

GHOST PARTICLES

Neutrinos reveal
cosmic secrets

EXTREME MEASURES

The desperate search
for an autism cure

SPACE SQUALLS

They drive up the
cost of electricity

NewScientist

WEEKLY June 26 - July 2, 2010



RISE OF THE QUANTUM MACHINES

They're on a mission to the edge of reality

US\$5.95 CAN\$5.95 No2766



CHIMP WARS

Land grab in
the rainforest

Science and technology news www.NewScientist.com US jobs in science



LEADING THE WORLD IN ARCTIC CLIMATE CHANGE RESEARCH.

THE UNIVERSITY OF MANITOBA RECEIVES CANADA EXCELLENCE RESEARCH CHAIR AND \$35 MILLION IN FUNDING FOR ARCTIC RESEARCH.

The key to global climate change may lie deep within Arctic ice. Now, the University of Manitoba has been recognized with one of the country's most prestigious research awards – the Canada Excellence Research Chair (CERC) in Arctic Geomicrobiology and Climate Change – to help uncover these secrets.

The new chair will be held by **Dr. Søren Rysgaard**, a distinguished geomicrobiologist from Greenland. He will join the 100-plus team from the University of Manitoba's Centre for Earth Observation Science in the Clayton H. Riddell Faculty of

Environment, Earth, and Resources. This world-renowned group will be the first to explore the Arctic on a micro scale.

With the CERC award and the support of other partners totalling \$35 million in funding, the team's focus on the Arctic's role in global climate change will cement the University of Manitoba's position as a leader in environmental and climate change studies.

For more information, please visit umanitoba.ca

INNOVATIVE RESEARCH. EXCEPTIONAL FACULTY. A SUPPORTIVE ENVIRONMENT THAT INSPIRES EXCELLENCE.



Canada Excellence
Research Chairs
Chaires d'excellence
en recherche du Canada

One university. Many futures.
umanitoba.ca

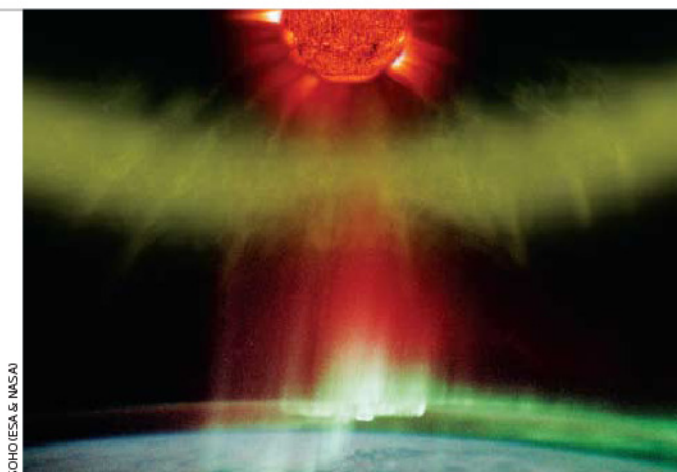


UNIVERSITY
OF MANITOBA

6

Space weather forecast

Scrambled rail signals and rusting oil pipelines; even mild space storms raise hell



SOHO/ESA & NASA

COVER STORY

34

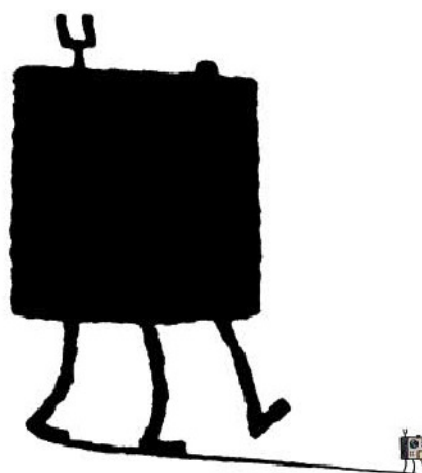
Quantum machines

Exploring the boundary between the quantum and everyday worlds



Cover image
Westmac

TOM GAULD



38

Climates frozen in time

To understand Earth's future, we need to reconstruct the past



MACDUFFEVERTON/RADIUS IMAGES/CORBIS

Coming next week...

Flying sub

It soars like an eagle and swims like a stingray

Instant expert: Relativity

The first in our series of free monthly pull-outs

News

3 EDITORIAL

Families affected by autism need more help

4 UPFRONT

Stem cells enable blind to see. Climate change helps space junk linger. Asteroid scanner goes live

6 THIS WEEK

Time to resurrect the sterile neutrino. Exotic matter in free fall. Grief: why old people don't bounce back. Eviction looms for summer berries. Stem cell solution for endangered species. Chimps go to war over mulberry tree

17 IN BRIEF

Freeze! World's coldest antiprotons. Female brain swells to find a mate. Chicks count from left to right, too

21 TECHNOLOGY

Pilotless planes jockey for airspace. The sand-burrowing robot. Will insurance wells provide relief?

Opinion

26 Empty words Public dialogue on synthetic biology is pointless unless it is acted upon, argue Tom Wakeford and Jackie Haq

27 One minute with... Robb Fraley

Monsanto's technology chief says his company is reinventing itself as a champion of healthy eating

29 LETTERS

On vivisection. Lost languages

32 Seeing is believing Christopher Chabris and Daniel Simons on their famous "invisible gorilla" experiment, and our review of their new book on how our intuition deceives us

Features

34 Rise of the quantum machines (see left)

38 Climates frozen in time (see left)

42 The lure of a cure If you thought you could treat your child's autism, wouldn't you give it a try?

46 Winning combinations Hidden forces are pushing and pulling on the levers of evolution

Regulars

29 ENIGMA

50 BOOKS & ARTS

Review Facebook's plan for world domination dissected

51 Reviews How religion evolved. Egyptian astronomy. International trout disaster

56 FEEDBACK

Baffling sounds

57 THE LAST WORD

Do bats get dizzy?

52 JOBS & CAREERS

Now with up to
£200 CASHBACK*

SHARP



***Image simulated. Reaction is not.**

THE NEW SHARP QUATTRON. FOR COLOURS NEVER BEFORE SEEN ON TV.

The Quattron is a world first, with a unique 4 colour technology giving you 1000 times more colour than any other television. By adding a yellow sub-pixel to the standard RGB colour matrix we can now produce shades of colour never seen before on TV. 22 years ago Sharp invented the LCD TV and now we have reinvented the technology. **You have to see it, to see it.**

See the difference the yellow sub-pixel makes at quattron.tv



*£150 cashback on LC40LE811E, LC40LE821E & LC40LE820E models. £200 cashback on LC46LE811E & LC46LE821E models. Promotional period 18.06.10 to 01.08.10. Full terms and conditions at www.sharp.co.uk/page/quattroncashback

NewScientist

LOCATIONS

USA

225 Wyman Street,
Waltham, MA 02451
Tel +1 781 734 8770
Fax +1 720 356 9217

201 Mission Street, 26th Floor,
San Francisco, CA 94105
Tel +1 415 908 3348
Fax +1 415 704 3125

UK

Lacon House, 84 Theobalds
Road, London WC1X 8NS
Tel +44 (0) 20 7611 1200
Fax +44 (0) 20 7611 1250

Australia

Tower 2, 475 Victoria Avenue,
Chatswood, NSW 2067
Tel +61 2 9422 2666
Fax +61 2 9422 2633

TO SUBSCRIBE

Tel 888 822 3242
subscribe@newscientist.com
An annual subscription in the
USA is \$154 including delivery.
An annual subscription in Canada
is CAN\$182 including delivery.
Canadian subscriptions distributed
by RCS International, 12182 Belden Ct,
Livonia, MI 48150

CONTACTS

Editorial & media enquiries

Tel 781 734 8770
jill.heselton@newscientist.com

Enquiries

Tel +44 (0) 20 7611 1202
enquiries@newscientist.com

Who's who

newscientist.com/people

Contact us

newscientist.com/contact

Display Advertising

Tel 781 734 8779
joe.mccabe@newscientist.com

Recruitment Advertising

Tel 781 734 8770
nssales@newscientist.com

Permissions for reuse

syndication@newscientist.com

Marketing

Tel 781 734 8778
marketing@newscientist.com

Newsstand

Distributed by Curtis Circulation
Company, 730 River Road, New
Milford, NJ 07646-3048
Tel 201 634 7400

Syndication

Tribune Media Services International
Tel 213 237 7987
email latsihelp@latsi.com

© 2010 Reed Business
Information Ltd, England.

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

Reed Business Information, c/o Schnell
Publishing Co. Inc., 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

Desperate for a cure

We must make sense of the uncontrolled experiment in autism therapy

HERE is the uncomfortable truth about autism: we know little about the many causes of this spectrum of disorders, nor how to treat them in an effective way. Feeling abandoned by mainstream medicine, some parents are driven to try unorthodox “cures” (see page 42). This is dangerous territory.

Most likely, these treatments do nothing. Some may help, though without proper trials we can't be sure. Some can also have dangerous side effects.

While behavioural therapies don't eliminate autism, they have at least been properly tested and are known to lessen symptoms. What is clear is that some parents will stop at nothing in the quest to find a cure for their children, even if there is no science behind their attempts.

What's to be done? Parents who

are using unorthodox treatments are conducting an enormous uncontrolled experiment on their children. It's not to be encouraged, but might it be possible to conduct a damage limitation exercise? Perhaps salvage something for science?

If parents were to record the doses and impacts of the

“Parents won't stop trying to treat their children, even if no science lies behind their attempts”

treatments they are trying in a central database, the data would admittedly not be solid enough to prove that a treatment works. But it would at the very least draw attention to the dangerous ones, maybe even tease out any promising ones.

The Interactive Autism Network

(IAN) in Baltimore, Maryland, runs such a database. Although the largest of its kind, only around 5 per cent of US families that have children with autism are signed up. A hike in the network's annual funding – just \$2 million at present – would help it recruit more families and make better use of its data.

This can offer a way out of the dilemma. On the one side are mainstream doctors who may have little to offer parents desperate for an effective treatment. On the other are those who say that unproven treatments can “reverse” autism. It's hardly surprising that parents may be misled by the hype of the latter. By joining the network, it's just possible that a useful treatment may emerge amid the slew of unorthodox therapies. If it is there, we need to find it. ■

Are we just violent apes?

THE fact that chimpanzees wage land-grabbing battles (see page 14) will be used by those who are cynical about human nature as evidence that warfare is inevitable. If our close relatives form coalitions to kill their rivals, such behaviour must be embedded in our DNA, they will argue.

But these battles are really no more than skirmishes: they have

little in common with human warfare. The idea that war is hard-wired is also weakened by the fact that different human cultures have different propensities for war. For example, people in modern societies are less likely to die a violent death than those from some traditional cultures, and war between democratic nations is relatively rare.

However, as resources become ever more scarce, these advances in peace may be reversed.

Resources also matter to chimps: a piece of land well-provisioned with fruit trees, for instance, is something to fight over. But this does not show the unavoidability of war. Instead, it serves as a reminder that a burgeoning global population and increasing pressures on supplies of food and water could lead to more than environmental turmoil. ■

The ghostliest particle of all

YOU could be forgiven for thinking that particles that whizz through the planet with no effect are inconsequential. Not so.

Such particles – neutrinos – occasionally interact with

matter, producing flashes in particle detectors. “Sterile” neutrinos, on the other hand, are even harder to find as they are loath to interact with ordinary matter – a characteristic that makes them a prime candidate for being the stuff of dark matter. Since their “discovery” in the 1990s, though, their existence

has been heavily debated.

Now physicists have repeated the original experiment and found that this ethereal entity may not be a mere statistical error (see page 10). If it turns out that sterile neutrinos are not a figment of our imagination, we may finally have answered one of the most pressing questions in cosmology. ■



One of the few free clinics in the US

Sub-ice ridge

THE discovery of an underwater mountain ridge could help solve the mystery of why Antarctica's Pine Island glacier is vanishing so rapidly.

A robot submarine sent beneath the glacier's floating ice sheet has shown that there is a ridge rising 400 metres from the sea floor. Until recently, the glacier would have rested on this ridge, preventing warm seawater from reaching the ice and melting it from underneath. But the submarine has shown that the glacier no longer rests on the ridge – it has thinned and now floats above it (*Nature Geoscience*, DOI: 10.1038/ngeo890).

"Once you tip the glacier off

"Once you tip the glacier off the ridge, warm water can reach the ice and melt it from below"

the ridge, it continues to thin, and this allows even more warm water over the top of the ridge, so it reinforces the whole process," says Adrian Jenkins

of the British Antarctic Survey.

In January, a modelling study suggested that if such a ridge did exist, then once the glacier retreated behind it, the glacier would not be able to recover.

"The study confirms our concern that this is a major area of ice mass loss that could be sustained," says Christian Schoof of the University of British Columbia in Vancouver, Canada. Pine Island glacier is one of a handful in West Antarctica which together are estimated to be responsible for about 10 per cent of global sea-level rise.

MASSIMO BREGA/THE LIGHTHOUSE/SPL



Given the all-clear

US last in healthcare test

THE only way is up for US healthcare. The nation has finished bottom of the pile in a survey of health provision in similarly developed countries.

Researchers with the Commonwealth Fund, a foundation in New York City that promotes research on health issues, surveyed patients and doctors in seven leading industrialised countries: Australia, Canada, Germany, the Netherlands, New Zealand, the UK and the US.

Based on a series of markers designed to assess healthcare quality, efficiency, ease of access, equality and the promotion of a long and healthy life, the US showed the biggest room for improvement, even though it spent \$7290 per person on healthcare in 2007. The winners were the Netherlands, who achieved the

best results despite spending just \$3837 per person.

Karen Davis, president of the Commonwealth Fund, attributes the Dutch success to the nation's excellent primary care system, which stresses continuity. "People have been with the same doctor for a long period of time," she says.

Davis expects the US to perform better in future surveys, thanks in part to health reforms that became law in March. Increased spending on IT systems should also help by reducing inefficiencies such as duplicated diagnostic tests.

But don't expect a rapid turnaround. Most of the provisions in the reform package on expanding health-insurance coverage will not take effect until 2014.

Restricted views

THE first of the asteroid-hunting Pan-STARRS telescopes is now on the lookout for threatening near-Earth objects, but its vision is impaired due to the US military.

From its perch atop the Haleakala volcano in Maui, Hawaii, PS1's mammoth, 1400-megapixel camera should uncover 100,000 new asteroids and identify any that are on a collision course with Earth. However, the US air force, which funded the development of the telescope, requires that software

automatically black out a swathe of pixels to hide the trajectories of passing satellites.

Last year this restriction, plus other shortcomings, meant that just 68 per cent of the total sky imaged produced usable pictures. As of March, improvements in image processing have boosted that figure to 76 per cent, says team member Eric Bell. Still, the asteroid hunters have had to add an extra set of observations for certain patches of sky to compensate for the possibility that an object might whizz by undetected.

Stem cell sight

STEM cells have restored sight to 82 people with eyes blinded by chemical or heat burns.

The results provide a timely boost for bona fide stem-cell researchers following a recent patient death due to an untested stem-cell treatment and mounting concerns over private clinics offering bogus treatments.

Of the 107 eye patients treated, some as long as a decade ago, the successful cases had sight restored

to a level up to 0.9 on a visual acuity scale, in which 1 represents perfect vision, reports Graziella Pellegrini at the University of Modena in Italy (*The New England Journal of Medicine* (DOI: 10.1056/nejmoa0905955)).

Most of the patients had burns in only one eye, so Pellegrini's team was able to treat them with corneal stem cells extracted from their good eye.

Harvested from the limbus, a disc surrounding the iris, the stem cells restored transparency to corneas that had become opaque via the destruction of the damaged eye's store of corneal stem cells.

Greenhouse junk

RISING sea levels, vanishing glaciers and earlier blooming of flowers are among the well-documented effects of climate change. An increase in space junk can now be added to that list.

The upper layers of the atmosphere have a braking effect on defunct satellites and spent rockets, eventually causing them to drop out of orbit and burn up. Arrun Saunders and Hugh Lewis, at the University of Southampton in the UK, studied the orbits of 30 satellites over the past 40 years, and recorded a gradual increase in the time they remain in orbit. They attribute this to the cooling and reduced density of the upper atmosphere caused by increasing carbon dioxide levels.

The researchers calculate that the atmosphere is reducing in density by 5 per cent every decade at an altitude of 300 kilometres. "The lower molecular braking means debris can remain in orbit up to 25 per cent longer," says Lewis.

This raises the risk of collisions with satellites and makes it more hazardous to launch spacecraft. Space agencies may need to double the amount of debris they plan to remove from orbit, the researchers say. They presented their work at a conference in Boulder, Colorado, last week.

Empty victory?

MONSANTO is notching it up as a victory, but whether an end to the ban on the firm's genetically modified alfalfa will actually lead to the seeds being sold is unclear.

In 2007, organic farmers sued Monsanto, winning an injunction that prevented the firm selling its "Roundup Ready alfalfa". The farmers argued the alfalfa had not been properly checked by the US Department of Agriculture (USDA) for its environmental impact.

Monsanto appealed, and on Monday the Supreme Court ruled that the lower court had been

"unjustified" in imposing its ban. However, it also ruled that the USDA had broken the law by allowing the seeds to be sold in 2005 in the first place. This means the GM alfalfa cannot be sold until the USDA carries out an impact

"A court was 'unjustified' in banning Roundup Ready alfalfa, but the seeds must still be investigated"

assessment. "That could take years," says John Bianchi, a spokesman for the Center for Food Safety in Washington DC, which is representing the farmers.

Lose loopholes, consider quotas

THE fate of whale species was being negotiated behind closed doors this week.

