

Within a couple of decades, the absence of floods had allowed woody vegetation, including fir trees, to grow in the riverbed, says Chris Robinson, an ecologist at the Swiss Federal Institute of Aquatic Science and Technology. The channel was choked with fine-grained sediment eroded from the river's steep banks, degrading the spawning grounds of brown trout. The stable, low-flow environment also favoured creatures not normally present in free-flowing Alpine streams, especially a group of crustaceans called *Gammarus*. They basically overran the Spöl, says Robinson, making up a startling 90 per cent of the dammed river's fauna by the time ecologists started looking closely.

When Thomas Scheurer at the Swiss Academy of Sciences received a report detailing the sorry state of the river in 1990, he decided something had to be done. "It was obvious that floods could improve the situation, but we had no concept of how to handle it," says Scheurer, who oversees research within the national park.



RESEARCH GROUP FOR ECOHYDROLOGY - ZHAW
Swollen on purpose:
the Sarine river in
Switzerland last year

The first step was to engage with the Engadin Hydropower Company, which operates the dams, as well as scientists, park managers and federal and local officials. Without a legal framework or a way of paying for “lost” hydropower revenue, there was always going to be resistance. But after years of negotiations, Scheurer got the nod for regular inundations, which began in 2000.

Flushed out

Dam operators have since unleashed dozens of artificial floods on the Spöl. It took a while to fine-tune them for the optimal timing and volumes required to flush out the crustaceans without losing too much sediment, says Robinson, but the results are encouraging. Twice-yearly torrents seem to be enough to keep the crustacean population sufficiently low to allow native invertebrates such as mayflies and stoneflies to flourish, he says. And brown trout are once again thriving as their spawning grounds are no longer clogged with fine sediment.

The long-term programme on the Spöl has not only paid off in terms of the river’s ecological restoration, says Scheurer; it has also encouraged others to pursue a similar course. The Swiss Federal Office for the Environment, for example, is planning to use artificial floods at 40 Swiss hydropower installations over the next 13 years. It’s one of the ways it hopes to fulfil a promise enshrined in a recent revision to the country’s Water Protection Act, to reduce the ecological impacts of hydropower plants by 2030.

Already the lessons are being applied to the Sarine, which is dammed in five places along its 128-kilometre length. In the section running down to Fribourg, it meanders through floodplains that no longer receive anywhere near as much water as they did before the dams, says Michael Döring, an ecologist at the Zurich University of Applied Sciences (ZHAW).

To mitigate this damage, Robinson, Döring and Diego Tonolla, also at ZHAW, designed a programme of carefully calibrated floods, working alongside hydropower producers, government officials and engineers. Its goals were tailored to the particular challenges along this segment of the Sarine, including the removal of algae and clogging sediment, reconnection with the floodplain, and a reduction in the species that have moved in to take advantage of the unnatural flows. It is still early days, but preliminary results indicate that the flood was large enough to address



PETE KERBIDE/NATIONAL GEOGRAPHIC/CREATIVE

JUST ADD WATER

The lower portion of North America’s Colorado river, which runs from the mountains of Colorado to the Gulf of California in Mexico, was once a thriving wetland teeming with life. As bobcats stalked their prey, clouds of birds soared above what the conservationist Aldo Leopold described as a “verdant wall of mesquite and willow”. When a series of dams were built upstream in the mid-20th century, however, the delta (pictured above) withered and dried.

A few years ago, the dusty scar left behind was the subject of a spectacular environmental experiment. Following several years of cooperation to help Mexican farmers whose irrigation infrastructure was destroyed by an earthquake, the US and Mexico hashed out a landmark agreement, known as Minute 319, to release a large pulse of water in the hope it would bring the parched delta back to life. The deluge started in March 2014, and a total of 132 million cubic

metres of water rushed from the Morelos dam, which straddles the international border.

The flood succeeded in rejuvenating native vegetation, smudging the delta green again. But the restoration didn’t last. Within a year, the greenery began to recede, and according to one analysis the experiment was only “minimally successful” at establishing cottonwood and willow seedlings, its primary goal. There was also an unintended consequence: the release of methane and carbon dioxide from the newly moistened riverbed.

Researchers are still trying to figure out how much greenhouse gas was released, but they don’t think the risks outweigh the benefits, however short-lived. But here’s the rub: the Minute 319 flood was always planned as a one-off experiment. To stand a chance of restoring the delta permanently, you would have to mimic the seasonal floods that came before the dams (see main story).

those problems and restore the river to something much closer to its natural state, says Döring.

Meanwhile, artificial floods are starting to make a splash around the world. The Spöl served as an important model for designing a long-term programme of floods released from Glen Canyon dam on the upper Colorado river, for instance, as well as artificial floods on Australia’s Snowy river and various waterways in Japan. “From an international point of view, the Spöl has been a major impetus for artificial floods,” Robinson says.

The rivers that benefit the most, however, might be those yet to be dammed. There are currently 3700 large dams planned

or under construction across the globe, including particularly intensive schemes in South America and Asia. “Although the dam-building era is largely over in developed nations, dam construction is rampant in many developing regions,” says Olden. Decision-makers there are aware of the dilemma dams pose. And although many cannot resist the boons that come with harnessing their rivers, now there is at least a viable strategy for mitigating the ecological costs. ■

Terri Cook is a science writer in Boulder, Colorado. Travel for this article was supported by the European Geoscience Union’s Science Journalism Fellowship

The queen of science



Mary Somerville transformed science from an obscure set of studies dominated by men into something far more egalitarian and accessible. **Chris Baraniuk** reveals her remarkable influence

VESUVIUS'S crater was spewing gases and snorting magma as the lady gingerly traversed it, handkerchief pressed to her nose. In places the lava had formed a crust hard enough to step on. As she peered through the cracks, glowing molten rock was visible beneath.

It was December 1817 and Mary Somerville, the first great populariser of science, was following her passion. Not content with merely interpreting scientific research, Somerville was eager to see natural phenomena for herself and so gather source material for her greatest work, *On the Connexion of the Physical Sciences*. Published in 1834, it was a revelation. It was a compendium that brought the latest knowledge of every branch of physical science together in one place. What's more, it was aimed at a mass audience – a pioneering piece of popular science writing that foreshadowed the magazines and bestselling books of today.

Today Somerville's name lives on in an Oxford college, but her wider legacy is largely forgotten. Later this year, though, she is due to be introduced to a fresh generation, as the new face of the Royal Bank of Scotland's £10 banknote – the first non-royal woman to be honoured in this way.

Born in 1780, Somerville grew up in the small town of Burntisland, not far from Edinburgh. She was fascinated by the natural world from the start, collecting shells and fossils, and observing birds and sea creatures. Though she was denied access to formal teaching beyond the basics, she was determined to educate herself, asking family friends for tuition in Latin, algebra, geology and natural history. "I sat up very late reading Euclid," she wrote of her life around the age of 15 in her memoir, *Personal Recollections*

from *Early Life to Old Age*. After contacting William Wallace, a prominent Scottish mathematician, she eagerly read every scientific book he recommended.

Her world really began to expand in 1812 when she married William Somerville, an inspector for the Army Medical Board who shared her passion for science. They moved to London, joining the same social circles as the foremost writers, scientific thinkers and artists of the day. She and the artist J. M. W. Turner knew one another well. "I frequently went to Turner's studio, and was always welcome," she recalled in her memoir.

When her husband was elected to the Royal Society and other eminent institutions, Somerville, barred from membership herself, began to write to other members asking for updates on their investigations. She wrote constantly, read the scientific papers she received, and jotted down all manner of science news in her journals. She spent much of 1817 on a tour through Europe, meeting many of her scientific heroes, including the adventurer Alexander von Humboldt. One notebook contained paragraphs on everything from the size of the sun to hurricanes in the South Pacific to the geology of the Cape of Good Hope.