"I think it's fair to say that key governments are viewing it as a make-or-break time," Sarah Duthie, of Greenpeace, told *New Scientist*, speaking from the annual summit of the International Whaling Commission (IWC). "It's difficult to see how negotiations will continue if there are still fundamental differences that can't be resolved by the end of the week."

In an attempt to do just that, IWC chair Christian Maquiera and vice-Chair Anthony Liverpool have put forward a new proposal. It eliminates certain loopholes in the so-called ban on commercial

whaling - including one that allows Japan to hunt whales for "scientific research". While this aspect of the new proposal gets the support of NGOs like Greenpeace, other elements are highly controversial.

For instance, the text suggests quotas for all hunted species, including some endangered ones. According to Maquiera and Liverpool, their proposal would lead to 14,000 fewer whales killed in the next decade, compared with the number of whales that would be killed if catch rates continued at 2009 levels.

But Greenpeace and WWF remain staunchly opposed to any hunting of endangered or vulnerable species. "We are all waiting to see if there is a new proposal," says Duthie.



How many more?

60 SECONDS

Cancer link trashed

Cellphone masts have been cleared of any link with childhood cancer by a study of 7000 British children - the largest study of its kind undertaken. Children who developed cancer between 1999 and 2001 were no more likely to have been born near a mast than healthy children (*BMJ*, DOI:10.1136/bmj.c3077).

Halfway to Pluto

The first mission to Pluto has passed a milestone. On 14 June, the NASA spacecraft New Horizons had covered half the distance to the dwarf planet. Despite New Horizons being the fastest object ever launched from Earth when it departed in January 2006, it will still take another five years to arrive at Pluto.

Female 'Viagra' flops

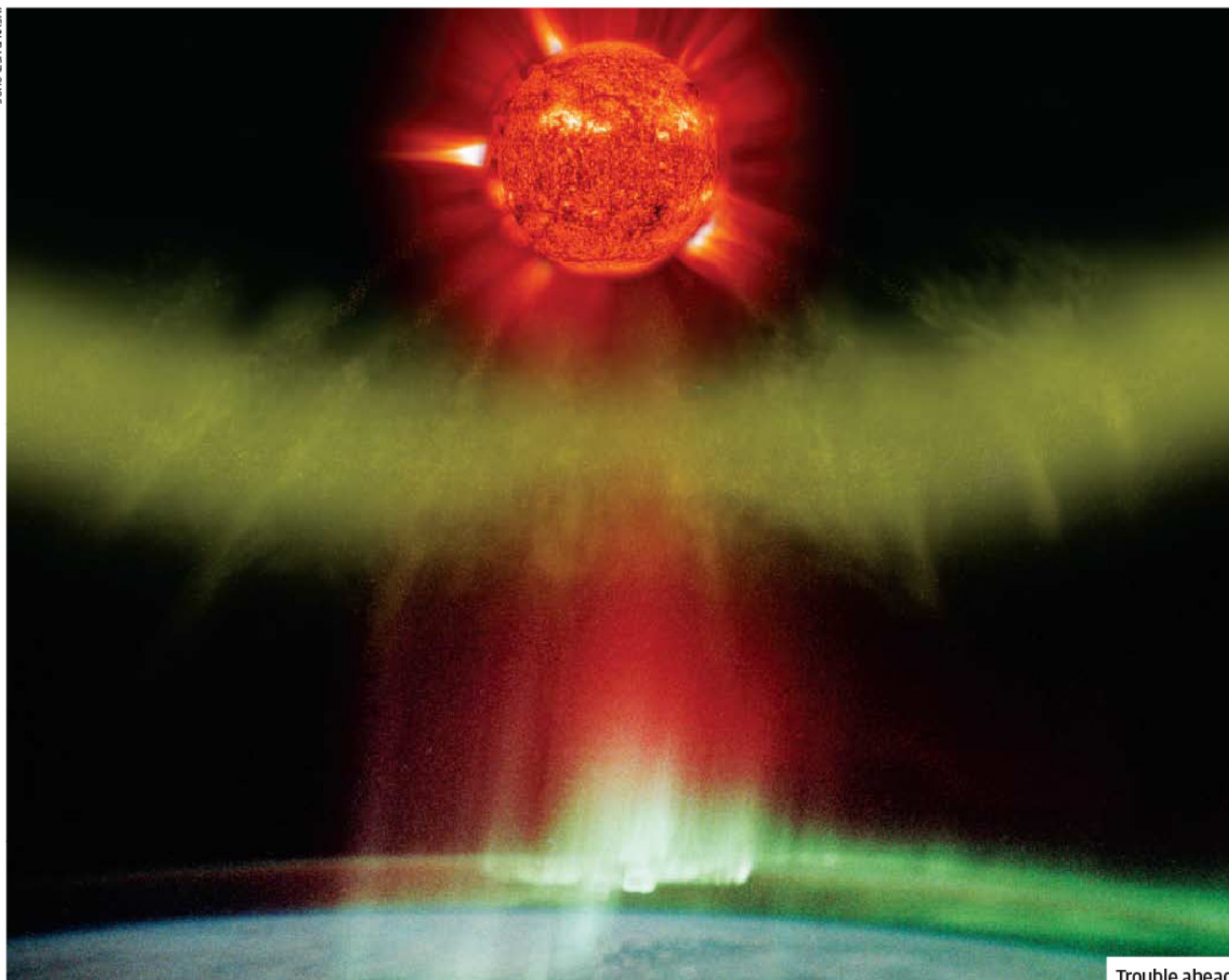
A drug designed to boost female libido was rejected last week by a panel from the US Food and Drug Administration. It concluded that flibanserin, developed to raise sexual desire in the brain, doesn't provide enough sexual satisfaction to offset the possible side effects of using it, which include fainting, dizziness, depression and appendicitis.

Ten-year savings plan

Just 10 years - that's the time required to save our closest cousin from extinction, say the IUCN and the Wildlife Conservation Society. They announced this week that east and central African nations have devised a plan that could - if implemented - protect 96 per cent of eastern chimpanzees.

The ol' swoop 'n' skim

NASA's Cassini spacecraft has performed a daring manoeuvre - skimming through the upper atmosphere of Saturn's moon, Titan, at a speed of 5.9 kilometres per second. The goal was to get close enough to the moon to see if it has its own magnetic field, which could signify an ocean beneath its icy surface.



Trouble ahead

When the sun belches...

Even modest solar activity can play merry hell with terrestrial technology, it is rapidly becoming clear

David Shiga

EVER think to check the space weather forecast? Power suppliers and the operators of oil pipelines and railroads might want to start.

Although it would take a truly massive space storm to cause a catastrophe, it is becoming clear that even modest solar activity poses a threat in our technology-dependent world. It makes railway signals go haywire and rusts oil

pipelines to the point that they may leak, not to mention wearing down key components in power grids, which could drive up the cost of electricity.

If our planet happens to be in the line of fire when the sun belches out clouds of plasma, these coronal mass ejections (CMEs), can greatly disturb Earth's magnetic field. Such magnetic disturbances in turn can generate currents in power

transmission lines, which act like giant antennas to pick up the disturbances.

A huge solar burst – similar in strength to one observed in 1859, the biggest on record – could wreck the world economy. Big storms that occur about once per decade can also create chaos, like one that caused a 9-hour blackout in Quebec, Canada, in 1989.

But the effects of smaller space

“Power transmission lines act like giant antennas, picking up disturbances in Earth’s magnetic field”

storms have not been examined in as much detail as they deserve, says Louis Lanzerotti of the New Jersey Institute of Technology, who is editor of the journal *Space Weather*.

Relatively minor space storms now appear to be behind a range of mysterious mishaps – railway signals malfunctioning in Archangel province in north-western Russia, for example, between 2000 and 2005. A study led by Eugenia Eroshenko of the Pushkov Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation in

In this section

- Reviving endangered species with stem cells, page 8
- Grief: why old people don't bounce back, page 13
- Exotic matter in free fall, page 13

Troitsk, Russia, examined episodes when signals turned red for minutes or even hours though the track ahead was clear, then spontaneously reverted to green.

Eroshenko's team found that 16 malfunctions of this sort observed between 2000 and 2005 coincided with space storms (*Advances in Space Research*, DOI: 10.1016/j.asr.2010.05.017). "We were surprised by such a clear correlation," Eroshenko says.

How could space weather switch railroad signals from green to red? CMEs appear to interfere with circuits used to sense whether a segment of track is occupied. A power source connected to the two rails normally maintains a voltage between them while they are unoccupied. When a train is present, it eliminates the potential energy difference between the rails by allowing electricity to flow from one to the other. Space storms may have the same effect on the rails as a train, generating unwanted electric currents that could cause the voltage between the two rails to drop and the signal to turn red.

The parts of the Russian railway studied by Eroshenko's team might be especially vulnerable to space weather because they are in the far north, and solar storms are most intense around the poles.

Team member Risto Pirjola of the Finnish Meteorological Institute in Helsinki thinks that if other countries start examining the timing of unexplained signal problems, they may turn up a similar link to space weather. The evidence of a link to space storms is "very convincing", says Rod Perala of Electro Magnetic Applications, a consultancy in Lakewood, Colorado, that studies the effects of space weather. It would be wise for railways in other countries to check their equipment for vulnerability to space weather, too, he says.

It should be possible to modify railways to prevent these problems. Some sections seem

immune to space weather, perhaps because of minor differences in electrical hardware, and the parts used in the problem-prone areas could be changed, Eroshenko says, but funds have been lacking.

Space weather may also make oil and gas pipelines more prone to rusting—a particular concern because rusty pipelines sometimes spring leaks, creating costly and environmentally damaging spills.

The chemical reactions that cause rust require electrons to flow from the pipe into the surrounding soil, so one way to keep corrosion at bay is to create a potential energy barrier that impedes this flow of electrons, using a power source attached to the pipe. Space storms, however, generate currents in pipes that can overwhelm this barrier, allowing corrosion to proceed.

Engineers have measured such currents, though no one has yet quantified how much these flows increase corrosion. "That's much harder to estimate because it's a long, slow process and it depends on a host of other factors" like soil composition and moisture, says David Boteler of the Geological Survey of Canada's Geomagnetic

Laboratory in Ottawa.

The worry is that corrosion induced by space weather may reduce the useful lifetime of the pipes, which in turn means they require early replacement. This could be a very costly problem, if for example it cuts the lifetime of a pipeline from an expected 60 years to 30, given the great expense of building new ones, Boteler says. And the effects on pipelines may be worldwide.

Richard Marshall of the Australian Bureau of

"If space weather cuts the lifetime of pipes from 60 to 30 years, that could be prohibitively expensive"

Meteorology's space weather unit found that space storms disrupted voltages in pipelines in northern Australia, which is just 20 degrees from the equator (*Space Weather*, DOI: 10.1029/2009SW000553).

"Geomagnetic effects are becoming an issue that must be considered for pipelines at all latitudes," says Boteler.

Subtle effects of run-of-the-mill space storms may also wear down key components in electric power grids, making them liable to early failure.

Space storms cause currents to flow in electrical transformers, which are used to boost the voltage of electrical flows to the high levels needed for efficient long-distance transmission and then back down again for safe use by consumers at the delivery point. Intense power surges due to big space storms can heat transformers enough within minutes to damage the insulation needed to prevent short circuits, which can cause them to explode.

More recently, there are signs that transformers can be destroyed by smaller currents over a period of hours or more. A long-lasting 2003 space storm delivered only relatively low-intensity currents to the South African power grid, but damaged several transformers anyway, notes US-based storm analysis consultant John Kappenman.

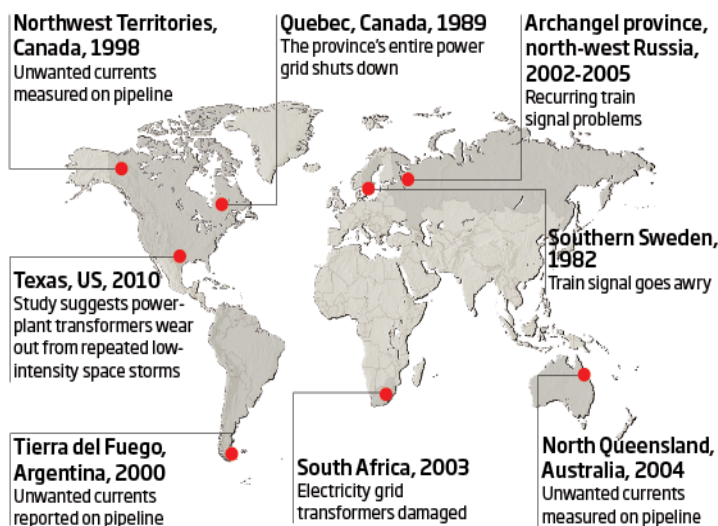
Kappenman raised concerns about low-intensity storms at a conference in March in Dallas, Texas, organised by the North American Electric Reliability Corporation. Small insults from numerous storms may accumulate over a period of years, causing transformers to fail, he says. The number of transformer failures in the US seems to mirror the 11-year rise and fall of the solar cycle, which governs the frequency of space storms, in data Kappenman presented at the conference.

The cost of replacing transformers gets passed on to consumers, though Kappenman says it is unlikely to account for more than a few per cent of the total cost of electricity. Still, the problem is pervasive. "Arguably every transformer that's out there has been exposed to some degree to this problem."

Lanzerotti emphasises the importance of such cumulative effects. "The big [storms] are so dramatic that people pay most attention to them," he says, "but I do think these cumulative types of effects deserve more attention." ■

Wreaking havoc

Only a massive space storm would cause a catastrophe but all these technical hitches were a result of modest space weather



Vital seed store set for destruction

Fred Pearce

THE WORLD'S largest scientific repository of fruits and berries, outside St Petersburg, Russia, could be bulldozed later this year to make way for new homes.

This week Cary Fowler, director of the Global Crop Diversity Trust in Rome, Italy, called for scientists to intervene to prevent "the largest intentional, preventable loss of crop diversity in my lifetime – during the International Year of Biodiversity".

Vladimir Putin, Russia's prime minister, and President Dmitry Medvedev have so far not responded to pleas to save the collection at the Pavlovsk experimental station. Staff there say the last chance to prevent the site being sold may come in a court hearing next week.

The Pavlovsk experimental station is one of 11 that are part of the N. I. Vavilov Research Institute of Plant Industry, one of the world's oldest seed banks. It holds more than 4000 varieties of fruits and berries, including more than 100 examples each of gooseberries, raspberries, and cherries, almost 1000 types of strawberries from 40 countries, from which most modern commercially grown varieties are derived.

Late last year, the Russian Ministry of Economic Development handed over a fifth of the station to the Russian Housing Development Foundation, a state body set up in 2008 to identify public land that could be sold to build private homes. On 28 June, a Russian court will rule on whether the rest of the site should be handed over.

A spokesman for the Housing Development Foundation told

New Scientist that the station land is "not utilised" and that its inspection showed that claims about there being "priceless collections on these pieces of land [are] false".

According to Fyodor Mikhovich, the station's director, "more than 90 per cent of the collection is found in no other research station". Norman Looney, president of the International Society for Horticultural Science, based in Leuven, Belgium, agrees that the collection is unique. He told *New Scientist* that with world food production likely to move north as a result of climate change, "these genetic resources will become even more important to breeders".

"It would be a major tragedy if the collection were lost," says Jim Hancock of Michigan State

University. One of the world's leading strawberry breeders, he says the collection houses many Russian varieties that are exceptionally hardy and disease-resistant.

Mikhovich says it is unlikely the courts will block the rest of the site from being handed over, so attention may soon focus on relocating the collection. Fowler, who is in charge of assembling seeds from most of the world's crops at a "doomsday vault" in the Arctic, says most of the seeds in the Pavlovsk collection will not survive freezing, and only planting can protect their genes for posterity.

"We will try to help them rescue the station. We have contacted a number of institutions to alert them that we may need to swing into action at short notice if the court rulings go against Pavlovsk," he says. "But no rescue effort will salvage much. There will be little time, there is no place to put the collection and quarantine regulations will prevent us sending it abroad quickly." ■

Frozen tissue could help save rare species

TAKE frozen cells from a dead animal, reprogram them to become sperm and eggs, then use these to bring endangered species back from the brink.

That's the aim of a collaboration between the San Diego zoo and The Scripps Research Institute in La Jolla, California. At the annual meeting of the International Society for Stem Cell Research in San Francisco last week, Inbar Friedrich Ben-Nun and Jeanne Loring of Scripps described how they have created induced

The long-term goal is to turn iPS cells into sperm and eggs, which can be used to breed rare animals

pluripotent stem (iPS) cells from the frozen skin cells of a deceased male drill (*Mandrillus leucophaeus*), an endangered monkey found in Nigeria, Cameroon and Equatorial Guinea.

The team's long-term goal is to coax iPS cells into becoming sperm and eggs. They will be making iPS cells from tissue held by San Diego zoo's Frozen Zoo project – which has samples from some 8400 individuals representing more than 800 species. The sperm and eggs could be used in IVF treatments to add genetic diversity to captive breeding programmes. "You could actually breed from animals that are dead," says Loring.

To create the iPS cells, the team used viruses engineered to carry four human genes that can reprogram adult cells into an embryonic stem cell state. However, the trick failed to work with cells from the northern white rhinoceros. Loring says it may be necessary to use rhino versions of the genes.

Another problem is that the reprogramming genes can make the iPS cells cancerous, though other researchers have developed techniques to make iPS cells without leaving copies of the genes behind.

Peter Aldhous ■



Won't survive the bulldozers

CHP LUTHERLAND/THE NEW YORK TIMES/REDUX/EYEVINE

NEW
FOR 2010

Horsepower meets brainpower.



Meet the all new 2010 Intel® Core™ Processor Family with Turbo Boost Technology.¹

So smart, it knows when you need a speed boost—and instantly provides it.

So revolutionary, computing will never be the same. www.intel.co.uk/core



Sponsors of Tomorrow:

Copyright © 2010, Intel Corporation. Intel, the Intel logo, Intel Core, Core Inside, Intel Sponsors of Tomorrow™ and Intel Sponsors of Tomorrow logos are trademarks of Intel Corporation in the U.S. and other countries.

¹ Intel® Turbo Boost Technology requires a PC with a processor with Intel Turbo Boost Technology capability. Intel Turbo Boost Technology performance varies depending on hardware, software and overall system configuration. Check with your PC manufacturer on whether your system delivers Intel Turbo Boost Technology. For more information, see <http://www.intel.com/technology/turboboost>.

Sterile neutrino back from the dead

David Shiga

A GHOSTLY particle given up for dead is showing signs of life. Not only could this “sterile” neutrino be the stuff of dark matter, thought to make up the bulk of our universe, it might also help to explain how an excess of matter over antimatter arose in our universe.

Neutrinos are subatomic particles that rarely interact with

ordinary matter. They are known to come in three flavours – electron, muon and tau – with each able to spontaneously transform into another. In the 1990s, results from the Liquid Scintillator Neutrino Detector (LSND) at the Los Alamos National Laboratory in New Mexico suggested there might be a fourth flavour: a “sterile” neutrino that is even less inclined to interact with ordinary matter than the others.

Sterile neutrinos would be big news because the only way to detect them would be by their gravitational influence – just the sort of feature needed to explain dark matter. Then in 2007 came the disheartening news that the Mini Booster Neutrino Experiment (MiniBooNE, pictured) at the Fermi National Accelerator Laboratory in Batavia, Illinois, had failed to find evidence of them.

But perhaps sterile neutrinos were dismissed too soon. While MiniBooNE used neutrinos to look for the sterile neutrino, LSND used antineutrinos – the antimatter equivalent. Although antineutrinos should behave exactly the same as neutrinos,

just to be safe, the MiniBooNE team decided to repeat the experiment – this time with antineutrinos.

Lo and behold, the team saw muon antineutrinos turning into electron antineutrinos at a higher rate than expected – just like at LSND. MiniBooNE member Richard Van de Water reported the result at a neutrino conference in Athens, Greece, on 14 June.

The excess could be because muon antineutrinos turn into sterile neutrinos before becoming electron antineutrinos, says Fermilab physicist Dan Hooper, who is not part of MiniBooNE. “This is very, very weird,” he adds.

Although it could be a statistical fluke, Hooper suggests that both MiniBooNE results could be explained if antineutrinos can change into sterile neutrinos but neutrinos cannot – an unexpected difference in behaviour.

The finding would fit nicely with research from the Main Injector Neutrino Oscillation Search, also at Fermilab, which, the same day, announced subtle differences in the oscillation behaviour of neutrinos and antineutrinos. Antimatter and matter are supposed to behave like mirror versions of each other, but flaws in this symmetry could explain how our universe ended up with more matter. ■



Neutrinos are tough to detect

Intonation is key to getting the question right

ANYONE who has tried to learn a new language knows how difficult it can be to learn a different grammar. Wouldn't it be great if there were rules of grammar that applied to all languages?

Perhaps there are. Norvin Richards of the Massachusetts Institute of Technology has proposed a universal rule linking intonation with where we place question-words like “what” and “who” in a sentence. This is the first time anyone has found a link between

intonation and word order in questions, and it could also help explain how babies learn to speak.

In some languages, a statement can be turned into a question by, for example, replacing the object of the sentence with a question-word and changing the intonation. In other languages, including English, the question-word also moves relative to the word it replaces: “Heather is buying a book” becomes “What is Heather buying?”

In his new book *Uttering Trees*, Richards claims that by studying the complex patterns affecting intonation in different languages, he can predict whether the question-word will move

and where it will go. He says he has checked this for 20 languages, such as Japanese and Basque, where the rules of intonation are precise enough for the idea to be tested.

Intonation can be mapped as patterns of pitch that are separated by breaks. Richards found that whether the question-word moves relative to the word it replaces depends on whether these breaks tend to come at the beginning of phrases or at the end.

“It’s a really neat idea,” says Seth

Cable, at the University of Massachusetts at Amherst. Cable is reasonably convinced that the rule applies to all the languages Richards has tested, although he says that it’s a thornier issue whether it will apply to the rest of the world’s languages.

“If correct, it is a very important discovery,” says Maria Luisa Zubizarreta at the University of Southern California in Los Angeles. Such a connection between syntax and intonation would help to explain how babies unravel word order from the continuous streams of sound that they hear, with changes in intonation acting as cues to grammar, she says. Eugenie Samuel Reich ■

“It could explain how babies unravel word order from the continuous stream of sounds that they hear”

Smarter business for a Smarter Planet:

What if your supply chain saw what you needed before you did?

On a smarter planet, it's possible to build a very different kind of supply chain. One that looks at the real-time data of the millions of customers and thousands of vendors it touches and acts on that knowledge – sensing, anticipating, even preempting. If a product is recalled, the supply chain knows and you're able to restock those shelves with new inventory. If a container en route to a partner is missing a part, the supply chain prompts a new shipment before operations are interrupted. If customers prefer red over yellow, the supply chain tells you to order more red and less yellow. IBM is helping companies all over the world build smarter, more self-aware supply chains.

A smarter business needs smarter thinking. Let's build a smarter planet. ibm.com/supplychain/uk



STARTING NEXT WEEK

NewScientist

INSTANT **EXPERT**

A new monthly series of collectable guides

The biggest ideas in science
by the biggest names in science

Your eight-page guide to **GENERAL RELATIVITY**
FREE with **New Scientist** next week

On sale from Thursday 1 July

Why losing a loved one can be lethal

Ewen Callaway

WHY do some widows and widowers quickly follow their spouses to the grave? It seems the so-called widowhood effect could be caused by the combined effects of stress and age-related changes in the immune system.

Previous studies found that among elderly men and women the risk of dying within three months of being widowed increases between 30 and 90 per cent. It had been suggested that this might be connected with changes in the immune system, yet exactly how was unclear.

Now new research has identified some of those changes, and shown that increased cortisol levels caused by stressful events such as bereavement worsen the situation.

Dehydroepiandrosterone sulphate, or DHEAS, is best known as an intermediary of sex hormones like testosterone and oestrogen, yet it also has a role in the immune system. While cortisol dampens immune responses, DHEAS boosts them. Levels of DHEAS usually peak and

begin declining when people are in their thirties.

Janet Lord, an immunologist at the University of Birmingham, UK, has previously found that people over the age of 66 who had a hip fracture had higher blood cortisol to DHEAS ratios than similarly aged people without fractures. Those with the largest disparities were most likely to develop bacterial infections, and Lord's team showed that in these people, white blood cells called neutrophils – a first line of defence against pathogenic bacteria – were less potent (*Aging Cell*, DOI: 10.1111/j.1474-9726.2005.00178.x).

When activated, neutrophils unleash a range of toxic molecules that kill pathogens. Now Lord's team has demonstrated that the presence of DHEAS causes neutrophils to produce one of their more lethal compounds, superoxide (*Molecular Endocrinology*, DOI: 10.1210/me.2009-0390).

In another ongoing but as yet unpublished study, Lord studied widows and widowers aged 65 and over who had been bereaved



Loss affects your immune system

during the previous two months. Preliminary results suggest they have higher cortisol to DHEAS ratios and lower neutrophil function than people who have not recently lost their partner. "When your cortisol is high, when you're in a stressed situation, that's when the lack of DHEAS will be important," she says. Lord's team plans to give supplements of a chemical closely related to

DHEAS to people for three months after hip fractures to see if it increases neutrophil function.

Peter Hornsby, at the University of Texas Health Science Center in San Antonio, says the new work is the "clearest, cleanest" proof that DHEAS can have a direct immune system effect. However, he is yet to be convinced that its drop in old age compromises the immune system, even under stress. ■

Exotic atoms in free fall will test relativity

WHAT do you get if you hurl a cloud of rubidium atoms down an empty elevator shaft? The answer is an exotic form of matter in just the right state to put a key assumption of Einstein's general theory of relativity to the test.

Einstein's "equivalence principle", which underpins general relativity, says that if you stand in a falling elevator, your acceleration should cancel out the pull of gravity, leaving you unable to tell whether you are in

free fall or whether there is simply no gravity present at all.

Determining whether this principle holds at the quantum scale might offer clues as to why quantum theory has so far resisted any merger with general relativity. One way to do this is to put a fragile form of matter that exists at the boundary between quantum and classical physics – a Bose-Einstein condensate (BEC) – into microgravity.

That is no simple feat, but Ernst Rasel of the University of Hannover in Germany and colleagues have now achieved it, during a 4.7-second free-fall plunge. Their trick was to create a device consisting of computer-controlled lasers and

a magnetic coil that can turn a cloud of rubidium atoms into an ultracold BEC "on the fly". The atoms are initially cooled by laser, then transferred to a magnetic trap for the final stage of cooling. This leaves a BEC, in which all atoms adopt the same wave pattern, forming a single quantum object.

The team put this device inside a 2-metre-long capsule and dropped it down a 110-metre shaft which had been pumped to a vacuum. More than 3 seconds into the fall, a camera captured

"To use the set-up to test the equivalence principle, the device will need to split the BEC during free fall"

the BEC's shadow as the quantum object expanded to take on classical dimensions – about 2 millimetres across (*Science*, DOI: 10.1126/science.1189164). An instant later, the capsule hit a thick layer of styrofoam balls at the bottom of the shaft.

To test whether quantum states obey the equivalence principle, the researchers will need to hone the device to split the BEC. This will allow them to send the two halves along separate paths, and analyse the interference pattern produced when they are reunited – an indication of how gravity acts on BECs in free fall. This can then be compared with a BEC's behaviour in space. Kate McAlpine ■

Chimpanzees kill to win new territory

Ewen Callaway

A BLOODY 10-year dispute in the Ugandan jungle ended last summer with the victors seizing territory held by the vanquished. It is the first solid evidence that chimpanzees kill their rivals to acquire land. It could also help explain the evolutionary origins of some aspects of cooperative behaviour in humans.

John Mitani, a primatologist at the University of Michigan in Ann Arbor and his team have observed the Ngogo chimpanzee troop in Uganda's Kibale National Park for over a decade. Between 1999 and 2009, they witnessed 18 lethal attacks led by Ngogo males on another, smaller group of chimps. They also found indirect evidence of three other lethal attacks, making the Ngogo troop one of the most violent groups of chimpanzees so far studied.

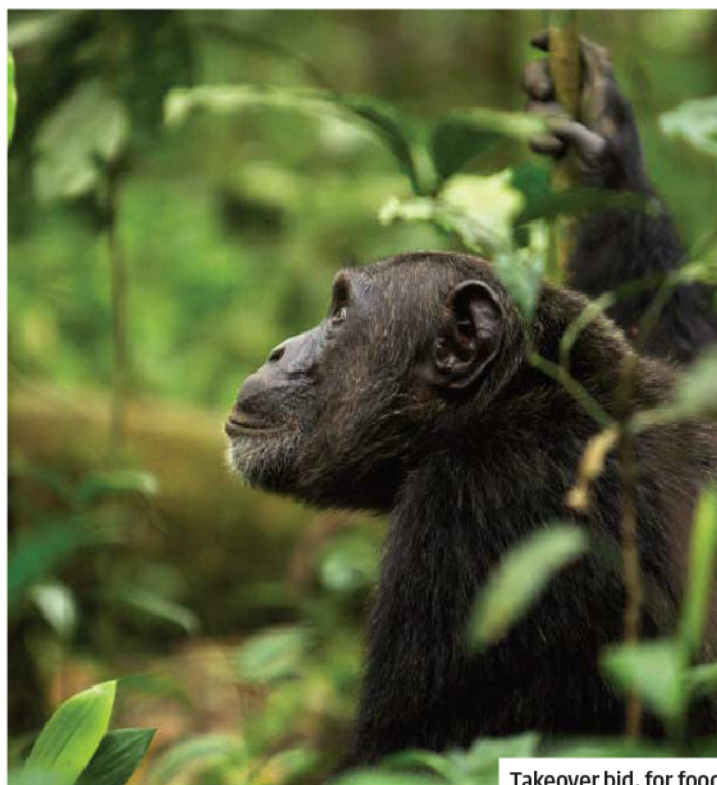
With more than 150 individuals, the Ngogo troop is two or three times as large as other well-studied groups. Superiority in numbers allows it to patrol its territory's hinterlands, where members are likely to encounter smaller, neighbouring troops. "Attacks are made when there's more of us

than them," says Mitani.

In mid-2009, his team noticed that the Ngogo chimps had finally seized the home range of their rivals, so increasing the size of their territory by 6.4 square kilometres, or 22 per cent. Where only adult males on patrol had previously visited this area, now the team saw them "going in there with females and children and acting and shouting like they would if they were in the middle of their territory", Mitani says (*Current Biology*, DOI: 10.1016/j.cub.2010.04.021). The Ngogo chimps were probably drawn by food: black mulberry trees had begun fruiting in the area around the time of the takeover.

The territorial gain is likely to bring about other advantages. Chimps in troops with large home ranges tend to weigh more than those with less land, and their females tend to have more young. Territorial gains could also draw in females from neighbouring troops, offering more mating opportunities to the males.

Similar changes have been seen in human hunter-gatherer communities, but Mitani cautions against drawing too many parallels between human



Takeover bid, for food

and chimp battles. Humans go to war for a variety of reasons ranging from disputes over resources to religion, and such conflicts can often be settled by negotiation.

In fact, rather than explaining the origins of war, chimp disputes could shed light on the evolution of cooperation. Mitani points out that the Ngogo chimps worked as tightly knit coalitions to kill their opponents, with benefits for the victorious troop. "There's an interesting relationship between cooperation and competition in

both chimps and in humans," agrees Michael Wilson of the University of Minnesota.

That relationship has been studied in humans by Samuel Bowles at the Santa Fe Institute in New Mexico. Using evolutionary models and archaeological evidence, he has argued that altruism emerged in humans as a result of violent conflicts between groups who were willing to die for their comrades and more selfish, individualistic populations – with the altruistic warriors winning out. ■

Diabetes link to 24-hour lifestyle

A FAULTY internal clock in the cells in the pancreas that produce insulin could be behind type 2 diabetes – a condition in which the body is unable to produce or use insulin properly.

The finding suggests that disruption of natural night and day cycles through artificial lighting may be a factor in the emergence of type 2

diabetes in adults. It also fits with studies showing that shift workers are unusually prone to the condition.

Insulin is produced by beta cells to control glucose levels in the blood. Joseph Bass of Northwestern University in Evanston, Illinois, and colleagues grew mouse beta cells in the lab to monitor insulin secretion. They found that beta cells lacking circadian "clock" genes produced 50 per cent less insulin, showing that these genes are essential for normal insulin production (*Nature*, DOI: 10.1038/nature09253). Likewise,

live mice with disrupted clock genes rapidly developed type 2 diabetes.

The next step, says Bass, is to identify the "switch" in beta cells that responds to the clock, and use it to develop a treatment.

"The key thing the researchers have shown is that disruption of this internal clock causes a defect in insulin secretion," says Noel Morgan

"Disruption of the internal clock in insulin-producing cells causes a defect in insulin secretion"

of the Peninsula Medical School in Exeter, UK, who studies type 1 diabetes, in which the body's own immune system destroys its beta cells.

In a separate study, Morgan showed that beta cells multiplied 10 times as fast in children newly diagnosed with type 1 diabetes than in healthy individuals (*Diabetologia*, DOI: 10.1007/s00125-010-1817-6). He believes that if the faulty immune response can be stopped, it might be possible to persuade beta cells to multiply and restore normal levels of insulin production. Andy Coghlan ■



THREE FULL HD SENSORS FOR MORE COLOURFUL MEMORIES.

When something incredible happens, you'll want to relive it in as much clarity as possible. That's why the Panasonic SD600 lets you record in full HD straight to SD card, and has three separate full HD colour sensors – for stunning detail and true-to-life colour, even in low light.

Intelligent auto makes it easier than ever to save those precious moments quickly, while face recognition ensures you can always focus on what matters most to you.

Because capturing the moment matters.

EVERYTHING MATTERS.



See why three sensors are better than one
at panasonic.co.uk/sd600
0844 844 3852



SAMSUNG

TURN ON TOMORROW

Discover the ultimate Android experience
on our brilliant Super AMOLED screen.



The Samsung Galaxy S powered by Android. Featuring over 50,000 apps, Google's Voice Guided Navigation, 4.0" Super AMOLED screen, HD record & playback, 1GHz processor for super fast internet access and Swype, the future of messaging. The Samsung Galaxy S smartphone, get more out of life.

Samsung GALAXY S
Welcome to more.



SUPER
AMOLED

Search 'Samsung Galaxy S'

Screen images are simulated. ©2010 Samsung Electronics Co. Ltd. Android is a trademark of Google, Inc.



Turbocharged evolution for corals living on the edge

THOSE trying to save corals from extinction have missed a trick by not focusing on the creative fringe communities, where the animals are evolving faster.

John Pandolfi at the University of Queensland, Australia, and Ann Budd at the University of Iowa, Iowa City, analysed physical and genetic changes in both live and fossilised samples of *Montastraea annularis*, a coral that has lived in the Caribbean for over 6 million years.

The pair found distinct changes in corals on the margins of the Caribbean reefs over millions of years, while samples taken from central locations were static.

This is most likely because fringe corals live in the most extreme conditions that the species can survive, pushing them to evolve faster into better-adapted variants (*Science*, vol 328, p 1558).