Personal connections she forged with eminent scientists were the lifeblood of what was to become *Connexion*. Von Humboldt shared stories of his expeditions. In an account of atmospheric pressure, Somerville wrote: "The air even on mountain tops is sufficiently rare to diminish the intensity of sound, to affect respiration, and to occasion a loss of muscular strength. The blood burst from the lips and ears of M. de Humboldt as he ascended the Andes."

No branch of the physical sciences was unfamiliar to Mary Somerville

She learned about electromagnetism from Michael Faraday, distilling that knowledge into lucid explanations of electric current, attraction and repulsion, batteries and much more. From George Airy she learned about light, planetary orbits and how to calculate the density of Earth; from the astronomer John Herschel she gleaned accounts of nebulae and binary star systems.

Another acquaintance, the politician Henry Brougham, persuaded Somerville to write her first work, an English version of the French mathematician Pierre-Simon Laplace's *Mécanique Céleste*. Published in





1831, *Mechanism of the Heavens* was used in teaching at the University of Cambridge for the next 50 years – something unheard-of for a woman at the time.

Somerville was one of the people who helped that to change. Throughout her life she championed women's right to knowledge, and the preface to *Connexion* described it as “my endeavour to make the laws by which the material world is governed more familiar to my countrywomen”.

Men and women bought the book in their thousands. It was a huge success, widely acclaimed across Europe. Though it deals with

fundamental concepts of matter, radiation and gravitation, there are no equations, and unfamiliar terms are explained in language that a broad range of readers could understand. She also used analogy to great effect, describing, for example, an annular nebula as a bright ring “filled with a faint hazy light like fine gauze stretched over a hoop”.

This is not to say the whole thing is an easy

“I hope to make the laws of the material world familiar to my countrywomen”

read. But the book served another important function. Scientific societies – from the statistical to the meteorological – were popping up left, right and centre, yet catered mainly to very specific tastes.

“Physical science is endlessly subdivided,” lamented the polymath William Whewell in his review of *Connexion* in *The Quarterly Review*. Demonstrating how everything is connected, as Somerville had done, was “to render a most important service to science”.

A popular journal, *Mechanics Magazine*, wrote a glowing review of *Connexion*, ending by saying, “Read it! Read it!” Whewell’s review noted that even the most knowledgeable readers “cannot but be struck with admiration at the way in which the survey is brought up to the present day”. His review even contains the first use of the word “scientist”, as he searched for a collective term for the people whose work Somerville had gathered together.

Finding Neptune

More than 9000 copies of *Connexion* were sold in the 1830s and it ran to 10 editions in all, each one revised completely. The book remained in demand throughout Somerville’s lifetime and was its publisher’s biggest-selling work of science until Darwin’s *On the Origin of Species* in 1859.

Part of the book’s appeal was that it did not just state facts but asked questions about what was as yet unknown. The fifth edition highlighted anomalies in tables charting the positions of Uranus, hinting that there was perhaps an eighth planet whose gravitation could account for the discrepancies. British astronomer John Couch Adams read this and was inspired. He was later jointly credited for discovering Neptune.

Hailed as the “queen of 19th-century science” on her death at the age of 91 in 1872, Somerville’s vast knowledge and tireless work in popularising an evolving discipline left its mark in many ways. It was she who introduced Ada Lovelace to Charles Babbage, inspiring her work on his analytical engine. Somerville was Lovelace’s mathematics tutor and chaperoned her to Babbage’s parties, where he showed off his calculating machines.

Somerville spent her final days in Naples, having travelled there after witnessing another eruption of Vesuvius. “I have every reason to be thankful that my intellect is still unimpaired,” she wrote, not long before she died. “I am perfectly happy.” A happy choice too, that her pioneering life is now to be remembered on the currency of her native country. ■

Best behaviour?

If the kids are struggling to maintain real and digital identities, what hope have their teachers, asks **Pat Kane**

The Happiness Effect: How social media is driving a generation to appear perfect at any cost

by Donna Freitas, Oxford University Press

Worried About the Wrong Things: Youth, risk, and opportunity in the digital world by Jacqueline Ryan Vickery, MIT Press

FACEBOOK'S Mark Zuckerberg is king of all he surveys in social media. His next horizon is near-mythical: techno-telepathy. Direct mind-to-mind contact is "the ultimate communications technology", the mogul says.

"You'll think a text or update and send it," affirmed his experimental tech director, Regina Dugan. The old Arthur C. Clarke line that "any sufficiently advanced technology is indistinguishable from magic" seems evergreen in 2017.

Look around your streets – or better, a mall, lobby or campus – and you'll see a generation of humans already deeply entangled in, and entranced by, their communication devices. As the next incessant blink, buzz or chirp pulls you towards the touchscreen yet again, haven't you ever felt the urge – accompanied by a twinge of your carpal tunnel – to just respond, or receive, in a purely mental way?

Zuckerberg's aspiration to go from iPhone to psy-phone seems more like a shift in degree than kind. Yet what Ray Kurzweil once called "the age of spiritual machines" sometimes has to deal with the sweaty, fleshy, emotional reality of human beings as they are, particularly younger ones budding through those (so far)

unavoidable heaves and surges we know as adolescence and early adulthood.

Going by these two fascinating ethnographies, even the digitally naturalised Generation Z (the kids of Gen X) are hardly ready for the direct and pure mingling of minds. Not while there's selfie-taking, sexting, cyberbullying or "Yik Yakking" to be done, day after day.

Yik Yak – a controversial Twitter-style app which shut down in April this year – provides Donna Freitas's *The Happiness Effect* with its malevolent subtitle. Through hundreds of interviews

"Nervy identity construction via social media occupies much of students' emotional lives"

with undergrads and graduates in 13 US colleges, Freitas lays out the regime of nervy identity construction through social media that occupies much of their emotional lives.

Whether it's due to their awareness that their timeline is a potential CV, or that their "likes" are an indicator of social status on campus, they are under pressure to display their best and most positive selves at all times. "Now you don't have to wait for your 10-year high school reunion to show off how great your life is," says junior student Brandy. "It's like that every day."

The anonymised Yik Yak app released a torrent of mutual abuse through some of Freitas's campuses. Out from under the compulsion to display public happiness, the Repressed

returned with a vengeance. "Yik Yak was like a bad soap opera," said one. Another abandoned the service "because I was overwhelmed by the racism and homophobia that exists on my campus".

So many of the tales here are about trying to establish some kind of autonomy over, or even just etiquette around, the endless connective demands of social media and smartphones. Ethics and mores are being established on the fly. Among Freitas's students, the general attitude towards visually led dating apps – where you display your wares to engage in "hook-ups" – was an extended "eewwww". For these febrile, nervy souls, steamy liaisons still need sociable encounters first.

Consistent with this reserve, the new ritual for courtly romance would seem to be the declaration that one's new boy/girlfriend is now "Facebook official". When a couple agree to change their relationship status on the platform, they are (in one male student's words) "standing on top of a mountain and shouting it out to the world".

So far, so sweet, so familiar. The ecstasies of online communication are tempered by recognisable real-world (and real-body) anxieties and modesties.

Freitas is obviously a good pastor and counsellor to these fluttery kids, even as she mines them for research. But her matronising tone does remind you that Facebook's founding circumstance was as a campus social network, profiting from



playing around with the status anxieties of Harvard University students.

The idea that the stifling managerialism behind Zuckerberg's network is seeking to enter your intimate mental life, at some stage in the neurotech future, feels like something that would invite neo-Luddism, if not outright rebellion.

One might have a romantic notion – the agenda-setting SF novels of Cory Doctorow come to mind – that the kids from the wrong side of the tracks would be the ones who demanded something different, less managed, more edgy, from their communication platforms. (Freitas's students are clearly



Having a new social machinery to hand is no guarantor of success

already thrums through these kids' lives. Petty and futile constraints on classroom tech use, and on the kind of digital material that children can bring in from their own enthusiasms, sets a tone of defeatism and alienation among some of the Freeway High kids.

The author has an obvious favourite pupil, a disruptive, deprived but poetic girl called Selena, with whom she spends considerable time. But she hears later that Selena has dropped out of school in the midst of her college preparations, and now has no connection with her. The book is strewn with tales of exclusion and struggle, in which parental backgrounds are chaotic and the demands of care, commuting and finding a place to live bear down too heavily on digitally ambitious youth.

Across both studies, and no matter the social positioning of each set of users, these young people evidently know they have a new kind of tangible social machinery in their hands (and minds): a machinery made of devices, networks and digital information, with which they can make a mark, pooling their knowledge and consciousness.

As responsible pedagogues, Vickery and Freitas are institutionalised (and institutionalising). And with Mark Zuckerberg – as with any Silicon Valley visionary mogul – you have to follow the profit-driven interest, not just gawp at the transhuman ambition.

Somewhere between the caring educators and the corporate disruptor, Generation Z is forging its own new society out of a digital revolution still in its early days. The streets will have their uses. And young, yearning bodies won't be ignored, either. ■

attending prestigious universities, where pressures to succeed keeps things normative.)

Jacqueline Ryan Vickery's book *Worried About the Wrong Things* has a cast of quirky, eccentric and talented young digital users, circulating in and around a working-class school near the Mexican border, with the pseudonym "Freeway High". But the tale it tells is how, amid circumstances of socio-economic distress, education fails to be the haven that can generate possibilities and progress. And one predictor of school failure is whether it uses digital technology from a "harm-driven" rather than an "opportunity-driven" perspective.

The book has an intriguing tension. The author's teacherly interests are evident – she promotes a "connected learning model" that imagines it can bring all the "learning moments" of a

Petty and futile constraints on classroom tech use sets a tone of defeatism and alienation"

pupil, wherever and whenever they happen, into one educational framework.

Yet the stories that unfold when she talks to the Freeway High students are pretty difficult to assimilate into any inclusive teaching system. In complete contrast to the compulsive

communicators of Freitas's book, two sensitive young Latino high-school film-makers (Sergio and Javier) often chose not to post their material on YouTube because they are insecure about its quality, and worried it might harm their career prospects, precarious and tentative as they are.

Freeway High has a classic teacher-liberator of the *Dead Poets Society* type – a Mr Lopez who runs evening Cinematic Art Projects and Digital Media Clubs for the pupils. But, as Vickery charts in great and persuasive detail, the school's prevailing "harm-driven" view of social media muffles and excludes the digital creativity that

Pat Kane is the author of *The Play Ethic* (Macmillan)

Skin-shuddering intimacy

Tattoos are not just artworks, they are performances, finds **Simon Ings**

Tattoo: British Tattoo Art Revealed,
National Maritime Museum, Falmouth,
UK, to 7 January 2018

TURN left as you enter *Tattoo: British Tattoo Art Revealed*, and you will be led through the history of a venerable and flourishing folk art. Turn right and you will confront a wall of 100 disembodied forearms. They aren't real, which is a nuisance for the artists who tattooed them – since silicone is nothing like as easy to work with as human skin – but a comfort for the rest of us.

Alice Snape, editor of *Things & Ink* magazine, curated this wall to showcase the range of work by today's tattoo artists in the UK. But you really need to see the rest of the exhibition first. You need time to contemplate the problem Snape's *100 Hands* is there to solve, that this is an exhibition whose subject is entitled to wander off, and cover up.

There's something frustratingly arch about tattooing. Tattooists jealously guard their stencilled designs (called "flashes") even as they create pieces that, by their very nature, come with their own sales reps. Clients (perhaps influenced by 2005's reality show *Miami Ink*) wax lyrical on the deeply personal stories behind their tats, then plaster photos of them all over Instagram.

Practitioners exploit their liminal status even while they bemoan their lack of recognition. In a show full of repeating figures and useful (though never intrusive) signposting, my favourites were the boards that tell you "what the papers said" at

different times in history. Every generation, it seems, has come to the same startling realisation that "tattoos aren't just for sailors", yet the information never seems to stick. Tattooing is an art that does not want to be fully known.

The problem facing the show's curators is: how do you define the limits of your enquiry? If the art has to be invited in, cajoled, reassured, even flattered into taking part, how do you stop shaky inclusion criteria from compromising objectivity?

Natural history solved the problem long ago. The rule used to be that if you wanted to study something you went out and shot it: the rifle was as much part of

your kit as your magnifying glass. The Maoris of Polynesia, aware of the value Western visitors put on souvenirs, used to catch people, tattoo their faces, decapitate them and sell their heads to collectors. The draughtsman aboard Charles

"People make tattoo guns out of anything that vibrates. The first were Victorian doorbells"

Darwin's ship the Beagle had a travel box lined with the tattooed skin of dead Maori warriors.

These days the tattooed collect themselves. Geoff Ostling, for one, has arranged for his heavily (and beautifully) tattooed skin to go to

the National Gallery of Australia after he dies. Gemma Angel, an adviser to this exhibition, spent her doctoral study among the 300 or so items in the Wellcome Collection's archive of human skin, and she reckons there's a growing interest in post-mortem tattoo preservation.

It is to this exhibition's great credit that it takes no time at all to find a voice pinpointing exactly what is so disconcerting about this idea. In a cabinet of personal testimonies I find this remark by a Catherine Marston: "Tattoo is an art form but I don't think they should be collected because when a person dies they die too. You hear of some really weird designers that use skin that's cut afterwards, once they die then that goes on display. I think that diminishes the whole idea of a tattoo. It's art with a time zone rather than timeless."

Such voices are valuable here because even this democratic, eclectic exhibition can't quite capture the shuddering intimacy of the form it celebrates. Tattoos are not just artworks, they are also performances. Getting a tattoo hurts just enough to make you dizzy, and lodges that intimate moment in your memory.

Though the art is the point of the show, it would not work nearly so well without the artefacts it has borrowed from working tattooists and from the Science Museum in London. People make tattoo guns out of virtually anything that vibrates. The first machines were made out of Victorian doorbells. You can salivate at images all you like, but nothing gets under the skin like a doorbell-based tattoo gun once wielded by Johnny Two-Thumbs of Hong Kong. ■



Captured in a silicone cast: art by tattooist Matt Houston

THE GREATEST SCIENCE SHOW IN THE KNOWN UNIVERSE

28 September to 1 October 2017 ExCeL London



120 brilliant speakers

103 interactive experiences Six action-packed stages

FOUR UNFORGETTABLE DAYS UNDER ONE ROOF

Our award-winning show brings your favourite science magazine to life. Explore everything from the origins of the universe to the secrets of your own mind.

Book your tickets now at newscientistlive.com



BEST
CONSUMER
SHOW



EVENT
OF THE
YEAR



BEST
CONSUMER
SHOW
LAUNCH



@newscilive



newscilive

#nslive

"BRILLIANT. VERY ENTERTAINING,
STIMULATING AND INFORMATIVE.
YOU MUST GO" 2016 VISITOR

A WILD LIFE EXPOSED

Thursday 28 September

Life is never dull for naturalist and impassioned campaigner **Chris Packham**. His travails at the far frozen poles, and the sticky forests and searing deserts in between, have brought him eye to eye with nature's most astonishing creatures and landscapes. He shares his story and theirs in this entertaining, family-friendly show, and asks: what of their future?



SCIENCE, FICTION AND THE FUTURE

Sunday 1 October

Margaret Atwood's books, like *The Handmaid's Tale* and many others, don't contain aliens and spaceships but often concern the future. She takes ideas that are current in science and speculates what they will mean for our society in the near future. Find out how science has influenced her life and her writing, and why her fiction is often labelled dystopian.



THE MUSIC OF PROOF

Thursday 28 September

Composer **Emily Howard** and mathematician **Marcus du Sautoy** introduce the world premiere of a musical work inspired by maths. Hear it performed by the Piatti String Quartet and learn what connects sounds and numbers.