"Rather than being marginal players battling to survive, this shows that corals living on the fringe are powerhouses of diversity," says Chris Fulton of the Australian National University, Canberra, who was not involved in the study.

Conservation efforts tend to focus on hotspots that have large numbers of different coral species or highly unique species. "We aren't poooh-pooing that idea," says Pandolfi. But he and Budd suggest they should take a close look at reef margins – particularly given the threat of climate change.

Fertility gives women's brains a boost

THE size of a woman's brain changes throughout her menstrual cycle, with some areas growing by as much as 2 per cent in the run-up to ovulation, when women are at their most fertile.

So say Belinda Pletzer and colleagues at the University of Salzburg, Austria, who took MRI scans of the brains of women during their monthly cycles.

In women not taking the pill,

the team found an increase in the volume of grey matter in the right parahippocampal and fusiform gyri, areas of the brain involved in spatial location and facial recognition (*Brain Research*, DOI: 10.1016/j.brainres.2010.06.019).

This boosts women's abilities to recognise faces, bodies and landscapes, says Pletzer, adding that this may help them to locate a high-quality mating partner.

The team found that the effect is short-lived, however. After ovulation, rising levels of progesterone cause the gyri to shrink back.

The team also found that women on the pill had a bigger hippocampus and cerebellum, associated with memory and movement, compared to controls. "The pill may exaggerate typical female behaviours such as superior language skills and memory," says Pletzer.

Hobbit was unique, not a sickly human

CASE closed – the "hobbits" that lived on the Indonesian island of Flores only 13,000 years ago were a unique species of hominin.

This was the first thought when the remains of a tiny, 18,000-year-old female were uncovered in 2003. Then in 2008 Peter Obendorf of RMIT University in Melbourne, Australia, claimed the remains were of a modern human with cretinism, a disease caused by iodine deficiency.

"I have put that claim to rest," says Colin Groves of the Australian National University in Canberra. He compared the Flores bones with those of 10 people who'd had cretinism, focusing on anatomical features that are typical of the disease. He found no overlap (*HOMO – Journal of Comparative Human Biology*, vol 61, p 211). William Jungers at Stony Brook University Medical Center in New York agrees the study finally puts that idea to rest.

Seat of blindsight found in the brain

SOME blind people have the remarkable ability to navigate physical obstacles without consciously perceiving them. It now looks like they have their lateral geniculate nucleus (LGN) – part of the thalamus in the middle of the brain – to thank for this "blindsight".

That's according to a team at the US National Institute of Mental Health in Bethesda, Maryland. They used macaques in which the primary visual cortex had been destroyed.

The monkeys' eye-focusing movements revealed that they were "seeing" images shown at the periphery of their visual field, but only if their LGN was intact (*Nature*, DOI: 10.1038/nature09179).

Supernovae made honeycomb cloud

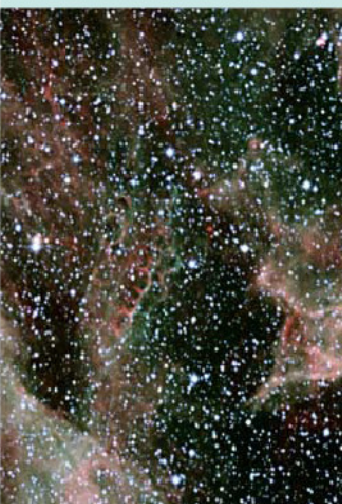
WHEN does an interstellar gas cloud look like honeycomb? When the debris thrown up by two exploding stars collides, suggests a new analysis of the mysterious Honeycomb Nebula (pictured).

Since it was first discovered in 1992, the curious shape of the Honeycomb Nebula, which lurks in a nearby galaxy called the Large Magellanic Cloud, has been a puzzle.

As it floats in an area of the LMC racked by the explosions of numerous supernovae in recent cosmic history, one theory was that the pattern might be caused by a set of localised ripples created when clumps of debris from an ancient supernova were hit by a blast wave from a relatively recent one.

This theory now has support. John Meaburn of the University of Manchester, UK, and his colleagues analysed the light spectrum of the Honeycomb Nebula and found that it resembles the spectrum produced by fast-moving gas in other supernova remnants. Their results will appear in *Monthly Notices of the Royal Astronomical Society*.

The case isn't closed: the honeycomb could be the result of a high-speed jet from a black hole slamming into surrounding gas. However, the team says the nebula's light spectrum is different to that of a black hole jet seen in a binary system called SS 433.



World's coldest antiprotons put antimatter in the frame

ANTIMATTER is powerful stuff, but is it a genuine mirror image of matter? The coldest antiprotons ever made take us a step closer to finding out.

The simplest antiatom, antihydrogen, is made of an antiproton and a positron, the electron's antimatter counterpart. If it is a mirror image of hydrogen, it should emit an identical spectrum of light. The way to test this is to create ultra-cold antihydrogen, allowing it to be trapped and studied. The hard part is cooling the antiprotons.

The ALPHA team – one of two racing to trap antihydrogen using the Antiproton Decelerator at the CERN laboratory near Geneva, Switzerland – uses electrons to do this. The flaw in the method is that the electric fields needed to remove the electrons afterwards reheat some of the antiprotons. This meant ALPHA's antiprotons never got below an average temperature of about 100 kelvin – not cold enough to produce antihydrogen that can be trapped.

Now the team has come up with a potential solution: after

removing the electrons, release the most energetic antiprotons. This yielded antiprotons with an average temperature of 9 K which, when combined with positrons, stand a good chance of producing antihydrogen that is cold enough (*Physical Review Letters*, in press). “We were a bit surprised how well this works,” says ALPHA spokesman Jeffrey Hangst.

Such “evaporation” produces fewer antiprotons than electron cooling alone, so it is still not clear whether it is the best way to produce antihydrogen for study.

One, two, three... food in this one?

HUMANS do it, and so do chicks: we all count from left to right.

Rosa Rugani of the University of Trento, Italy, and her colleagues trained chicks to find food rewards in either the fourth or sixth of 16 dispensers. Initially, reward dispensers were black while the empty ones were white. But they were gradually made to be white as well, which meant that the chicks had to “count” to obtain the food.

For training, the dispensers were placed in a line pointing away from the chicks. The line was then turned 90 degrees so that the chicks faced all 16 at once, and had the choice of counting the dispensers from either the left or the right. The team found that the birds counted from the left, always going to a dispenser fourth from the left, not the right (*Biology Letters*, DOI: 10.1098/rsbl.2009.0960). The same was true for adult nutcracker birds.

Rugani says animals and humans may instinctively count from the left because the right hemisphere of the brain – which processes the left field of vision – is dominant in visual tasks. This suggests counting from the left may be instinctive rather than culturally learned, say the team.



Learn to navigate using language

OUR ability to solve spatial tasks may be linked to our linguistic skills, say researchers who studied the effect of sign language on spatial cognition.

Jennie Pyers at Wellesley College in Massachusetts and colleagues studied two groups of deaf people who learned to communicate using Nicaraguan sign language. The first cohort learned a simple form that had few signs for spatial terms. The second learned an expanded version 10 years later at the same age, which included a variety of directional signs.

To test their spatial awareness, Pyers placed a cup in each corner of

a room with three grey walls and one red. Individuals saw a token being placed under one of the cups before being blindfolded and disorientated. The blindfold was then removed and participants asked to find the token.

The second cohort outperformed the first, with those who most consistently used spatial markers when signing the most successful at finding the hidden token (*Proceedings of the National Academy of Sciences*, DOI: 10.1073/pnas.0914044107).

This suggests that the acquisition of language can enhance spatial cognition, says Pyers.

OPEN SCIENCE SUMMIT 2010

— UPDATING THE SOCIAL CONTRACT FOR SCIENCE —

BERKELEY iHOUSE | BERKELEY, CA

JULY 29 - 31, 2010

This summer, scientists, hackers, students, patients, and activists will convene to discuss the future of our science/technology paradigm.

Topics include:

- Synthetic Biology
- Gene Patents
- Open Data
- Open Access
- Open Source Drugs
- Patent Pools
- Microfinance for Science
- DIY science
- DIY Biology
- Alternative Funding for Science
- Open Health/Medicine
- Patient Advocacy for Innovation

Ready for a rapid, radical reboot of the global innovation system for a truly free and open 21st century knowledge economy? Join us at the first Open Science Summit, an attempt to gather all stakeholders who want to liberate our scientific and technological commons to enable a new era of decentralized, distributed innovation to solve humanity's greatest challenges.



REGISTRATION AVAILABLE NOW
OPENSOURCESUMMIT.COM



Browse with confidence.

Every single day we help to protect more people against cyber threats than any other browser – over three million malware attacks blocked daily. In addition, we have blocked more than 125 million phishing sites to date. Powerful protection – it's just one of the reasons Internet Explorer 8 is the most widely used browser in the world.



Download the world's most widely used browser for free at
internetexplorer8.co.uk



ALEXANDREURET-LUTZ



Corrected Eye sight

Software goes to art school

WANT to reshape a panoramic photograph to a more standard format without distorting perspective? A group of 18th-century painters have shown the way.

Thomas Sharpless, a retired software engineer based in Philadelphia, Pennsylvania, and his team knew that the 18th-century *vedutisti* painters had excelled at wide-angled views of Italian cities that appeared to preserve perspective perfectly. They couldn't have done this with the rectilinear method of capturing perspective that most camera lenses use, he reasoned.

So the team set about reverse-engineering the trick by picking 14 *vedutisti* paintings of the interiors of buildings for which they had ground plans. They identified 20 points in each painting and located them on the corresponding plan. They then used

this information to create a mathematical projection function and incorporated it into a piece of software, called Panini. Panini can squash the width of a panoramic image while retaining perspective.

In the photo (left), a 180-degree panorama of the London Eye has

"The team set about reverse-engineering the trick by picking 14 *vedutisti* paintings"

been reshaped using Panini. The upper image shows a rectilinear version of the same shot.

Team member Daniel German, a computer scientist at the University of Victoria in British Columbia, Canada, presented the work at the Computational Aesthetics 2010 conference in London last week.

First graphene touchscreen

THE biggest graphene sheet ever created has been used to make a touchscreen.

Graphene is conductive and transparent, making it ideal for use in flat displays. But until last year, the largest graphene sheets were microscopic. Then, a team at the University of Texas in Austin showed that flowing hot methane and hydrogen over a copper surface caused a reaction that left sheets centimetres wide on the copper.

Now Jong-Hyun Ahn at Sungkyunkwan University in Suwon, South Korea, has incorporated the process into a printing press fed with flexible copper sheets to produce graphene with a diagonal diameter of 76 centimetres. He used it as a transparent electrode in a touchscreen (*Nature Nanotechnology*, DOI: 10.1038/nnano.2010.132).

3.4%

of all cars sold in 2015 will have electric or hybrid motors, according to the consumer-spending analysts JD Power

Roll up for power on the nanoscale

A NANOSCALE power-storage device has just got even smaller, thanks to a trick borrowed from the large-scale world.

Capacitors store electrical energy on the surfaces of two conducting plates separated by an insulating layer. Because they release energy more quickly than chemical batteries, they are good for providing a sudden burst of power.

In large-scale devices, the layers are usually rolled up into a cylinder to make the device more compact. Now Carlos César Bo' Bufon and his team at the Leibniz Institute for Solid State and Materials

Research in Dresden, Germany, have created nanoscale capacitors in a similar way. They begin by depositing thin layers of metal and insulating material on top of a host substrate. The lowest metal layer of titanium and chromium is placed under strain, so once the substrate is removed, the layers roll themselves up (*Nano Letters*, DOI: 10.1021/nl1010367).

Shrinking the nanoscale capacitors allows more electrical power to be stored in a small space. The rolled-up device provides a capacitance of 200 microfarads per square centimetre of chip surface. That's at least twice what is possible with other capacitors using the same material, says team member Oliver Schmidt.



"The pipeline will produce our future cyber-guardians"

The Collegiate Cyber Defense Competition, organised by the US government, education officials and military contractors, aims to encourage young hackers to focus on protecting the internet, says **Alan Paller**, research director of the SANS Institute (usatoday.com, 21 June)

Sky full of planes, ground full of pilots

Once uncrewed aircraft can fly safely in civil airspace, will it be long before cargo planes and passenger jets lose their pilots too?

Paul Marks

WOULD you fly in an airliner knowing there were no pilots in the cockpit? This is no mere hypothetical question. The US Federal Aviation Administration this month kicked off what could be the first step in a journey towards the full automation of the airliners we all travel on.

The FAA commissioned the Boeing subsidiary Insitu, based in Bingen, Washington, and the New Jersey Air National Guard to begin investigating ways for civil aircraft to share their airspace with remotely piloted uncrewed aerial vehicles (UAVs). In the UK, a research programme called Astraea 2, led by BAE Systems and Airbus owner EADS, is pressing ahead with similar aims.

The goal on both sides of the Atlantic is to allow UAVs to share civilian airspace, rather than clearing a section of airspace for every UAV flight, as happens now. While this segregation of the sky has prevented collisions,

controllers would also need robust ways to manage flocks of UAVs – whose remote pilots may be hundreds of kilometres away.

Why contemplate opening up the sky to drones? For one thing, they could provide a relatively cheap boost to border-monitoring efforts, says Lambert Dopping-Hepenstal, an Astraea 2 project chief at BAE. At the moment, even in a country the size of

the US, he says, “there is not enough segregated airspace” to support such schemes. Other mooted applications include surveillance, search-and-rescue and crop monitoring.

It won't stop there. Once UAVs can avoid passenger jets, remotely piloted cargo planes are likely to take to the skies, pushed by some compelling economics. “The cargo airlines want very

much to lose their pilots. The money that would be saved in salary and benefits, including retirement and healthcare costs, is pretty staggering,” says Mary Cummings, a former US navy fighter pilot who now researches ways to automate aviation systems at the Massachusetts Institute of Technology.

Indeed, some UAVs are already big, cargo-capable beasts: the largest variant of the Northrop Grumman Global Hawk has a 38-metre wingspan, similar to that of the aviation industry's veteran workhorse, the Boeing 737.

The FAA's project will initially focus on air traffic control procedures, whereas Astraea 2 researchers are focusing on a sense-and-avoid system for UAVs that is comprised of “cooperative” and “non-cooperative” elements.

“You just don't need someone with a million dollars' worth of pilot training any more”

arranging clearance for every flight is time-consuming and curtails potential fly-at-a-moment's-notice applications for UAVs.

If they are to share civilian airspace, uncrewed planes will need to be able to sense the presence of other aircraft and take evasive action. Air traffic

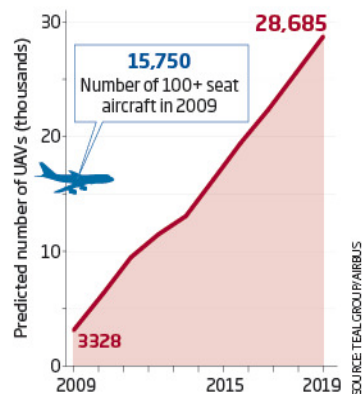
BRI STILLS



Fly this plane and land it? Surely you can't be serious

Drone-filled skies

With the number of uncrewed aircraft set to soar, civil airspace could get crowded



Today's airliners use a cooperative system called the Traffic Alert and Collision Avoidance System (TCAS), whereby radio transmitters on each plane announce its position, height and heading. The system constructs a picture of what's in a plane's airspace and calculates collision risks. If a risk is detected, a loud, synthesised voice tells the crew to climb or dive to avoid the danger.

"UAVs will have to respond to these TCAS alerts," says Dopping-Hepenstal. But when planes without TCAS venture close, things get tricky. Some of these "may be radio silent or have low electromagnetic signatures, making them difficult to detect", he says. This is where the non-cooperative elements kick in.

Astraea is developing a battery of sensors, including infrared heat sensors, millimetre-wave radars and optical cameras, to ensure UAVs know if a plane is nearby.

While infrared sensors and cameras should spot a plane in open air, they may lose it in cloud. That's when millimetre-wave radar, which easily pierces fog, takes over.

"Using multiple collision-sensing methods is clearly the safest approach," says Noel Sharkey, an autonomous-systems engineer at the University of Sheffield, UK. "But what happens in unpredictable circumstances? Human creativity can avert serious problems that have never arisen

before." And while UAVs will have a remote pilot, "what happens if the wireless link to the pilot gets lost?" he asks.

Even trusted technology like TCAS fails on occasion, which worries Peter Ladkin, a safety-critical systems engineer at Bielefeld University in Germany. "Flying UAVs in civilian airspace, and mandating safety devices for them and their airspace co-users, has large, maybe even overwhelming, political, legal and social dimensions. It is not just a technology issue," he says. The repercussions from fatalities caused by the failure of a UAV's sensing technology would be profound, Ladkin adds.

Cummings is convinced that the cost-saving potential will prove compelling. Autopilots and auto-landing systems – by which aircraft automatically follow a radio beacon to the runway – already do so much of the actual flying that pilots will eventually be seen as an unnecessary expense, even in passenger planes. "You just don't need someone with a million dollars' worth of pilot training any more," she says.