SOLVING INTELLIGENCE: THE FUTURE OF AI

Friday 29 September

Demis Hassabis has worked as an artificial intelligence researcher, neuroscientist and video game designer. He is founder and CEO of DeepMind, a company that is building software more powerful than the human brain to solve the world's most complex problems. Find out how machine learning is on the way to solving the greatest of them all – understanding human intelligence.

WHO RUNS THE WORLD? ALGORITHMS!

Thursday 28 September

Algorithms have come to control our daily lives in ways we don't even notice, from deciding who should get mortgages and job interviews to who should go to jail and much, much more. Mathematician **Hannah Fry** explains how staggeringly smart algorithms are and exposes their dark side. Who is monitoring them? And can we be sure that they're doing what we think they are?

LIFE ON THE OCEAN FLOOR

Saturday 30 September

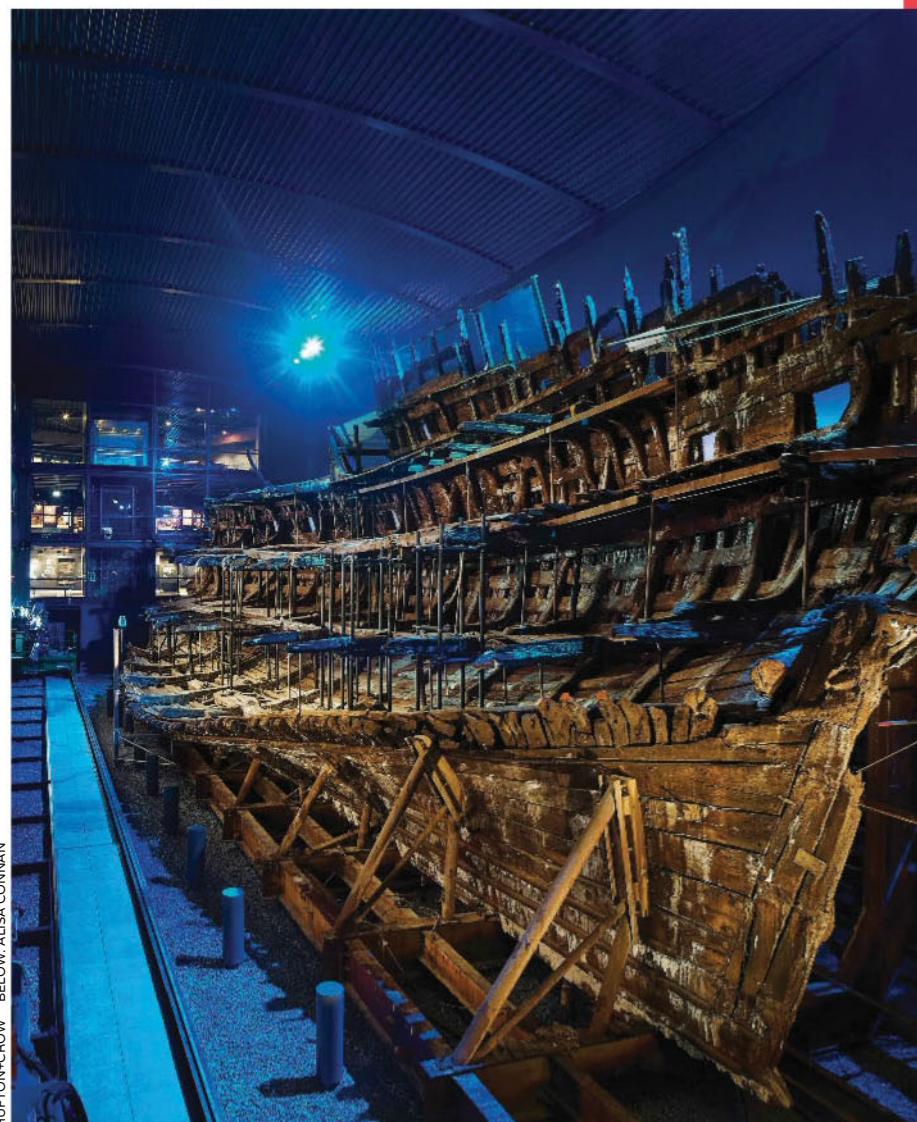
Marine ecologist **Alan Jamieson** explores the deepest spots of the ocean floor. Find out what it's like 8 kilometres beneath the waves and about the sea creatures overturning our understanding of extreme ocean environments.

VILLAGE FETE OF THE FUTURE

Thursday to Sunday

Roll up, roll up! The science village fete is back with new games for all the family. Classic fairground attractions are reinvented to explore how the world will change: examine future shortages with our fast and funny game show *Higher or Lower*, pit your might against robots in *Test Your Strength*, and try to keep your planet orbiting in *Two Body Problem*.

"LOTS AND LOTS OF INTERESTING THINGS TO SEE... WISH I HAD BOOKED FOR MORE THAN ONE DAY!" 2016 VISITOR



HUFFTON+CROW BELOW: ALISA CONNAN

TUDOR TREASURES

Thursday to Sunday

The Mary Rose was Henry VIII's flagship until it sank in 1545 near Portsmouth. Nearly 440 years later the world watched as it rose from its watery resting place. Now is your chance to get your hands on its precious artefacts. Explore Tudor materials using the latest techniques, and discover how science is saving the Mary Rose for future generations.

SUPERBUG CHALLENGE

Thursday to Sunday

Think you know about superbugs? Test whether you've got what it takes to hold out against drug-resistant infections using current and new antibiotics. Top the league table and win a cuddly Giant Microbe. How long can you survive?

MEET THE AUTHORS

Signatures and selfies with your favourite science writers. Featuring Margaret Atwood, Alice Roberts, Randall Munroe, Sean Carroll, Nick Lane, Lucie Green, Chris Stringer, Helen Czerski, Jim Al-Khalili, Chris Packham and many more.



HESTON'S FANTASTICAL FOOD

Friday 29 September

How does food influence your emotions? Are squares spicier than circles? Can music make a dish taste better? What should go into a menu for astronauts? Award-winning chef **Heston Blumenthal** has all the answers. Join him on an unforgettable multi-sensory food odyssey.

MUCH MORE TO EXPLORE

There are talks, attractions and loads of exhibits. To see the full programme, plan your visit and book your tickets go to newscientistlive.com

THEATRE HIGHLIGHTS

MAIN STAGE

THURSDAY A WILD LIFE EXPOSED Chris Packham
FRIDAY TEN SPECIES THAT CHANGED OUR WORLD Alice Roberts
SATURDAY WHAT HAPPENED AT THE BIG BANG? Sean Carroll
SUNDAY THE BORDER BETWEEN LIFE AND DEATH Adrian Owen

HUMANS

THURSDAY IS THERE A CURE FOR AGEING? Linda Partridge
FRIDAY TURNING OUR GENES INTO MEDICINE Adrian Thrasher
SATURDAY THE MICROBIOME AND YOUR ROUTE TO BETTER HEALTH Kevin Whelan
SUNDAY THINKING HARD ABOUT MEDITATION Miguel Farias

ENGINEERING

BAE SYSTEMS
INSPIRED WORK

THURSDAY WELCOME TO HYPERLOOP ONE Alan James
FRIDAY CROSSRAIL, CITIES AND THE FUTURE Laurie Winkless
SATURDAY THING EXPLAINER: COMPLICATED STUFF IN SIMPLE WORDS Randall Munroe
SUNDAY SYNTHETIC BIOLOGY: DESIGNING THE FUTURE Paul Freemont

COSMOS



THURSDAY GRAVITATIONAL WAVES: A NEW ERA OF ASTRONOMY Sheila Rowan
FRIDAY THE TWO GREATEST MYSTERIES IN PHYSICS David Tong
SATURDAY WHO OWNS THE MOON? Jill Stuart
SUNDAY CASSINI'S GRAND FINALE Michele Dougherty

EARTH



THURSDAY CLIMATE CHANGE: WINNERS AND LOSERS Jane Hill
FRIDAY IS LIFE QUANTUM MECHANICAL? Jim Al-Khalili
SATURDAY FEEDING THE WORLD, HEALTHILY AND SUSTAINABLY Charles Godfray
SUNDAY WHY IS THERE ONLY ONE SPECIES OF HUMAN? Chris Stringer

TECHNOLOGY



THURSDAY WHEN COMPUTERS GET ACCESS TO YOUR EMOTIONS Rosalind Picard
FRIDAY BUILDING ROBOTS: COMPLEXITY, CYBERNETICS, COCKROACHES Ravi Vaidyanathan
SATURDAY WHEN BAD STATS MAKE FAKE NEWS David Spiegelhalter
SUNDAY IS TRYING TO PROTECT YOUR PRIVACY FUTILE? Angela Sasse

To see the programme in full and
book your tickets, go to newscientistlive.com

WHY ARE DOGS' NOSES WET?

NewScientist

the phenomenal
NewScientist
series
over 2,500,000
copies sold!

HOW LONG IS NOW?

Fascinating answers to
191 mind-boggling questions



From gravitational waves to goldfish memories, explore some of the world's most mind-bending phenomena in the latest book from NEW SCIENTIST.

NewScientist





3 Postdoctoral Fellows

The Department of Physiology at The University of Tennessee Health Science Center is searching for three outstanding Postdoctoral Fellows to conduct research in the laboratory of Dr. Gadiparthi N. Rao.

These positions will be in the area of cardiovascular research and are immediately available to study the role of endothelial cell dysfunction and GPCR signaling in vascular diseases and VEGF signaling in retinal neovascularization. Experience in two or more of the following areas is preferred: Cloning, protein-protein interactions, signal transduction, confocal microscopy/live-cell imaging, atherosclerosis, guide wire injury/restenosis and/or retinal angiogenesis.

Candidates must have a Ph.D. or M.D. with a strong background in biomedical sciences and candidates with publications as first authors in journals with 5 or more impact factors are preferred.

Applicants should send their CV and three letters of reference to Dr. Gadiparthi N. Rao, George and Elizabeth Malloy Professor, at rgadipar@uthsc.edu.

UTHSC is an Equal Employment/Affirmative Action Title VI/IX/Section 504/ADA/ADEA Employer.



National Institute
on Aging
Intramural Research Program

Department of Health and Human Services
National Institutes of Health
National Institute on Aging

The National Institute on Aging (NIA), a major research component of the National Institutes of Health (NIH) and the Department of Health and Human Services (DHHS), is recruiting for a postdoctoral position in The Section on DNA Helicases, Laboratory of Molecular Gerontology. Research in the Laboratory of Molecular Gerontology involves the study of genomic stability maintenance. The focus of our group is to investigate the functions of DNA helicases defective in premature aging and cancer disorders. The objective of this research is to understand the molecular and cellular roles of human DNA helicases in pathways that are important for the maintenance of genome stability. Genetic and biochemical approaches are used to characterize the roles of helicases in cellular DNA metabolic pathways and the mechanisms of unwinding by human DNA helicases.

Interested candidates must have a Ph.D. or M.D. with less than five years of postdoctoral experience and research experience in molecular biology, and training in mammalian cell culture techniques. Salary is commensurate with experience and accomplishments. Submit letter of interest, curriculum vitae, and references to:

Robert M. Brosh, Jr., Ph.D., Senior Investigator NIA-NIH,
Laboratory of Molecular Gerontology,
251 Bayview Blvd., Suite 100, Baltimore, MD 21224 USA.

Phone: **410-558-8578**, or E-mail: BroshR@mail.nih.gov

For additional information on this position, visit
<https://www.ipr.nia.nih.gov/branches/lmg/rbrosh.htm>

HHS and NIH are Equal Opportunity Employers



THE WORLD'S
BRIGHTEST MINDS
ALWAYS INNOVATE.



At St. Jude Children's Research Hospital, we know what can be achieved when the brightest scientific minds face the fewest barriers. That's why we provide world-class facilities, State-of-the-art technologies, Extraordinary support. And a collaborative, bench-to-bedside environment where you can see, firsthand, how your science translates into survival for the children we serve. Quite simply, at St. Jude, we encourage you to dream big, and we give you everything you need to be the force behind our cures.

Multiple Faculty Positions
Department of Computational Biology
Memphis, TN

St. Jude Children's Research Hospital is a private, not-for-profit institute that is internationally recognized for its commitment to performing cutting edge research and providing state-of-the-art clinical services, with the goal to improve the outcome for children with cancer and other catastrophic diseases. St. Jude is the first and only pediatric cancer center to be designated as a Comprehensive Cancer Center by the National Cancer Institute. It is engaged in ongoing expansion of its facilities as well as patient care and scientific research activities.

Recognized as a world leader of genomic research in pediatric cancer, the Computational Biology department at St. Jude Children's Research Hospital is currently seeking exceptional candidates for multiple FACULTY positions. We are seeking investigators to lead multidisciplinary research programs of systems biology, biological image analysis, medical informatics, drug screening, and epigenetics, by integrating dry lab computational methods with wet lab experiments. Research that has proven or potential biological or clinical applications are of particular interest. This search is open for mid-career or senior investigators with a strong record of independent research, as well as motivated early career investigators interested in establishing innovative research programs.

As part of a significant expansion from a research program to an academic department, the newly established Computational Biology department occupies 28,700-square-feet of laboratory and office space. Computational Biology investigators have access to dedicated departmental shared resources established for BIG data analysis and functional validation. They include priority access to cloud computing infrastructure and a local high-performance computing facility including a new state-of-the-art data center, a core wet lab available to support dry lab faculty, an engineering team for high throughput data analysis and a genomics laboratory for developing new sequencing technologies and assays. The research environment at St. Jude is highly interactive with collaborative opportunities across all basic research and clinical departments, as well as access to institutional shared resources managed by PhD-level scientists.

We offer very competitive packages, including generous startup funds, computing resources, equipment, laboratory space, personnel support and continued institutional support beyond the start-up phase. A faculty position at the Assistant, Associate or Full Member level may be considered. Successful applicants must hold a PhD degree, have at least three years of relevant postgraduate experience or a demonstrated track record of developing novel, high-impact computational methods.

Ready to join a team that is always innovating, because we believe anything is possible?

Interested applicants should submit a curriculum vitae, a 2-3 page summary of research interests, and the names of three references to:

ComputationalBiologyRecruitment@stjude.org.

St. Jude Children's Research Hospital is an Equal Opportunity Employer.



Diversity drives discovery.

Become an NPP Fellow. Propel NASA's missions.



Fields of study include:

- Aeronautics and Engineering
- Astrobiology
- Astrophysics
- Biological Sciences
- Cosmochemistry
- Earth Science
- Heliophysics Science
- Planetary Science
- Technology Development
- Science Management

Image: Philip Lange/
Shutterstock.com

Apply now: npp.usra.edu

EDITOR'S PICK**Belly gratification at the press of a button**

*From Ros Groves,
Watford, Hertfordshire, UK*

Elie Dolgin gave a fascinating insight into genetic influences that might lie at the root of some people eating beyond satiety, through their heightened response to the appeal of food (3 June, p 30). It is very difficult to isolate specific genes for appetite, as

Dolgin emphasises. I wonder what environmental influences might have come into play to make obesity more widespread in recent years, despite an abundance of food in developed countries for more than 50 years. Has the convenience factor in today's lifestyle had such an impact on the modern brain that it is becoming incapable of tolerating frustration?

We can access missed TV programmes, watch most films, buy virtually any product and have it delivered to the door, serve a large meal, have our questions answered and contact anyone in the world and receive a reply – all at the click of a button. Has the fact that daily needs are met instantaneously rendered us incapable of tolerating the slightest hunger pang and a short wait until the next mealtime?