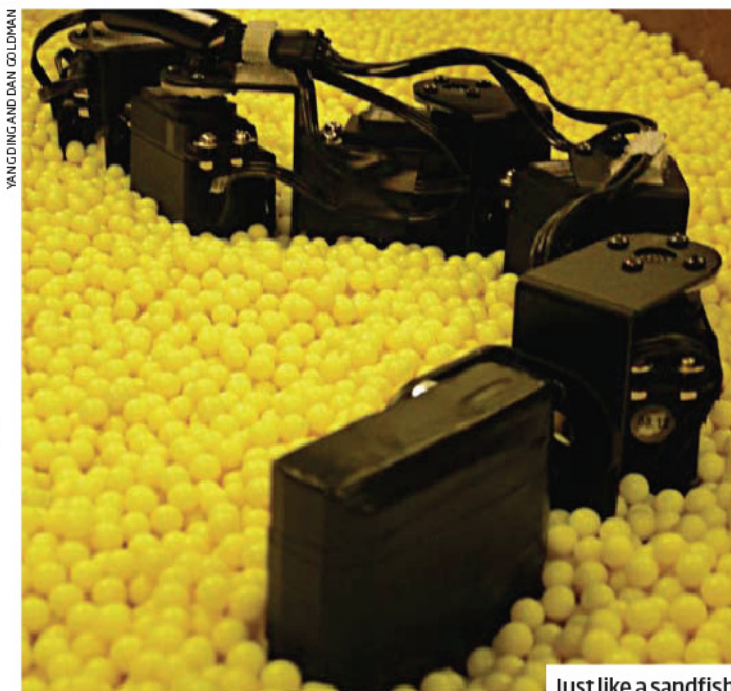
Carolyn Evans of the British

"If round trips from Boston to LA on an unmanned jet cost only \$50, people would stampede to get on board"

Airline Pilots Association says UAVs will "still need a remote pilot trained to the same level of expertise. But they might not need a co-pilot – so pilots, as you might expect, are not overly keen on the idea."

Would Evans fly on a remotely piloted plane? "It's like the spartan offerings of some budget airlines: it's not a product I like the sound of. So no, you won't find me catching one."

Cummings is unperturbed. "If round trips from Boston to Los Angeles on the first new unmanned airliner cost only \$50, people would stampede to get on board," she says. ■



Just like a sandfish

Lizard-inspired robot can 'swim' through sand

TO ADD to the robots that can crawl over land, fly through air and swim underwater comes one that can swim through sand. Such robots could help find people trapped in the loose debris resulting from an earthquake.

Navigating through sand is harder than moving through water or air because sand can behave as both a solid and a fluid. We have no equations to describe how such substances flow, let alone to predict how an object can "swim" efficiently through them. But the sandfish lizard, *Scincus scincus*, can travel through sand effortlessly, so Daniel Goldman and Ryan Maladen's team at the Georgia Institute of Technology in Atlanta decided to find out how they do it. They found that once the sandfish is submerged, it tucks its limbs into its sides and propels itself forward by wiggling from side to side.

Working with Paul Umbanhowar of Northwestern University in Evanston, Illinois, the team plugged their results into a computer model, which they used to show that a snake-like robot with just seven body segments could travel through a granular medium like sand. Encouraged, the team built a

35-centimetre-long version of the robot, made from seven aluminium segments linked by six motors, all clothed in spandex to prevent the motors from becoming jammed.

The team then tested their robot by burying it in a container filled with plastic spheres 6 millimetres across. When the robot undulated its body at a frequency similar to the lizard, they found it could move forward at speeds of up to 0.3 body lengths per wave cycle – just below the 0.4 body lengths per cycle that a submerged lizard can achieve. The robot could eventually match the lizard for speed, says Goldman, if more jointed segments are added to make its movements smoother.

Howie Choset, a roboticist at Carnegie Mellon University in Pittsburgh, Pennsylvania, thinks that the physics and the biology-inspired approaches to robot movement will one day meet and "at the intersection will be a deeper understanding of how biology works and how to make robots better". The team will present their robot at the 2010 Robotics: Science and Systems Conference in Zaragoza, Spain, next week. James Urquhart ■

INSIGHT

Drilling 5000 metres into the seabed is a last resort, but the only way to stop the oil

IMAGINE drilling into a cylinder just 18 centimetres wide and 5500 metres below the sea floor. That's the feat BP will have to accomplish if its relief well is to stem the flow of oil from the stricken Deepwater Horizon.

"There isn't anything else you can do," says Greg McCormack at the University of Texas at Austin. All previous attempts to plug the leaking well have failed.

A relief well is intended to provide an opening into the casing of the original well at a point near the oil reservoir. BP is drilling two wells at the same time to avoid lengthy delays if one should fail. The company may also have to try many times before it

succeeds in hitting so small a target at such great depths.

To direct the drill, BP is using a technique called measurement while drilling (MWD). Accelerometers and magnetometers attached to the drill bit monitor the movement and direction of the well bore and transmit this information back to the surface.

The system sends these messages by creating pulses in the flow of mud that is constantly pumped in and out of the borehole to clear away the rock cuttings, says Ken Arnold, who runs KACI, an oil industry consultancy in Houston, Texas.

The pulses are created by briefly closing and opening valves in the drill



GERALD HERBERT/GETTY

pipe to restrict the flow of mud – the resulting pressure fluctuations can be detected by sensors and interpreted by computers on the surface. "They provide the information needed to plot to within 3 metres of where the bit is the whole time," he says.

Once close to their target, the

Help is on the way, but a relief well won't be ready until August

engineers can home in on Deepwater Horizon's well by detecting fluctuations in Earth's magnetic field caused by the steel and concrete foundation that surrounds it.

When they do drill a pipe into the original well, they will pump in mud until there is enough to counteract the pressure of the oil and gas in the reservoir. At that point the whole well can be sealed with concrete.

So would it be possible to tap this deep-sea oil reserve once the initial well has been sealed? "It's too early to say," a BP spokesman told *New Scientist*. He said the drilling, which began last month, is on track for completion in early August. **Helen Knight** ■

FRONTIER.AC.UK

A NON PROFIT ORGANISATION
CONSERVATION
DEVELOPMENT
TRAVEL

250 PROJECTS
OVER 50 COUNTRIES
5 CONTINENTS

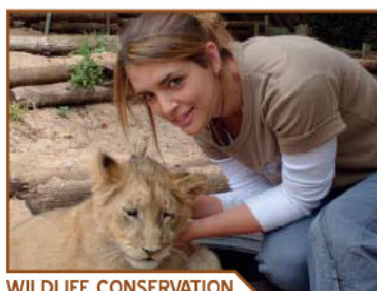


ETHICAL ADVENTURES

Frontier has been operating conservation research programmes throughout the tropics for 20 years. Frontier Volunteers have contributed to some outstanding research leading to the formation of numerous National Parks and a host of effective community-led conservation programmes.



TEACHING & COMMUNITIES



WILDLIFE CONSERVATION

0207 613 2422
INFO@FRONTIER.AC.UK

Harness hot electrons to double solar cell efficiency

SOLAR cells could see a boost in their theoretical maximum efficiency from 31 per cent to 66 per cent, thanks to a novel way of harnessing electrons whose energy is normally lost as heat.

The most efficient silicon solar cells turn 25 per cent of the incoming light into electricity, but even with further improvements these cells will reach a theoretical limit at 31 per cent, because incoming light creates large numbers of extremely energetic electrons that lose energy to their surroundings in just a picosecond – too rapidly to be harnessed.

In 2001, Arthur Nozik of the National Renewable Energy Laboratory (NREL) in Golden, Colorado, suggested that quantum dots – nanoscale chunks of semiconducting material – could slow the rate at which "hot" electrons lose energy by 1000 times. That's because the energy levels within quantum dots are widely spaced, making it difficult for electrons to jump between them. The energy levels are closer together in a bulk

semiconductor, so jumping levels and losing energy as heat is easier.

Now, Xiaoyang Zhu at the University of Texas at Austin and his colleagues have shown that those longer-lived hot electrons can pass into a wafer, boosting chances of harnessing them. They recorded a change in the optical properties of a titanium dioxide wafer coated with lead selenide quantum

"The hot electrons can pass into a titanium dioxide wafer, boosting chances of harnessing them"

dots characteristic of an influx in electrons, but they had engineered the system such that only hot electrons could enter the wafer (*Science*, DOI: 10.1126/science.1185509).

Matthew Beard at NREL, a member of Nozik's 2001 team, says the work represents "one more step towards the goal of radically increasing solar energy conversion efficiencies". Anil Ananthaswamy ■

THERE'S MORE TO LIFE THAN A VOLVO. THERE'S SPOILING YOUR COLLEAGUES WITH EXECUTIVE LUXURY, AND WITH 119 G/KM CO₂, NOT SPOILING YOUR BALANCE SHEET. THAT'S WHY YOUR FLEET SHOULD INCLUDE THE S80 *DRIVE*

Fuel consumption figures for the S80 range in MPG in (L/100KM): Urban 15.7 (18.0) – 52.3 (5.4), *Combined 23.3 (17.1) – 62.8 (4.5) Extra Urban 32.5 (8.7) – 70.6 (4.0), CO₂ Emissions 284 – 119g/km.



A handcrafted leather interior with walnut wood finish and 12 speaker surround sound makes the Volvo S80 a pleasure to drive. And with the option of an efficient D3 or more powerful D5 engine – both with emissions of 139g/km, 53 mpg* and BIK of 19% – it also offers the luxury of choice. For more information call 08457 300 140 or visit www.volvocars.co.uk/fleet



Volvo. for life

Let's really talk

There is no point having public dialogues on technologies like synthetic biology unless they are acted on, say **Tom Wakeford** and **Jackie Haq**

LAST month, Craig Venter and his team put synthetic biology centre stage when they created "artificial life". They stitched together a genome from small stretches of DNA and transplanted it into a cell, which then started replicating.

"Synthia" is an important advance. But, like claims that genetically modified crops would quickly feed the world, the hype over synthetic biology may tempt governments to divert scarce resources from technologies that are already proven. The claims for "synbio" include the possibility of generating organisms able to halt climate change by absorbing excess carbon. All in the name of a public effectively excluded from setting goals for research.

Over the past year, in a pilot project meant to begin to address this democratic deficit, the UK's Biotechnology and Biological Sciences Research Council (BBSRC) and the Engineering and Physical Sciences Research Council (EPSRC) invited members of the public – drawn at random – to a series of workshops where they could quiz researchers about the technology.

We were two of a large number of expert advisers overseeing this dialogue since its inception, attending some focus groups, and talking to anonymised participants. With serious flaws emerging in the way the dialogue was commissioned and conducted, it is vital the lessons learned from this pilot are applied to the fuller dialogue that is due to begin later this year.

First, the entire process was undertaken using a commercial market-research approach rather



than a public dialogue approach. Contrary to established good practice, the councils decided that the workshops should be held in private, saying it was too soon for any discussions to take place in public.

That's because, along with many scientists, the councils appear nervous of anything that risks providing spaces in which non-scientists' views, which they appear to consider ill-informed, can be heard. Scientists present at a workshop to design the process expressed a desire to avoid being caught unprepared by another MMR, referring to the public scare over a spurious link between autism and the triple measles,

mumps and rubella vaccine given to children in the UK.

There is also a collective memory within the scientific establishment of the UK's public discussions of the genetic modification of crops – the "GM Nation?" debates in 2003. Science policy-makers have convinced themselves that their openness allowed the debate to be dominated by anti-science extremists, though researchers such as Alan Irwin of the Copenhagen Business School in Denmark, who studies the

"The hype over synthetic biology risks diverting scarce resources from proven technologies"

relationship between science and the public, provided evidence to the contrary.

In researchers' minds, the MMR and GM scares, and even the BSE disaster get lumped together as examples of the ignorant mob versus scientific truth. The problem is that in the cases of GM and BSE, the mob was partially correct. The risks of feeding cattle the brains of other cattle had not been accurately assessed, and GM foods were not a magic bullet to increase yields of smallholder farmers. In both cases, not only were official predictions flawed, but key experts were reluctant to be frank about the uncertainties and gaps in knowledge underlying their advice.

In 2005, as the next subject of public opposition looked to be nanotechnology, some of us felt we might have come up with a solution. Backed by three research councils, the UK government and Greenpeace, the Nanojury was one of the first "upstream" engagements, designed to allow people to shape the new science and thus be more likely to trust its regulation.

The jury raised a number of concerns about nanoparticles, which were echoed by the Royal Society and Royal Academy of Engineering. However, no effective regulations have been put in place, and multinationals continue to expose us to nanoparticles and to applications of the technology that have not yet been revealed.

After keeping the synbio dialogue in camera, the report, *Synthetic Biology Dialogue*, was launched two weeks ago. An

accompanying press release claimed that the process showed “most people are supportive of the research” and just want it regulated properly. Yet our conversations with participants, and elements of the report itself, suggest this summary was both too simplistic and too emphatic.

In our view, the synbio focus groups did not have sufficient opportunity to discuss the extent to which big business decides the pathway major new technologies will take. The need for investors to make a return locks the rest of us into a particular path that becomes immune from public scrutiny.

The presence of oil giant BP on the board of the company Venter set up to exploit synthia, and the \$600 million the company received from Exxon for synbio development suggest these firms are looking to use the technology to expand the fossil fuel industry. Most synbio investment comes from private corporations, making the research subject to commercial confidentiality, yet there is no evidence that these key aspects were covered by the focus groups.

We fear the upstream approach could have the same outcome in the synbio pilot dialogue as in nanotechnology. If its key failings are not addressed, the Venter model is likely to triumph and the future will be imposed through patented genes and products, with regulators and the public forced into a dangerous game of catch-up.

In the 21st century, democracies deserve real dialogue that allows us all to examine state and corporate agendas, and lets civil society voices set the terms of the debate. Synbio may or may not help us tackle the challenges facing the world, but if we do not effectively involve everyday people in its regulation, any benefits are likely to accrue to the already rich and powerful, at the expense of the rest of us. ■

Tom Wakeford and Jackie Haq are at the Policy, Ethics and Life Sciences Research Centre, Newcastle University, UK

One minute with... Robb Fraley

Monsanto's chief technology officer claims the agri-biotech giant is reinventing itself as a champion of healthy eating

So far, selling genetically modified food seems to have benefited Monsanto more than consumers. Will that change?

Within the next couple of years our plants will have several traits with direct consumer benefits. We have introduced two genes that allow soybeans to produce about 20 per cent of their oil as an omega-3 fatty acid. It doesn't have the fishy odours that are normally associated with the breakdown of omega-3s and means companies can formulate foods with direct benefits for cardiovascular health.

What types of foods might contain this oil?

We've created yoghurts, soy milks, we can do salad dressings and we are working on energy bars. There's even an opportunity to coat pastries and bread products. We're working with a partner company called Solae that has a broad experience of bringing soy ingredients to food companies.

Do you have any other nutrition products in the pipeline?

We've altered the soybean oil biochemical pathway so that it produces less trans-fat and less of the saturated fats that also have a negative cardiovascular effect. Effectively we have made soybean oil the same as olive oil in terms of its healthiness. We have consulted with nutrition groups, who recognise the benefits of this product. It's called Vistive Gold, and we're working with food companies to use it to cook French fries, make salad dressings and more.

What about improving agricultural yields?

Critics argue that biotech has yet to deliver.

Everyone knows the challenges that agriculture faces: food security, global warming, use of water, use of grains for biofuels. As the population continues to increase, some say we'll need to double production of grain.

Monsanto is on the verge of launching a new set of genes that can provide drought protection and is also working to improve fertiliser efficiency. Changes in plant breeding may be even more dramatic. We now know all the genes in a corn



PROFILE

Robb Fraley led the development of Monsanto's herbicide-resistant genetically modified crops and now oversees its global crop and seed technology and research

plant. That opens the door for breeders to make very precise crosses. Then there's automation: we have robots that can pick up individual seeds and shave off a small sample for DNA analysis, increasing the efficiency of what a breeder can do by thousands of times.

We're also seeing dramatic changes in the agronomic system. Tractors being sold now have GPS systems, so farmers can plant the seed precisely where the fertiliser is. As a result of all these advances, we think it will be possible to double yields from 2000 levels for cotton, corn, soybean and canola by 2030.

Monsanto has often been attacked by environmentalists. Do you think you'll ever find common ground?

There are groups that are anti-biotechnology and with whom there will never be a meeting of minds. But we have had partnerships with environmental groups in the US and South America. In addition, we already supply vegetable seeds to the organic market.

Interview by Peter Aldhous

Reduced Stock Obsolescence

Improved Order Accuracy

Enhanced Visibility & Control

Increased
Delivery Reliability

Shorter Lead Times

Improved Productivity

Seamless Transformation

Streamlined

Customer Satisfaction

Higher Profitability

Increased Market Share

Quicker Time To Market

Continuous Improvement

IT'S NOT JUST A SUPPLY CHAIN. IT'S A COMPETITIVE ADVANTAGE.

.....

DHL Supply Chain brings the unique insights, tailored business solutions and cross-industry expertise that will set you apart from the competition. By creating and optimizing a supply chain customized to your needs, we can deliver the improved speed, efficiency, flexibility and service that will make a real difference for your business. And, with that behind you, it won't be long before you're in front of everyone else.

www.dhl.com/advantage

EXCELLENCE. SIMPLY DELIVERED. **DHL**

Views on vivisection

From Michelle Thew, BUAV

It is rare that the British Union for the Abolition of Vivisection, which exists to oppose animal experimentation, finds itself in broad agreement with Simon Festing, chief executive of Understanding Animal Research, a group which promotes acceptance of vivisection (5 June, p 22).

Festing discusses recent studies that have found that a significant amount of animal research into human disease is not published – presumably because the results are negative – and that experimental design, statistical analysis and reporting are often poor. As he recognises, all this has important implications for human health, quite apart from animal welfare.

The lack of relevance to people of animal studies is striking. Andrew Knight's review of the efficacy of research using chimpanzees, genetically our closest cousins, found that less than 15 per cent of a statistically significant random sample of papers (14 out of 95) had been cited by subsequent papers with relevance to medical advancement (*Journal of Applied Animal Welfare Science*, vol 10,

p 281). Within these, chimpanzee research was not considered to play an essential part in the development of the human treatment. There is little point in animal studies being better designed if there is a fundamental problem with extrapolating data to humans.