Should the young bank blood for the future?

From Peter Hoare,

Ashwicken, Norfolk, UK

I enjoyed your report on the benefits of transfusions of younger blood plasma (10 June, p 8). Given the interest in freezing human eggs and sperm for later use, it made me wonder whether I should advise my grandchildren to put some of their blood in the freezer for their own possible use in the future. It's far too late for an old man like me, but maybe I could get a quick snort when they're not looking.

Gene editing the immune system: a new dawn

From Tony Kelly,

Crook, County Durham, UK

It was fascinating to learn that gene editing may one day equip

the immune system to defeat cancer and some currently intractable infections (3 June, p 6). What are the chances, I wonder, of it correcting malfunctions of the immune system itself? I have in mind of course allergies, multiple sclerosis and certain devastating inflammatory conditions that are suspected of being autoimmune in origin. Such an outcome would be truly dramatic and herald a new dawn for humanity and a new era in medical science.

A plea from the US for the world to impose tariffs

From Steve Billings,

Acton, Massachusetts, US

Chris deSilva expressed concern over the reaction of US president Donald Trump to a carbon pricing border tariff adjustment imposed by the rest of the world (Letters, 13 May). I'd like to invite the rest

BECOME AN EVEN BETTER YOU

How to... boost your brain, eat better, hack your senses, tune your life skills and get the best rest

Buy your copy from all good magazine retailers or digitally.

Find out more at newscientist.com/thecollection



NewScientist

"I suppose that's one way to get elected officials to care about drinking water"

EmilyBeforeItWasCool finds hope in a parliamentary candidate's fears over hormones in water making us all gay (Feedback, 17 June)

of the world to please hit us with that tariff. Most Americans are now concerned about climate change, but far too few are aware that a carbon fee and dividend plan would stimulate the economy while reducing carbon emissions and protecting consumers. A carbon tariff would prompt a much-needed national conversation within the US about the wisdom of pricing carbon.

When will they ever learn on building safety?

From Clyde Reynolds,
Carrickmacross, Ireland

The London Building Act of 1709, in response to the Great Fire of 1666, banned flammable materials (mainly wood at the time) on outer walls. This was developed in the Building Act of 1774, which included regulations on wall materials and thicknesses, window

reveals, roof parapets, walls and other measures to limit the spread of fire. How is it that 300 years later we can see fire jumping from flat to flat on the recently refurbished Grenfell Tower in London?

Bread of heaven: feed me till I want no more

From Fred White,

Keyworth, Nottinghamshire, UK
Spending hard-earned cash on non-industrialised foods is not a health fad, as Anthony Warner depicts it (17 June, p 24). For me at least, it is political activism in support of farmers and producers concerned about sustainable food production rather than profits for investment portfolios.

From Annemieke Wigmore,

Cudworth, Somerset, UK
I, too, am irritated by fad diets like JERF and Eat Clean. But I would

like more clarity on the trial in which 20 people ate wholegrain sourdough or industrial white bread. How long did it last? Did they eat their usual foods the rest of the day? What were the markers in which there was apparently "no significant difference"?

Warner tells us healthfulness is defined by chemical composition of food: I don't think even faddists will disagree. I would be surprised, though, if the composition of industrial white is not very different from that of wholemeal sourdough. I don't stigmatise anyone for their weight or food choices. The ever-increasing size and clout of the major food providers is to blame for the poverty of our diet.

The editor writes:

■ Trial participants were asked to avoid other sources of wheat carbohydrates for one week and to

stick to the white or sourdough, in quantities to some extent prescribed by the researchers. After a two-week break, the participants switched to the other type of bread for a week. The main metabolic markers examined were those linked to glycaemic control and risk levels of developing type 2 diabetes.

The long shadow cast by dark advertising

From Alex Kashko,
Edinburgh, UK

Your list of six technology pledges that should be in every political manifesto misses at least one pachyderm in the parlour (27 May, p 20). The winner of the 2016 US presidential election targeted population segments down to individuals, profiled using data from social media. It is highly likely these methods were also ➤

GALAXY ON GLASS



Spectacular wall art from astro photographer Chris Baker

Available as frameless acrylic mix or
framed backlit up to 1.2 metres wide.

A big impact in any room. All limited editions.

www.cosmologychris.co.uk

or call Chris now on +44 (0)7814 181647

www.facebook.com/galaxyonglass

used by the Leave campaign in the UK's 2016 EU referendum. They let candidates tell one voter one thing and another the opposite.

Obviously they are lying to at least one voter, but neither will detect this. It will encourage voters to ignore political communications, though it may still subliminally affect voting. We need technical, legal and cultural barriers to prevent such abuse of data. Any election or referendum in which these techniques were used should result in a new ballot – or award victory to a side that did not use them. Perhaps we can use an AI to detect use of these methods.

The editor writes:

■ Indeed: and in a following issue Matt Reynolds called for transparency over this "dark advertising" (10 June, p 25).

Hope in the search for consciousness

From Quentin Macilray,
Limassol, Cyprus

Bob Holmes, asking what is the point of consciousness, traces a

line from selective attention to hedonistic attention or emotions to modelling of the self, or parts of the self (13 May, p 28). Surely the modelling analogy can be taken further? Even bacteria can model up/down, light/dark and chemical gradients. Higher animals can recognise (map) individuals of their own or other species.

Highly nimble predators need a detailed geographical map of their hunting domain and prey. Social animals map not only the physical characteristics but also the personality of companions: dominant/submissive, likes me/hates me and so on.

It is a short step from there to mapping the "self": I am dominant, second in hierarchy, quick to anger, friend of X... Thus we become not only conscious, but conscious of self.

Most encouragingly, the article places consciousness firmly on the evolutionary spectrum, and quite far back at that. This implies there is also a probability that any life on other planets is intelligent life. The search for extraterrestrial intelligence has always postulated intelligent life, with no rationale

other than that we can expect to hear from extraterrestrials only if they are intelligent. Now we have a positive reason to hope.

Eating people is almost entirely wrong

From Chris Overland,
McLaren Vale, South Australia

A reader relates a close friend reporting inadvertently participating in a cannibal feast in Papua New Guinea 30 years ago (Letters, 10 June). This tale is almost certainly apocryphal.

I was a patrol officer there between 1969 and 1974. I lived and worked in very remote parts of the country, some only notionally under the control of the colonial administration of which I was a part. During that time there was, to my knowledge, only one proven incident of cannibalism.

All cannibalism there was ritualistic in nature and certainly not for subsistence. It was comparatively rare even in the pre-colonial era. It is extremely improbable that, in the 1980s, selected cuts of a human – called *longpella pik* (long pig) in Neo-

Melanesian Pidgin – would have been cooked and consumed in the manner described. The cooking process described is certainly used, but I have never heard of it being used to cook human flesh.

My surmise is that the friend was the victim of a practical joke by some mischievous Papua New Guineans, who will gleefully perpetrate these on a guileless *dim dim* (white person).

In this case they seem to have been spectacularly successful and to have helped reinforce a pervasive myth about the true extent and nature of cannibalism in their traditional societies.

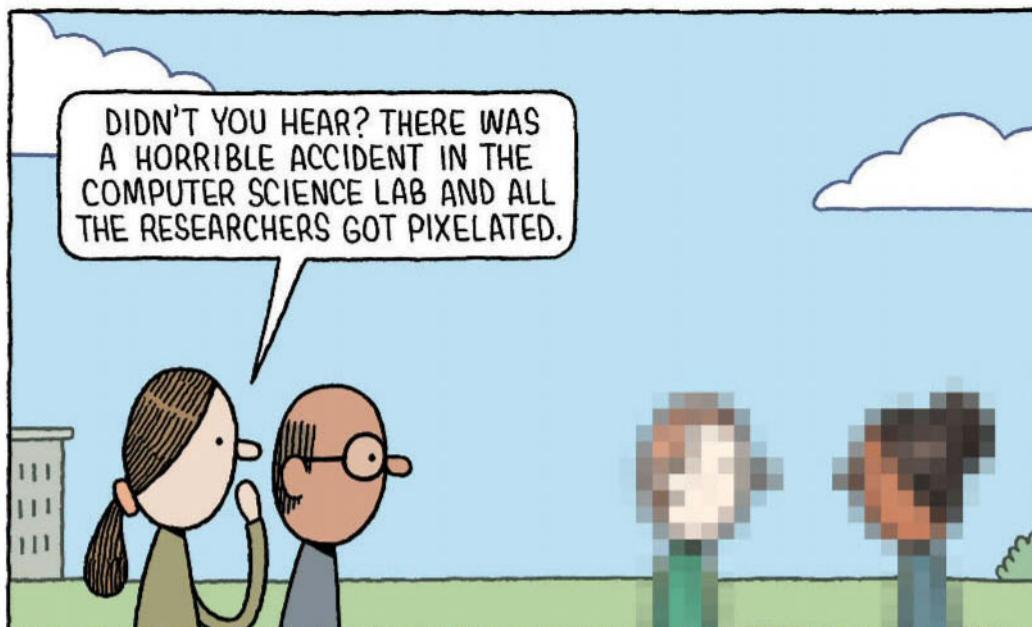
Credit is due to Marc Isambard Brunel

From Jeff Bagust,

Southampton, Hampshire, UK

Jon Noad comments on the ability of a mollusc called the piddock to bore tunnels through rock (The Last Word, 27 May). But credit for the tunnel under the Thames between Rotherhithe and Wapping is due to Marc Isambard Brunel – a great engineer who is often overshadowed by his son Isambard Kingdom. Marc patented a method for "Forming drifts and tunnels underground" in 1818 and managed construction of the tunnel from 1825 to 1843.

TOM GAULD



For the record

■ The researcher we quoted about a jacket to control drones is Carine Rognon (17 June, p 9).

■ Pick a spelling, any spelling... the name of the stage magician who debunked medium Henry Slade was John Nevil Maskelyne (17 May, p 42).

Letters should be sent to:
Letters to the Editor, New Scientist,
110 High Holborn, London WC1V 6EU
Email: letters@newscientist.com

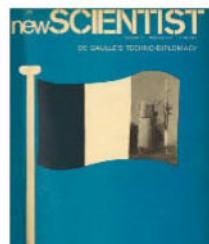
Include your full postal address and telephone number, and a reference (issue, page number, title) to articles. We reserve the right to edit letters. New Scientist Ltd reserves the right to use any submissions sent to the letters column of New Scientist magazine, in any other format.

OLD SCIENTIST

What was New Scientist talking about in Julys past?



MIKE HOLLIST / ASSOCIATED NEWSPAPERS/REX/SHUTTERSTOCK



WE DON'T have a crystal ball for the concerns and crises of the future. But when we raise the alarm, you had better pay attention.

Back in 1966 we already knew that some bacteria had the alarming knack of resisting penicillin. We were unsure, though, whether this trait was stable and hereditary. In our 7 July issue, we

reported that Elizabeth Asheshov at the Central Public Health Laboratory in London had taken 50 strains of *Staphylococcus aureus* that were resistant to penicillin or tetracycline, or both, and grown them at high temperatures. Some lost their resistance to one antibiotic, some to the other, some to both and some to neither, which suggested that this skill was owed to something other than the "central genetic apparatus". Asheshov also found that resistance could be transferred between strains. Was this the first confirmation of a problem we know all too well today?

By 1988, we were all over global warming and its terrifying consequences. In our 14 July issue, we warned that the Thames barrier (see photo), built to defend London from flooding, could be overwhelmed by the middle of the 21st century. Almost three decades later we warily note that although the barrier is still giving sterling service, it is closed far more often than originally envisaged.

More mundane, but equally deadly, was the danger we reported in our 16 July 2005 issue: talking on the phone while driving leads to more crashes. The UK government has recently increased penalties for drivers who use handheld phones. However, the 2005 research, carried out by Suzanne McEvoy's team at the University of Sydney, also studied the use of hands-free devices – which are still legal to use while driving in the UK and elsewhere. It discovered that speaking even without holding the phone made an accident four times as likely.

Identifying the coming travails of life on our planet is one thing; predicting responses to them is a far less exact science. **Mick O'Hare** ■

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

NewScientist Connect

LOOK FOR YOUR HERO ON NEW SCIENTIST CONNECT

Find your hero (or heroine) on New Scientist Connect – there are plenty to choose from.

Meet like-minded people who share similar interests to you – whether you're looking for love, or just to meet someone on the same wavelength, no matter where you are in the world.

Start your search now at:
<http://dating.newscientist.com>

*Join now
FOR
FREE*





PAUL MCDEVITT

HOPING to get a foot in the door of the space-based hosiery market, Sock'M announces itself as "the first fashion brand to manufacture designer socks made for space travel".

"Space tourism is closer than we think," the press releases declares optimistically, "and Sock'M is here to challenge the commonplace tendency of space being dominated by those with large budgets."

On its website, Sock'M derides the sartorial standard for astronauts as "styleless, technical 'costume'". A little disparaging for a bespoke suit that can keep a human comfortable in the freezing, UV-riddled vacuum of space, Feedback thinks, and besides, there's nothing styleless about the dashing silver foil number sported by John Glenn during NASA's Mercury programme.

An "innovative project to meet the challenging conditions in space," Sock'M offers socks laced with gold and silver threads "which help inhibit the electrostatic charge commonly found in synthetic fabric when in zero gravity". This is an odd choice, as the socks themselves are made from all-natural cotton, and besides, any

space tourists skimming low Earth orbit will still be a long way from zero gravity. The firm also says that the foot warmers are "for those of us that don't have the resources or the tools to travel to space," neatly undermining the sole reason for their existence.

Still, Feedback must admit that at €10 a pair, the millimetre closer to space you would be while wearing them still delivers a better rate of return than any investment you might have made in a space tourism start-up.

THE spring supplying our swollen file on enhanced waters shows no signs of running dry (20 May): Anne Barnfield reports the existence of a Canadian offering, Neurogenesis Happy Water, which offers the wet stuff replete with delicious minerals, notably lithium.

"Happy Water's mission is to provide consumers everywhere with the opportunity to experience the benefits of this unique, naturally functional water," says the website, adding "Happy Water is more than hydration... it's a state of mind."

Tired of T-shirts informing him the wearer had completed this marathon or the other, Philip D. Welsby has printed his own declaring 'I have never completed a marath'".

Although it points out the role of lithium in treating mood disorders, the company website is careful to avoid explicitly promising a mood boost from anything other than good old hydration and the cheery yellow packaging.

"Although not explicitly stated in the advertising, use of the term 'neurogenesis' in the product name does imply the creation of neurons," says Anne. Those worried this could put Happy Water in contravention of the UK's blanket ban on mind-altering substances will be pleased to know that "one neuroscience lab tested this, and unsurprisingly found no significant effect on brain neurons".

In the meantime, there's always the classic pep pop, 7Up – supposedly named for the atomic number of the same mood-enhancing ingredient.

KEEPING an eye open for alternate routes home, Mick Martin notes that the rear window of the bus he was travelling in bears the notice: "In emergency break glass with hammer". The hammer is thoughtfully provided just above the notice, but in a glazed box saying: "To obtain break glass".

"On the other side of the bus is a second hammer," says Mick, "presumably there to release the first, but this is also in a glazed box. I looked in vain for a third box, but I presume the designer realised that by now the bus was bound for Hilbert's Hotel." He recommends anyone catching a bus in Cardiff should bring their own hammer.