Publication of negative results of animal studies along with registration and tracking of the studies, as is now compulsory with clinical trials, would reduce the duplication of animal suffering and provide a more complete scientific picture.

However, in the BUAV's experience, pleas for transparency are likely to fall on deaf ears. In the past, researchers and government officials have used every trick in the book to stymie requests for freedom of information. Nonetheless, it is certainly time for greater openness – for everyone's benefit. *London, UK*

From Richard Mountford

Even the best animal experiments for human medicine suffer from the problem that they are looking at artificially induced disease in the wrong species, living in unnatural conditions. Surely, it is time to focus our finite research

funds on the many more reliable medical research methods now available: epidemiology, microdosing, computer modelling and tissue cultures. If the European Union were to set a date for ending animal experiments, then developing non-animal research methods will be taken far more seriously. *Hildenborough, Kent, UK*

From Derek Williams

Mark Mattson warns that the unhealthy conditions in which lab animals are kept can detrimentally affect test results for new medicines (15 May, p 24). He fails to mention a fundamental characteristic of all the most commonly used animals (rats, guinea pigs and so on): coprophagia is part of their normal function. They also have a large caecum for fermentation of food on its second cycle through the gut.

Do researchers take into account the different digestive systems of the lab animals and the intended recipients of the medicines they test? I doubt it. *Donvale, Victoria, Australia*

The coming dystopia

From Karen Rodgers

The conclusion to Henry Harpending's review of Spencer Wells's *Pandora's Seed* was chilling: "governments should close international borders to migration and impose a draconian policy of family limitation like China" (5 June, p 42).

Sustainability and orderliness can be achieved through rational argument and consensus. Where they are imposed from above and raised to the level of absolute values, the result is sterility: the destruction of all individuality, creativity and self-determination. Such action would be the end of that which makes us human and makes life worth living.

I begin to wonder whether the scientific legacy of our own



generation to our children will not be greater freedom and a better life, but rather an existence in a dystopia too awful to imagine. *Cambridge, UK*

In a word

From Daniel Harbour, Department of Linguistics, Queen Mary, University of London

Christine Kenneally's provocative article is a welcome airing of scientific work on human language (29 May, p 32). However, it repeats an error from Evans and Levinson's original paper: that the Native American language Kiowa has a suffix meaning "unexpected number of". In 10 years' work on the language, I have yet to find it. The Kiowa do use a suffix to say "three or more young men", or "not-two hairs" (*togul+dau*; *aul+dau*). But if *dau* meant "unexpected number of", Kiowas would have to think that teenagers don't hang around in groups and hairs come in pairs.

My response, published with Evans and Levinson, pointed out this error, as well as showing that Kiowa strongly supports the Chomskian concept of a universal grammar (*Behavioural and Brain Sciences*, vol 32, p 456). *London, UK*

The editor writes:

■ Evans and Levinson have published a correction to the Kiowa example in the same issue of *Behavioural and Brain Sciences* (vol 32, p 472). The general

Enigma Number 1601

Box of dates

BOB WALKER

Each year Joe buys a simple calendar that just shows year, month, day and date. This year he realised that if he starts saving each year's calendar he will eventually have a full set of different calendars and will never need to buy one again.

For which year will Joe buy his last calendar?

WIN £15 will be awarded to the sender of the first correct answer opened on Wednesday 28 July. The Editor's decision is final. Please send entries to Enigma 1601, New Scientist, Lacon House, 84 Theobald's Road, London WC1X 8NS, or to enigma@newscientist.com (please include your postal address).

Answer to 1595 All mapped out: 636 millimetres

The winner Jim Jamieson of Marlow, Buckinghamshire, UK

point about plurals not being straightforward still stands, and can be exemplified with another language: Nēn from Papua New Guinea – also cited in the original article. In Nēn you take duals (for two) as the basic stem, with a derived non-dual (anything other than two), while the affixing system distinguishes singular versus non-singular (two or more). Plurals are then composed by combining non-singulars with non-duals (numbers for which there is neither one nor two). In a further twist, you get exhaustive plurals by combining the dual with the singular.

From Robert Morley

Kenneally refers to some 200 languages as “critically endangered”, lamenting the loss of 115 more. Natural scientists inevitably seem to see change as detrimental, but surely if we all spoke the same language it would be a very positive outcome for humankind.

Language differences inevitably contribute to tribal behaviour in international relations, and even

UNLIKE THE REST OF US – ONE LANGUAGE SHOWS HIM HE DISAGREES WITH EVERYBODY



within nations: consider the cultural divide and financial burden of maintaining bilingualism. One global language please, and the sooner the better. London, UK

Rational optimist

From Matt Ridley

In her article Liz Else claims that in *The Rational Optimist*, I “failed to recognise that there is more to the

health of corals than the amount of bicarbonate in the sea” (12 June, p 28). Yet I state clearly in my book: “Take coral reefs, which are suffering horribly from pollution, silt, nutrient runoff and fishing”.

The five experts Else consulted, while critical of my conclusions, actually confirm the factual truth of my statements about corals. The single exception is where two claim that temperature is changing at an unprecedented rate. They must be unaware of the work of W. Dansgaard and others which points to estimates of warming at the end of the last ice age of 7 °C in 50 years or less (*Nature*, vol 339, p 532), which is nine times as fast as the 0.161 °C per decade recorded since 1975.

Since one of them accuses me of cherry-picking studies, he might be interested that an important new meta-analysis of 372 different experimental studies by Iris Hendriks and others (*Estuarine, Coastal and Shelf Science*, vol 86, p 157) concludes that marine ecosystems are “more resistant to ocean acidification than suggested by pessimistic predictions”, and that ocean acidification “may not be the widespread problem conjured into the 21st century”.

A full response to their critique is on my website at www.rationaloptimist.com. Newcastle upon Tyne, UK

Psychobubble

From Geraint Day

Stephen Lea’s argument that economics is incomplete unless psychology is taken into account (8 May, p 24) reminded me of something that I was taught several years ago. At the very beginning of the health economics part of a course in epidemiology, my tutor stated that “economics is a branch of psychology”. That seems to put into perspective the reliability of economists’ predictions and forecasts.

Furthermore, in the immediate aftermath of the recent UK general election, sections of the media never tired of telling



us that financiers and various economists were unhappy with the hung parliament in which no single political party was in charge. It seems that those views were more influenced by political preferences than economics.

All this serves as a reminder that much of economics is at least under the influence of politics – itself a branch of psychology, perhaps. Swindon, Wiltshire, UK

Evolving physics

From Sebastian Hayes

Marcelo Gleiser seems to assume that either there is a single grand unified physical theory or there is fundamental asymmetry and lawlessness built into the universe (8 May, p 28). In doing so, he goes along with the implicit assumption in physics that laws extrapolated from observed effects in one corner of the universe will be valid everywhere and for all time.

This assumption is, however, unprovable, and might be wrong. Instead, the universe could have built into it the potential to update the physical laws that were needed to get it started in the first place.

Perhaps this hypothesis that the physical world has the capacity to modify the rules

governing its behaviour is rejected because it smacks of vitalism – seemingly a much more serious scientific sin than mathematical Platonism, which asserts the immutable nature of mathematical entities. But given the dismal failure so far of grand unified theories and string theory, which Gleiser himself admits, maybe it is time for a new approach.

Shaftesbury, Dorset, UK

For the record

■ As noted in a recent article (19 June, p 24), common names can lead us into confusing territory.

A fine example was our recent reference to the monarch butterfly (5 June, p 32), which is known as the wanderer in Australia.

■ The relief wells mentioned in our article on the Deepwater Horizon oil spill (5 June, p 5) do not work by relieving the pressure inside the well. Rather, they allow engineers to pump a specialised heavy liquid into the flowing well to bring it under control. The liquid is denser than oil and so exerts pressure to stem the flow of oil. This makes it possible to pour cement in through the relief well to seal off the well for good.

■ We must have been asleep when we placed Victor Spoomaker in the Netherlands in our article on lucid dreaming. He is in Germany, at the Max Planck Institute for Psychiatry in Munich (12 June, p 36).

■ To clarify, the prediction of a 0.3 °C drop in temperature that may arise from solar activity is independent of, and would be dwarfed by, any increase in global temperature due to climate change (12 June, p 30).

Letters should be sent to:

Letters to the Editor, New Scientist,
84 Theobald's Road, London WC1X 8NS
Fax: +44 (0) 20 7611 1280
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. Reed Business Information reserves the right to use any submissions sent to the letters column of *New Scientist* magazine, in any other format.

BECAUSE EVERY PAGE COUNTS
TO SUSTAIN VALUABLE RESOURCES



KYOCERA is proof that environmental sustainability and economic efficiency can go hand in hand. ECOSYS printers from KYOCERA employ exceptionally durable components to deliver far less waste than other printing systems plus reduced emissions and exceptional recycling possibilities. And because our machines consume less they also cost significantly less to run, page after page. So our unique ECOSYS technology will not only help to preserve precious natural resources but also your budget. Visit www.everypagecounts.co.uk to find out more.



KYOCERA. COUNT ON US.

KYOCERA MITA UK Ltd - Phone: 08457 103 104 - www.kyoceramita.co.uk

KYOCERA MITA Corporation - www.kyoceramita.com

ECOSYS

THE NEW VALUE FRONTIER

 **KYOCERA**

Would you spot the gorilla?

The “gorilla in our midst” psychology experiment is up there among the world’s most famous. But as **Liz Else** found out from **Christopher Chabris** and **Daniel Simons**, the psychologists who devised it, exactly how it fools half of the people who take part is still a mystery

How did you come up with the experiment?

Christopher Chabris: We didn’t say, “let’s do a really intriguing experiment people will talk about for years”. It was just a class project on visual attention in a course we were teaching 12 years ago. The gorilla suit was lying around in a lab. If it hadn’t been there, who knows?

Daniel Simons: Our study revisited work from the 1970s by Ulric Neisser, where subjects had to watch a video and count the times players passed a ball. Neisser had someone with an open umbrella walk through the game, and many people didn’t notice it. But his video had an odd, ghostly appearance which gave people an excuse for missing the person with the umbrella. We filmed the entire game with a single camera so that everything was fully visible – and the person in the gorilla suit was there for 9 seconds! When we showed the video, only half of the viewers saw the gorilla.

Is it the same for every group?

DS: The first subjects were Harvard University students but it worked as well with everyone we tested. For years, whenever I showed the video, I held my breath, thinking everybody would notice it. It took years before I could discount that gut instinct. Missing the gorilla is jarring. It’s natural to assume that you would see it, so it’s surprising and compelling when you realise what you’ve missed.

So why do people miss the gorilla?

CC: It’s like a Rorschach (inkblot) test for cognitive abilities or personality: people think there must be something different about the people who see the gorilla compared with

those who don’t. Some speculate that if you are in a detail-oriented job, you are going to notice it because you notice everything, or you are not going to notice it because you are really good at focusing. But the truth is, so far no researcher has found anything that solidly predicts who is going to see it and who is not.

DS: We have looked at basic measures of attention and memory – how much you can hold in mind while doing something else, and how much you can take in with one attentional glance. These basic measures predict how well you can focus attention and count the passes, but they don’t seem to predict whether you will notice the gorilla. I have just done a follow-up to the gorilla study, which I showed to about 1000 vision scientists who knew about the original video. As the gorilla enters, I introduced two changes:

“If we were aware of our limitations, we wouldn’t text while driving”

a backdrop curtain changes from red to gold, and one player wearing a black shirt leaves the court. The vast majority missed both, despite knowing the video was about unexpected objects. When they started looking for a gorilla, they missed other unexpected events.

Is there an evolutionary reason to miss things?

DS: I think that’s the wrong way around. These failures of awareness are more a consequence of something that we need to do and that we do well – focus attention. To do any task, you



DANIEL SIMONS

need to focus on things that matter and avoid things that don’t. One consequence is that sometimes you filter out things you might want to see. Intuitively we think that things that matter will catch our attention, but they don’t.

CC: In our book (reviewed, right) we tell the story of a Boston police officer chasing a suspect. When you do that, you’re paying careful attention, figuring out where he’s going, if he’s got a gun or is throwing evidence away. The officer ran past an incident of police brutality taking place close by and later claimed not to have seen it. He went to prison because the jury didn’t realise the extent to which focusing on one task makes you unable to see outside that. They decided he lied to protect fellow officers.

So our picture of reality can be very wrong?

DS: Our picture of reality is correct most of the time for most of what we do. It is inherently incomplete, though, and most of the time we



don't realise how much we miss. Usually, it doesn't matter – we see what's relevant to what we're doing. It's important to know that we have such limitations, though. We think we see more than we do, and that has consequences. We also think our memories are more perfect than they are, that we understand complex systems better than we do. If we were aware of our limitations, we wouldn't text and drive or think everybody who mis-remembers is lying.

Can you devise another experiment this good?

CC: The statistics are against it! But who knows what we'll find lying around tomorrow... ■

If I beat my chest, surely you'll notice

PROFILE

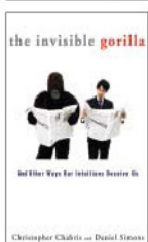
Christopher Chabris is a psychology professor at Union College in New York; Daniel Simons is a psychology professor at the University of Illinois at Urbana-Champaign. The "Gorillas in Our Midst" study is at bit.ly/bg2r17

Intuitive errors

The consequences of failing to notice the unexpected can be deadly, so what's going on?

The Invisible Gorilla: And other ways our intuitions deceive us by Christopher Chabris and Daniel Simons, HarperCollins, £16.99/\$27

Reviewed by Michael Bond



EVEN if you haven't taken the invisible gorilla test, you've probably heard of it. It consists of a short video of two teams of students

moving around while they pass basketballs. The idea is to count the number of passes made by one team while ignoring those made by the other. Roughly half of those who take the test fail to notice a person dressed as a gorilla who strolls into the middle of the players and beats its chest at the camera. The viewers are concentrating so hard on counting the passes that they're blind to the unexpected, even though it is staring them in the face.

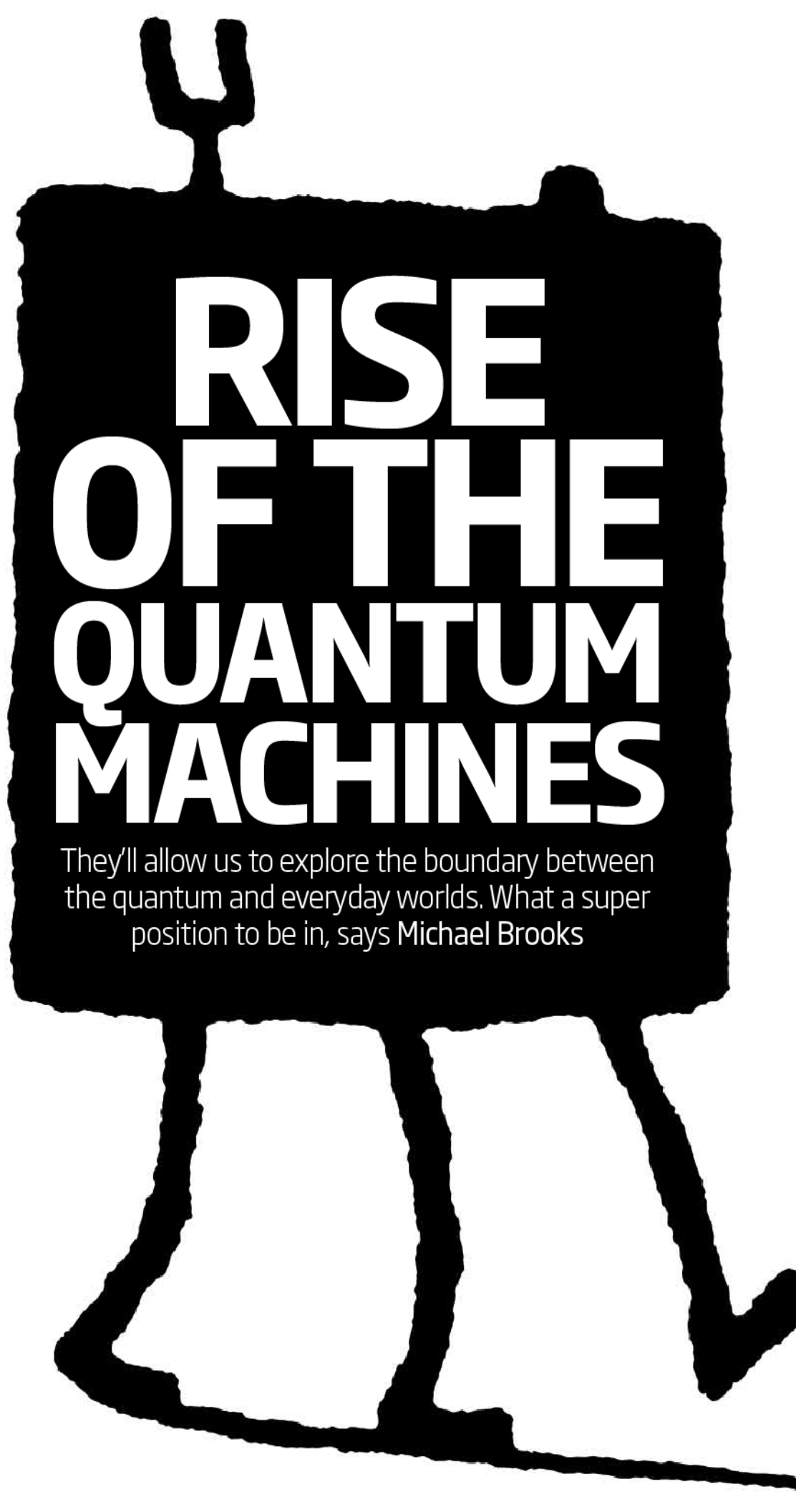
This book is by the psychologists who devised that experiment (see left). Their aim is to show how easy it is to miss things that are right in front of us when we're not looking out for them, and how illusions and distorted beliefs lead us astray every day. They cover what they consider to be six of the most common intuitive errors: inattention blindness (failing to see things that are in plain sight); the belief that our memories are more reliable than they are; the tendency to think someone is competent if they are confident; the illusion of knowledge (we know much less than we think); the assumption that things that occur together must be causally related (think MMR vaccine and autism); and the increasingly

popular notion that cognitive exercises make us smarter (in fact, physical exercise has a much stronger effect).

Some of these biases have been widely written about, but it is worth reading them again here for the clarity with which Chris Chabris and Dan Simons explain them and their talent for making them relevant to everyday situations. They demonstrate, for example, how over-confidence in one's abilities can be hilarious in a talent show contestant or an incompetent criminal caught on camera, but worrying when it dissuades other members of a group from sharing their own – less confidently held but nonetheless important – opinions. And such over-confidence can be positively dangerous in a witness whose apparently credible evidence is given undue weight by jurors or police.

The authors are strongest in the area they have studied most. Failures of attention, they note, are increasingly relevant because of our reliance on fast-response technologies such as cars and cellphones. A delay of a tenth of a second in noticing an unexpected event is of little consequence when walking, but when driving could kill you, or someone else. Which makes all the more salutary the finding that talking on a cellphone triples our chances of missing something unexpected (such as a gorilla among a group of basketball players).

Chabris and Simons use science and anecdotal evidence so effectively in explaining all this that three days after reading their book I feel confident in saying it has changed my life. I just hope I'm not deluding myself. ■



RISE OF THE QUANTUM MACHINES

They'll allow us to explore the boundary between the quantum and everyday worlds. What a super position to be in, says Michael Brooks

QUANTUM theory is our most successful theory of physics. There is not one shred of experimental evidence that doesn't fit with its predictions. So why, if it ain't broke, is a growing number of researchers expressing a desire to fix it?

"Everything depends on whether you believe quantum mechanics is going to go on describing the physical world perfectly to whatever level you push it," says Nobel laureate Anthony Leggett, who studies the quantum world at the University of Illinois at Urbana-Champaign.

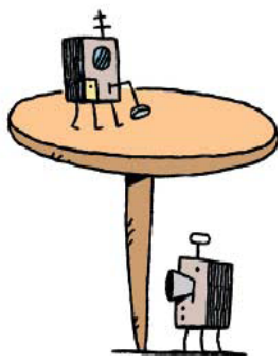
Leggett thinks it won't, that there are too many issues with quantum theory to think it anything more than an approximation of reality. "I'm inclined to put my money on the idea that if we push quantum mechanics hard enough it will break down and something else will take over – something we can't envisage at the moment," he says.

The question is, how hard can we push it? Experiments have never had the sensitivity to pinpoint a weak spot in quantum mechanics. But thanks to a breakthrough earlier this year, that might be about to change. A new swathe of experiments is coming onto the scene that should be up to the job. Welcome to the dawn of the quantum machines.

Such machines are promising to patch a gaping hole in every experiment that has ever been used to back up our view of the quantum world. Take the simple process of measuring a photon's spin. Thanks to the strange nature of the quantum world, it can actually be spinning in two directions at once, a phenomenon known as superposition. When we use a detector to measure the spin, however, the superposition disappears and we register a spin occurring in one direction or the other.

Quantum theory does not explain why this happens. "We don't really understand the measurement process," admits Stephen Adler at the Institute for

"The new breed of quantum machines promise to patch a gaping hole in every experiment ever made"



Advanced Study in Princeton, New Jersey.

If you want to know how little we know, ask a roomful of physicists what goes on when we measure a particle's properties. All will be able to calculate the result of the measurement, but the explanation they give will differ wildly. Some will tell you that new parallel universes necessarily sprang into being. Others will say that, before a measurement is performed, talk of particles having real properties is meaningless. Still others will say that hidden properties come into play.

Another group will tell you that they deal with physics, not philosophy, and dismiss the question without giving you an answer. It has been thus for more than 80 years. "These conceptual challenges are still not understood at all," says Markus Aspelmeyer at the University of Vienna in Austria. "We're still right at the beginning."

Experiments investigating the quantum world have traditionally focused on what are known as interferometers. Researchers fire a single quantum particle, such as a photon, towards two apertures in a screen. Common sense says the photon has to go through one aperture or the other. However, as long as you don't measure which aperture it went through, something remarkable happens.

At a screen on the far side of the twin slits, an interference pattern forms. This can only occur if the photon goes through both slits at the same time and interferes with itself. In other words, as long as nobody is watching, the photon exists in two different places at once.

A measurement changes everything, however. If you set up the experiment so you can see which slit the photon goes through,

the interference pattern disappears; the photon will have gone through one slit or the other, but not both.

The situation is analogous to one of the most famous thought experiments in physics, that of Schrödinger's cat. Here, an unfortunate feline is sealed in a box with a vial of poison and a lump of radioactive metal. When the metal emits a radioactive particle, it triggers a mechanism which will break the vial, killing the cat. But because the box is sealed, there is no measurement, and the particle remains in a superposition of emitted and not emitted. According to quantum logic, the cat is therefore alive and dead at the same time.

Schrödinger came up with this bizarre scenario to show that there was something wrong with quantum theory. There's no way, he said, that something as non-quantum as a cat can be in a superposition of alive and dead – whether it is being observed or not.

Others beg to differ. Markus Arndt at the University of Vienna has demonstrated that carbon-70 molecules can go through two slits at once, too. Though these ball-shaped molecules aren't quite as substantial as cats, they can nonetheless be seen through a microscope.

Quantum tuning forks

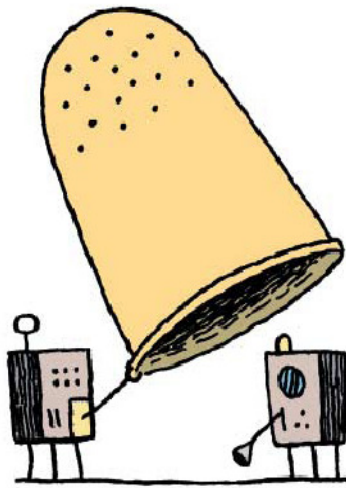
Such interferometer experiments have been extremely useful in teaching us about what constitutes a measurement. It turns out that measurement doesn't have to be a deliberate action. Experiments have shown that if conditions allow an observer to infer which slit the photon went through – if, say, there were stray photons in the apparatus that could bounce off the test photon and thus give away its position – the superposition will disappear. This destruction, or collapse, of the superposition is known as decoherence.

Exploring when decoherence occurs has allowed us to find out more about what makes the quantum world tick. However, there is still an enormous amount we don't know. And here we are running up against a difficult logistical problem.

Pushing at the boundary between the quantum world and that of classical physics means using ever larger molecules to see where decoherence destroys superposition. But the bigger the molecule, the harder it is to control outside forces and stop them from disrupting the molecule's delicate quantum state. For large molecules, uncontrolled decoherence effects rule, spoiling the very effect you want to measure.

TOM GAULD





"Building the first quantum machine has taken years of painstaking work"

This is where the quantum machines come in. At the moment, they don't look like much. The most advanced of them is little more than a sliver of aluminium about 50 micrometres in length. It functions as an oscillator, something like a quantum tuning fork. The key is its mass. Even the relatively large clusters of carbon atoms Arndt sends through his interferometer are lightweights compared with the mass that quantum machines will have (see "Mass matters", opposite). "They operate at masses which are orders of magnitude larger than even the most massive clusters we are using," Arndt says.

This is useful because the mass of a quantum object plays an important role in several alternative explanations of how the quantum world works. For the past seven years, Dirk Bouwmeester at the University of California, Santa Barbara (UCSB), has been building a quantum machine to test an idea put forward by mathematician Roger Penrose of the University of Oxford. In 2003, Penrose suggested that gravity might cause superposition collapse. If this were so and heavy, or extremely close, objects were found to be unable to sustain being in two places at once, this could help us understand the inner workings of the quantum world and the measurement problem.

Testing such ideas, however, will require quantum machines of almost incomprehensible sensitivity. The necessary apparatus involves mirrors 10 micrometres across that weigh just a few trillionths of a kilogram. "It's a difficult experiment – it will take maybe 10 years to complete," Bouwmeester says.

His experiment calls for the mirrors themselves to be put into a superposition – in other words, in two different places at once. Verifying that, however, will mean measuring how much they are deflected by a photon that is itself in a superposition. If Bouwmeester's calculations are correct, the deflection will

be less than a billionth of a millimetre.

Though Bouwmeester's machine is years away from telling us anything, another quantum machine is ready to go: the aforementioned quantum tuning fork, created by Aaron O'Connell and his colleagues at UCSB. In March they reported that they had managed to get it to rest peacefully in its ground state (*Nature*, vol 464, p 697).

This was not easy to achieve – it has taken years of painstaking work – but it means that, like an atom, the oscillator is in a state in which it will absorb energy only in distinct incremental amounts, or quanta. Its movements are so minute that adding a single quantum of energy will affect its motion or change its position. And, also like an atom, it can exist in a superposition.

O'Connell's team have managed to put their sliver of aluminium into a superposition of oscillating and not oscillating. They did this by putting the oscillator next to a tiny electric circuit that exhibits strange quantum behaviour, such as forcing current to move through it in two different directions at once. Being in the vicinity of this strange behaviour made the oscillator pick up similarly strange quantum states.

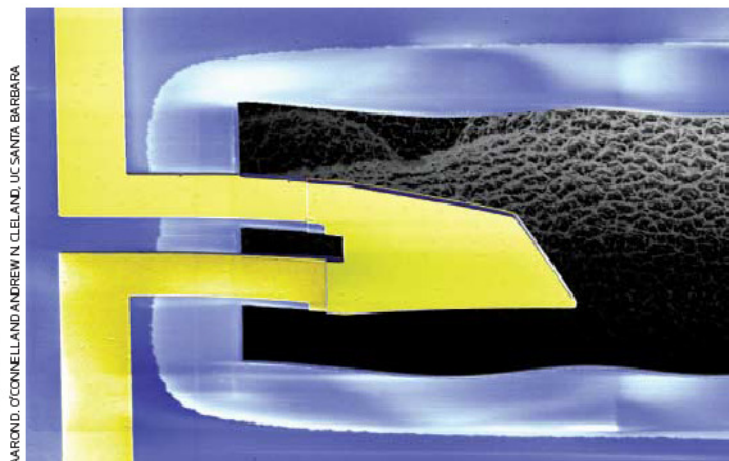
The experiment is a move towards a

genuinely macroscopic case of something being in two places at once. If we can get there, it would be the mechanical analogue of a cat being alive and dead.

There is still some way to go before we are quite ready to resolve the paradox of Schrödinger's cat. Though the oscillator is large enough to see with the naked eye, the difference between its static and oscillating positions is tiny, just 10^{-16} metres. To see a meaningful deviation from standard quantum mechanics, the separations would have to be at least an order of magnitude larger – possibly a lot more, Arndt reckons.

Nevertheless, says Arndt, the breakthrough is "really stunning". He, like everyone else, is excited to see what might come of this new age of quantum machines. "The first key applications are improved tests of the foundations of quantum physics," he says.

This could be done by watching the behaviour of such oscillators under various conditions, such as different temperatures and oscillation frequency. Placing it next to different kinds of quantum circuits and using various ways of protecting it from the environment might also expose hitherto unseen quantum behaviours. Because the quantum machine is so unusually large, it



AARON O'CONNELL AND ANDREW N. CLELAND, UC SANTA BARBARA

One way to test quantum theory is with this sliver of aluminium

is possible that it will do things that quantum theory does not predict.

O'Connell's group has not seen any deviations from the basic Schrödinger equation that describes the quantum world yet. "It seems to work just fine, from what we've seen so far," says John Martinis, who leads the team.

But these are only the first of a new wave of tests. Last year, Adler and Angelo Bassi of the University of Trieste in Italy pointed out that a quantum machine could test a proposal made by a group of physicists at Trieste more than a decade ago: that the Schrödinger equation is

only an approximation of a deeper theory, and that adding a term to it that describes random noise might make it more accurate.

In this "continuous spontaneous localisation" model, the random noise is linked to the mass of the objects involved and it is this rather than the measurement process that causes the decoherence. Adler and Bassi have now shown how this could be tested – and how it might reveal something new about the universe (arxiv.org/abs/0912.2211).

What is this noise? Electromagnetic hiss? Chaotic Brownian motion of the particles? Something entirely unknown to physics? It's not clear, Adler says, but the latter possibility is the most likely if their model turns out to be right. "There could be a new cosmological field," he says. "At present it's not detectable and it's going to be very hard to detect."

The idea of a new field permeating space sounds far-fetched, but Bouwmeester reckons we shouldn't rule anything out. "We know a lot but we are far from having understood everything," he says, pointing to the surprising conclusion from astronomical observations that the universe is filled with dark energy and dark matter. "There is room for some very big surprises."

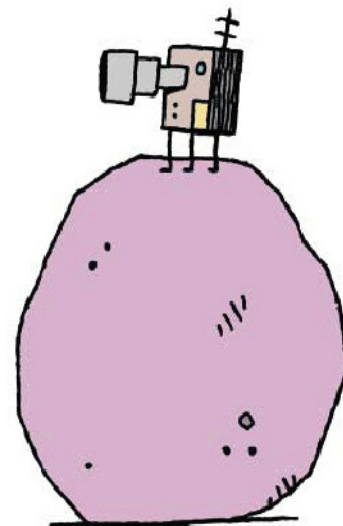
A deeper theory

And, as Adler points out, it's no more fanciful an idea than saying quantum stuff is inherently incomprehensible – that it is a matter of mysterious measurement processes or new universes forming every time a particle is detected to be doing one thing and not another. "Make the superposition collapse a real process and you don't have to explain it away through interpretations," he says.

Another test on the horizon has been devised by Charles Wang and his colleagues at Aberdeen University in the UK. This quantum machine is not a microfabricated piece of aluminium, but a gas of super-chilled atoms designed to check whether the quantum uncertainty principle is responsible for the collapse of superpositions.

First formulated by Austrian physicist Werner Heisenberg, the uncertainty principle says that empty space is fizzing with particles that pop in and out of existence due to uncertainties in the energy of the vacuum. In 2000, Ian Percival of Queen Mary, University of London, suggested that these ghostly entities could affect the way subatomic particles form superpositions and interact with each other.

Wang and colleagues plan to test this



theory. They propose that the energy inherent in empty space will affect in a particular manner the movements of an ultra-cold gas of atoms, called a Bose-Einstein condensate (arxiv.org/abs/1002.2962). The result of Wang's experiment – which he hopes to carry out in the near future – might reveal a previously unconsidered influence on the quantum world.

Any, or none, of the schemes could change the way we view the quantum world and the way we interact with it. If mass and gravity turn out to be affecting quantum behaviour, that might tell us something about the elusive theory of quantum gravity that physicists are trying so hard to create. Penrose reckons we will eventually be forced to combine Schrödinger's equation describing quantum particles, an understanding of the measurement process, and the principles of Einstein's theory of gravity into one theory, and that each of these three aspects of reality will then be seen as nothing more than an approximation to a deeper fundamental truth.

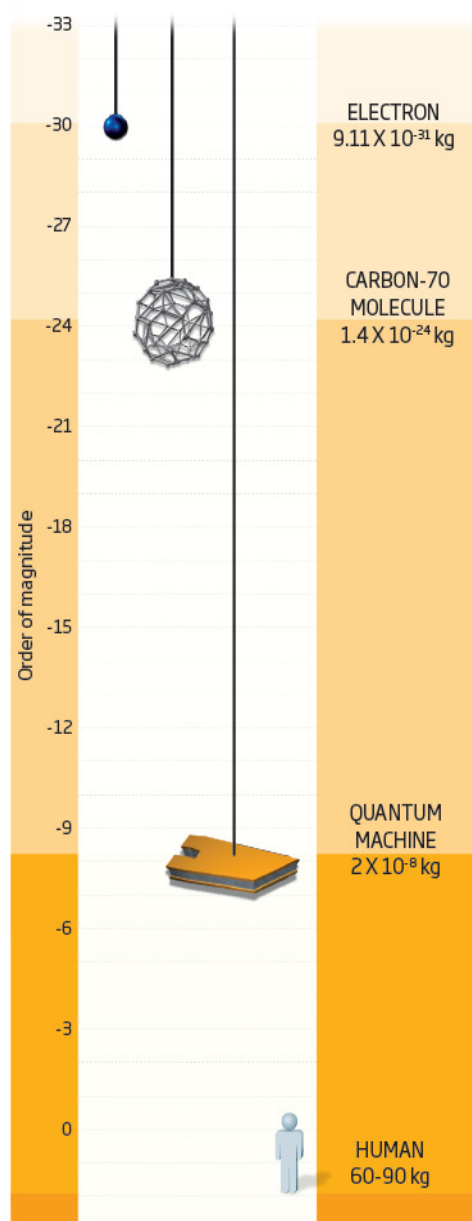
Bouwmeester is excited that, while all eyes are on the high-energy potential of the Large Hadron Collider at CERN, near Geneva, Switzerland, the quantum machines might tell us something more fundamental about the universe. "Most theorists would probably not expect big things to come out of the type of experiments we are doing," he says. "They probably think we have to go to huge energies to resolve such fundamental issues."