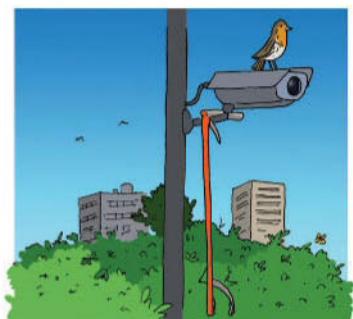
A TALE that marches on relentlessly: Howard Ritter says "Not to give the etymology of Nazi more attention than it's due," (too late, Howard) "but I must correct both John King (27 May) and Stuart Tallack (10 June) as to the contraction for *Nationalsozialistische Deutsche Arbeiterpartei*".

The shorthand word, says Howard, is neither a retronym of NS nor a clipped contraction of *Nationalsozialistische*. "The true

explanation is simple: the word 'national' in German is pronounced like 'not-seeo-nahl'. Nazi is simply a lexeme reflecting the pronunciation of the first two syllables of that word." This is akin to the "Dems" in the US.

AND lastly (we hope), Matthew Smylie writes to point out that Nazi is the predominant term in English. "In German, the party seems to be more often referred to by the full name, and in Heidelberg, where I live, German-language tourist information signs that reference Nazi Germany often refer to 'the time of the national socialists'" Matthew admits this level of lexical pedantry might make him a grammar Nazi.

THE rise of the robots takes a turn for the tidier. Bob Morley reports signs on the M27 in Hampshire



telling drivers "CCTV cameras take your rubbish home". Bob says he's yet to see any of these mechanical Wombles picking up litter, and what the CCTV cameras are doing with it at home is anyone's guess.

AND finally, Emma Smith writes in with a location based retronym. "Being a resident of Bristol, I must let you know of a nominative version that's known in this city. There is an area here called Lawrence Weston, which residents refer to as 'El Dub'."

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.

Silver linings?

Should we expect clouds to look different as global warming proceeds?

■ The role of clouds and oceans are the two biggest uncertainties in mathematical models of the climate. But one would expect a warmer world to lead to an enhanced hydrological cycle, with more evaporation and an increase in globally averaged precipitation from more rain-bearing clouds.

The physics is complicated as clouds can simultaneously cool the planet through reflection of solar radiation and warm it by absorption of infrared radiation emitted from Earth's surface.

Whether warming or cooling wins is partly dictated by the altitude at which water vapour condenses or water freezes. Feathery, high-altitude cirrus clouds have a warming effect, so more of these would increase the anthropogenic greenhouse effect. Stratus is the layer of clouds that blankets the whole sky on overcast days – more of these will reduce any warming. This is partly because they are at low altitude and only slightly cooler than Earth's surface.

*Mike Follows
Sutton Coldfield, West Midlands, UK*

■ I suspect the answer is "not particularly", because clouds are varied and they affect each other's appearance. For example, a white cloud shading another equally white cloud can make it look grey or even black, and sunset clouds

look golden or red because some of the sunlight they reflect has been filtered by other clouds.

A warmer climate might produce either more or less cloud regionally, with updraught and concentrated wind patterns favouring currently unusual shapes, such as more dramatic cumulus or lenticular clouds, or more rippled bars.

Feathery high-altitude cirrus might become more common, though obscured by lower cloud

"A warmer climate might produce more or less cloud with wind patterns favouring unusual shapes"

banks, and if turbulence carries microscopic dust to great altitudes, we might expect more Turner-esque cloudy sunsets, but most such effects would be variants of familiar patterns.

Of course, if Earth's water evaporated to such an extent that our entire atmosphere clouded over – with the kind of purple cloud ceilings seen over Kansas in tornado weather or the solid black cloud ceilings seen on Venus – we would notice. But plenty of other concerns would distract our attention before that happened.

*Jon Richfield
Somerset West, South Africa*

Stoned again

Your question about throwing stones leads me to another. I am left-handed, but like many of us in

this back-to-front world, I can do most things fairly well right-handed. Yet when it comes to throwing overarm or skimming stones, I can only do it right-handed and not with my dominant hand at all. Does anyone know why this might be?

■ If someone were to ask your correspondent to look at some specified target through a small cardboard tube, I suspect they would put it to their right eye. This is because they are likely to be left-handed and right-eyed, as I am. I frequently function as a right-hander when the activity involves aiming, especially using a telescope or rifle sights.

Other activities can go either way. I throw a ball left-handed, but a Frisbee right-handed. However, unlike your correspondent, I skim stones left-handed. This variability is probably due to the degree to which an individual's brain connections support left-handedness and right-eyedness.

*Richard Roth
Sidney, Ohio, US*

■ I am left-handed, left-eyed, left-footed and left-eared. I have no trouble throwing or skimming stones or anything else with my left hand – overhand, side-arm or underhand.

But I have met left-handed people who are not left-eyed or left-footed. All such connections are cross-wired, meaning all my physical coordination is isolated in the right hemisphere of my brain.

Perhaps the questioner is of

The writers of answers that are published in the magazine will receive a cheque for £25 (or US\$ equivalent). Answers should be concise. We reserve the right to edit items for clarity and style. Please include a daytime telephone number and an email address if you have one. New Scientist retains total editorial control over the published content.

New Scientist Ltd reserves all rights to reuse all question and answer material that has been

submitted by readers in any medium or in any format and at any time in the future.

Send questions and answers to The Last Word, New Scientist, 110 High Holborn, London WC1V 6EU, UK, by email to lastword@newscientist.com or visit www.newscientist.com/topic/lastword (please include a postal address in order to receive payment for answers). Unanswered questions can also be found at this URL.

mixed preference and the resulting crosstalk between hemispheres, routed through (and delayed by) the corpus callosum, results in less hand-eye, or hand-step, coordination.

*Anthony Castaldo
San Antonio, Texas, US*

■ I am left-handed. From an early age, my son always picked up pens with his left hand, and still writes with his left hand, but over the years it has become clear that he is actually right-handed. I can only assume that this happened because he copied me.

*Sylvia Potter
Guildford, Surrey, UK*

■ I have the same situation as your correspondent, but the opposite way round. My mother puts this down to being advised to try to change my obvious left-handedness when I was young. In the past this was thought to be sensible.

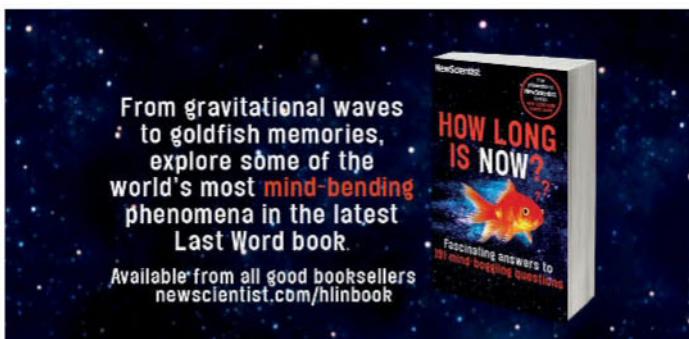
*Anton Fletcher
Droitwich, Worcestershire, UK*

This week's question

POLLUTION RESOLUTION

If I replace my old diesel car with a less polluting new petrol one, how long will it take for the reduced pollution of the new car to outweigh the increased pollution caused by the manufacture of the new car and the disposal of the old, assuming average usage?

*Steve Morrisby
Pinner, Middlesex, UK*





Professor Dame Carol Robinson

2015 Laureate for United Kingdom

By Brigitte Lacombe



Science needs women

**L'ORÉAL
UNESCO
AWARDS**

Dame Carol Robinson, Professor of Chemistry at Oxford University, invented a ground-breaking method for studying how membrane proteins function, which play a critical role in the human body.

Throughout the world, exceptional women are at the heart of major scientific advances.

For 17 years, L'Oréal has been running the L'Oréal-UNESCO For Women In Science programme, honouring exceptional women from around the world. Over 2000 women from over 100 countries have received our support to continue to move science forward and inspire future generations.

JOIN US ON [FACEBOOK.COM/FORWOMENINSCIENCE](https://www.facebook.com/forwomenninscience)