Though the road ahead looks to be a bumpy one, everyone is excited about quantum machines opening up a new vista. It's a chance to probe the quantum world with a "new and unexplored regime", Aspelmeyer says. "This is really testing quantum physics in its extremes." ■

Michael Brooks is a consultant for *New Scientist* and author of *13 Things That Don't Make Sense* (Profile). He tweets at twitter.com/DrMichaelBrooks

Mass matters

Quantum machines are orders of magnitude more massive than anything that has demonstrated quantum behaviour before, such as electrons and molecules





Climate conundrum

Ice ages when greenhouse gas levels were high, soaring temperatures when they were low. Just what was going on in our planet's past, asks Anil Ananthaswamy



MACDUFF EVERTON, RADIUS IMAGES/CORBIS

CROCODILES in the Arctic? You better believe it. There was a time, about 90 million years ago, when the Earth was so warm that crocodile-like creatures lived and bred inside the Arctic Circle. At other times, ice has spread over large parts of the planet.

The prime suspect for these dramatic swings in Earth's climate is carbon dioxide: hot periods over the past half a billion years generally coincided with high levels of CO₂ in the atmosphere and vice versa. A few studies, however, suggest that there may be periods when it was cold when CO₂ levels were high, or hot when CO₂ levels were low. So what was going on at these times? Are we missing part of the climate puzzle?

Explaining these anomalies matters, because researchers are increasingly looking at past changes in our climate to help find out what's in store for future generations as CO₂ levels shoot up. Such studies provide "real-world" guides to the future that do not rely on computer models alone.

The tricky part about studying the climate of the past is working out what happened millions or even billions of years ago. Luckily, there are all kinds of clues to look at. Rocks reveal much about conditions at the time they formed; many rocks form only when there is liquid water, for instance. Ice sheets also leave numerous signs of their presence, from distinctive patterns of erosion to the mud and boulders they deposit.

Combine all the different indicators, and a consistent picture of past temperature emerges. While there have been ice ages from time to time, there is evidence of liquid water stretching back more than 3 billion years. Indeed, for much of Earth's history the planet has been warmer than it is now.

This is surprising, because the sun has been getting steadily hotter and emits one-third more energy now than it did 4 billion years ago. If Earth's climate was all down to the sun, the planet ought to have grown steadily hotter.

In 1981, Jim Kasting of Pennsylvania State University in University Park suggested that this relative stability in climate is all down to a CO₂ "thermostat". It has to do with the long-term carbon cycle: some CO₂, in the form of organic matter or carbonate rocks, gets buried deep in the Earth's crust for a time, and is eventually released back into the atmosphere by volcanoes.

The first step in the formation of carbonate rocks occurs when CO₂ reacts with silicate ➤

Cold, hot, cold, hot - what causes the dramatic swings in Earth's climate?

"The more we look to the past, the more evidence we find that CO₂ is very important for controlling Earth's climate"

rocks. This process is called weathering – and the rate of weathering, Kasting pointed out, depends on the temperature. When the planet warms, weathering speeds up, removing more CO₂ from the atmosphere and thus causing the temperature to fall. When the planet cools, weathering slows but volcanoes keep on pumping out CO₂, so levels eventually rise.

You would not want this kind of thermostat controlling your fridge: it can take millions of years to have a major effect, so there can still be wild swings in the climate. However, it might help explain why Earth's temperature has remained in the vital liquid water range.

Bubble trouble

The implication is that although any number of factors can affect the climate – from orbital variations to changes in the position of continents – the level of greenhouse gases, and CO₂ in particular, is the most important. To find out if this is true, we have to look at how CO₂ levels have changed in the past.

The best way to do this is to measure CO₂ levels in the tiny bubbles of air trapped in the ice sheets of Greenland and Antarctica – but this does not take us back very far. "The oldest ice on the planet is about a million years old, maybe a little older," says Aradhna Tripathi of the University of California, Los Angeles.

To get an idea of CO₂ levels in the more distant past, researchers have to rely on less-direct methods. One is to model the long-term processes affecting CO₂ levels, such as the amount of volcanism and the rate of fossil-fuel formation. Geochemists have been refining such models for decades, which provide a broad-brush picture of average CO₂ levels over tens of millions of years but cannot tell us much about shorter-term swings.

Another method is to look at the density of the pores, or stomata, in fossilised leaves. Plants need stomata to let CO₂ in, but they also lose water through them, so they usually have no more than necessary. "It has been observed in many plants that the density of the pores goes down as CO₂ goes up, and it tends to be a species-specific response," says Dana Royer of Wesleyan University in Middletown, Connecticut. Royer and others have estimated past CO₂ levels by looking at the changes in stomatal density in plant lineages that have otherwise not changed much over time, such as *Ginkgo biloba*.

Measuring the ratio of isotopes of carbon in fossil soils and shells in marine sediments can also give an idea of changes in CO₂ over the past half billion years or so. There are issues with all

of these approaches, but in general they all support the idea that global temperature and CO₂ levels are linked. Over the past 400 million years of Earth's history, CO₂ levels have been relatively low when the planet had extensive ice sheets, from about 330 to 290 million years ago and from 35 million years ago to today. For the rest of the time, they have been much higher (see graph, right).

Nevertheless, hidden in these broad sweeps of time are some nagging inconsistencies. Take the Miocene, from 23 to 5 million years ago, the time that saw the growth of ice sheets in Antarctica. In the middle of the Miocene, about 15 million years ago, there was a period of relative warmth. However, reconstructions suggest CO₂ levels over this period remained low, below 300 parts per million (ppm).

The existence of such inconsistencies no more disproves the idea that CO₂ causes warming than your house warming up on a sunny day proves it does not get warm when you turn the heating on – rather, it suggests that some other factor caused the warming. In theory the mid-Miocene anomaly could be due to the sun warming, for instance, except that as far as we know the sun's output, while gradually increasing, otherwise varies very little.

Volcanoes are part of the long-term cycling of carbon from rocks to the atmosphere

So Wolfram Kürschner of Utrecht University in the Netherlands and colleagues decided to check the results of earlier studies using a method based on stomatal density. After examining fossilised leaves from three plant groups, Kürschner's team reported in 2008 that while CO₂ levels fell from 600 ppm to below 300 ppm at the start of the Miocene, they rose to 500 ppm during the mid-Miocene warmth before falling again (*Proceedings of the National Academy of Sciences*, vol 105, p 449).

Meanwhile, Tripathi and her colleagues were developing their own method for revealing past CO₂ levels. Their technique involves studying the ratio of boron to calcium in the fossil shells of creatures that lived in surface waters. This ratio is related to the ocean's acidity at the time the shells grew, which in turn is linked to atmospheric CO₂ levels.

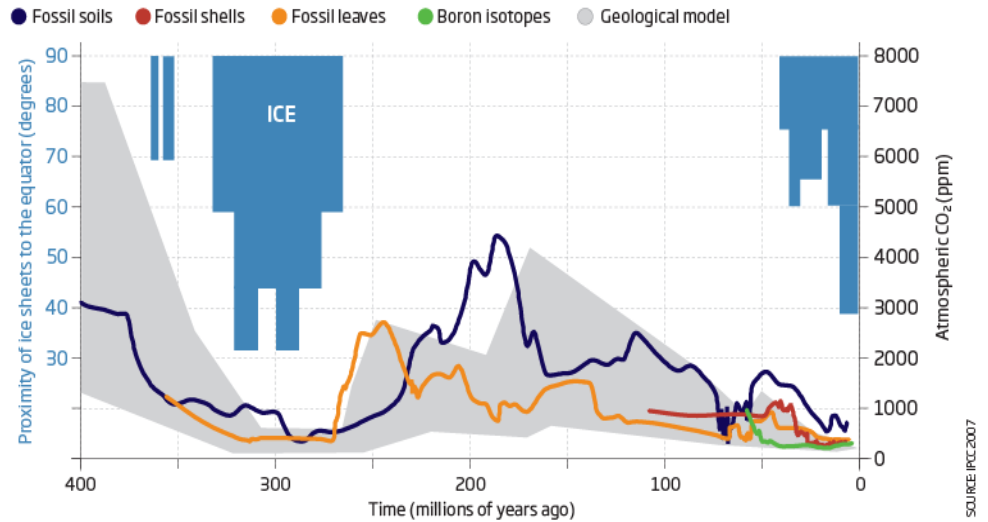
The team used fossils in deep-sea sediment cores from two sites in the western tropical Pacific Ocean to reconstruct the CO₂ history of the last 20 million years. First, Tripathi's team showed that CO₂ levels for the past 800,000 years calculated using their method match those measured in the ice cores, strong evidence that their technique is accurate. Looking further back, they too found that CO₂ levels were high in the mid-Miocene, ranging from 350 ppm to 500 ppm – comparable to today's level



PAST CO₂

Working out how the level of CO₂ in the atmosphere changed in the distant past is extremely difficult, and different methods produce somewhat different results. The broad picture is clear, though: ice sheets grew when the CO₂ level fell and vanished when it rose

Method of determining past CO₂



of 380 ppm (*Science*, vol 326, p 1394).

The story is similar for other apparent inconsistencies. Towards the end of the Ordovician period, 440 million years ago, the planet entered a deep ice age that caused a major extinction, even though CO₂ levels appeared to have been high. However, more detailed studies by Seth Young of the University of Indiana in Bloomington show levels did fall at the start of the ice age. They rose later as weathering slowed, eventually bringing about the end of the ice age.

Rather than some unknown factor being behind these inconsistencies, it now appears they were simply due to problems with the earlier studies. "The more we look at the past, the more evidence we seem to find for this idea that CO₂ is very important for controlling Earth's climate," says Tripathi.

So what is going to happen next? How do findings based on studies of past climate compare with the predictions made by computer models? "None of these are a perfect representation of the Earth," says Tripathi. "Can we use the past response of climate to better understand how sensitive Earth's temperature is to greenhouse gas levels?"

Climate sensitivity refers to how much global temperature rises when the level of CO₂ in the atmosphere doubles. Just about everything hinges on this number. The higher Earth's climate sensitivity, the more temperature and sea level will rise as we pump CO₂ into the atmosphere, and the greater the disruption to our civilisation and ecosystems. "If somebody wants to argue intelligently against some kind of CO₂ effect on climate, they tend to focus on very low climate sensitivities, say 1 °C per CO₂ doubling," says Mark Pagani of Yale University.

True sensitivity

Sensitivity is defined as the effect of doubling the level of CO₂ in the atmosphere because CO₂ has less effect as levels rise. If an increase from 280 to 560 ppm warms the planet by 1 °C, an increase from 280 to 1120 ppm should warm it by 2 °C. Indeed, physics tells us that for every doubling of CO₂ the Earth's temperature should rise by 1 °C – if nothing else changes.

In reality, all kinds of things change when the planet heats up. When the atmosphere warms, for instance, it holds more water vapour, a potent greenhouse gas, which leads to further warming. Warming also reduces the area covered by snow and sea ice, meaning less energy is reflected back into space, again leading to further warming. Plugging such

feedbacks into computer models gives a climate sensitivity of between 2 °C and 4.5 °C, with a best estimate of 3 °C, the last report of the Intergovernmental Panel on Climate Change concluded.

Unfortunately, in some ways this figure is misleading, and not just because of the uncertainties in the models. The deeper problem is that current climate models include only feedbacks that kick in rapidly in response to warming. Feedbacks that kick in only after decades or centuries, such as changes in the extent of ice sheets on land (as opposed to snow and sea ice), are left out.

So the true climate sensitivity, or Earth system sensitivity, could be larger than the short-term sensitivity. And because existing climate models are not yet sophisticated enough to include slow feedbacks, the only way to work out the Earth system sensitivity is to look at the effect of past CO₂ rises.

Royer and colleagues recently made a rough estimate of the average Earth system sensitivity over the past 400 million years based on all the past CO₂ reconstructions. Their calculations suggest that it is around 3 °C per CO₂ doubling (*Nature*, vol 446, p 530).

"The deep time [data] cuts the tails off of the uncertainties," says Richard Alley of Pennsylvania State University. "The really low value of just 1 °C for doubling of CO₂ just doesn't work. And the really high values, 10 to 11 °C for doubling of CO₂, don't work either. A number of 3 °C or somewhat higher works pretty well."

The trouble with Royer's approach is that climate sensitivity is not constant. There appear to be times – when ice sheets have grown bloated towards the end of ice ages, for instance – when just a little "nudge" can lead to dramatic warming. In the absence of

large ice sheets, sensitivity might be lower.

To get a more accurate picture, researchers have to look at periods similar to the present. One such time is the early Pliocene about 4.5 million years ago, when CO₂ levels were around 400 ppm – only slightly higher than they are now – yet the Earth was more than 3 °C warmer, with smaller permanent ice sheets and sea level up to 25 metres higher.

One recent study of the Pliocene concluded that the Earth system sensitivity at this time was 4.5 °C per CO₂ doubling (*Nature Geoscience*, vol 3, p 60). Another study, by Pagani and colleagues, using a different methodology, found that it could have been as high as 7 °C per CO₂ doubling (*Nature Geoscience*, vol 3, p 27).

Other studies also point to the Earth system sensitivity being significantly higher than model predictions. This does not necessarily mean that we can expect more warming than predicted by 2100, as studies of past climate reveal the response to CO₂ rises after many centuries. What it does suggest is that the planet will keep warming long after reaching the "maximum" predicted by current models if CO₂ levels remain high. "If the Earth actually has a very high sensitivity, it puts more pressure, if you will, on trying to find solutions for what's going on now," says Royer.

So while many of the details have yet to be settled, the big picture emerging from studies of past climate couldn't be clearer. Carbon dioxide is the most important of the many factors affecting the planet's climate. And if we double the level of CO₂ in the atmosphere, we can expect the temperature to rise around 3 °C in the short term and keep climbing over the following centuries. ■

Anil Ananthaswamy is a consultant for *New Scientist* based in London

If you thought you could treat your child's autism, wouldn't you give it a try? Jim Giles discovers why desperate parents are taking desperate measures

The lure of a cure

LEO MILIK is a success story. At age 2 he was diagnosed with autism. After his mother heard the condition could be linked to certain foods, she eliminated wheat and dairy products from his diet. Now six years later, Leo has only a mild form of the condition. He attends a mainstream school and doctors say that in a few years he could lose his diagnosis altogether.

There's one wrinkle in this tale. The diet that appears to have turned Leo around has recently been tested in a randomised, placebo-controlled trial for the first time. The researchers reported last month that it provided no evidence the diet worked.

The diet is not the only unorthodox treatment around; a range of "biomedical" therapies that purport to treat the root causes of autism have gained popularity in recent years. These range from vitamins and antibiotics through to drugs supposed to remove heavy metals from the body, and even a hormone treatment that can delay puberty.

The autism "biomed" movement is well organised. An organisation called the Autism Research Institute, based in San Diego, California, lists the hundreds of doctors and therapists who provide these treatments. There are countless websites where parents swap advice; some members speak of trying out dozens of treatments, and spending many thousands of dollars over the years.

Some say biomed has helped their child, but others tell heart-rending tales of dashed

hopes. None of these therapies has been shown to cure or even alleviate autism in good-quality trials. Some are very expensive, others are difficult and time-consuming. A few are even dangerous. This raises a question: why do so many parents of children with autism opt for unorthodox remedies, some of which are no better than snake oil?

Desperation is part of the answer. Autism is mysterious in origin, variable in manifestation, and lacks any known means of prevention or cure. And it has some unique characteristics that collectively tempt parents down the biomed route. The condition has also become the subject of several myths that encourage parents to throw science out of the window. "The evidence doesn't come into it most of the time," says Vanessa Green, a psychologist at Victoria University of Wellington in New Zealand.

Autism is a spectrum of conditions that cause problems with language, social interactions and imagination. Some infants seem to show autistic traits from a few months of age, while about a third develop more typically, but then regress some time between the ages of 1 and 3.

We still do not know what causes autism. The best guess is that most cases are the result of a genetic vulnerability acting in concert with factors in the womb, perhaps maternal infections. As treatment, all mainstream doctors can offer are speech and behavioural therapies. One common approach is a form of rote learning known as applied behavioural analysis, in which children are taught to perform simple actions for small rewards. A number of studies have shown that over several years, ABA improves speech and academic ability.

Out of options

Maria Milik, Leo's mother, thinks behavioural therapies did help her son, but for her and many other parents, they are not enough. Faced with a paucity of medical help, many families feel they have no choice but to experiment with biomed. Milik started Leo on the diet after a nutritionist said that her son might be allergic to wheat and dairy products. "I thought she was crazy but I had run out of options and was getting nowhere with the mainstream medical community."

A lack of medical help is not the only factor driving the explosion of biomed. Another is the recent emergence of several myths about the condition. Perhaps the best known centre on the claim that vaccines can trigger autism. In the UK, concern revolves around the triple vaccine for measles, mumps and rubella (MMR). ►





Adherents claim that three vaccines in one shot overloads the immune system. Vaccine fears have a different focus in the US, where some groups claim that the mercury in thimerosal, a preservative in some vaccines, is responsible.

Many large epidemiological studies have shown children who received MMR or thimerosal are no more likely to be autistic than those who didn't. Yet as with any conspiracy theory, the more evidence that emerges to disprove the idea, the more the goalposts shift and the theories morph into broader, vaguer claims. Some parents now reject the entire childhood immunisation schedule, claiming it is "too much, too young". In the US there is a prominent anti-vaccine movement that is suspicious of many of the additives in shots; their rallying cry is a call to "green our vaccines".

Implicitly linked with the vaccine myth in some people's minds is the belief that autism rates are skyrocketing, and that the cause must therefore be rising levels of some environmental toxin. When the US news programme *Today* asked readers for their views on autism in an online poll last month, for example, one response option was labelled: "So many more cases, so many more vaccinations – it can't just be coincidence."

It's true that the number of diagnoses of autism has increased dramatically in many western countries. Before the 1980s, autism was thought to affect around 1 in 2000 children in the US; now almost 1 in 100 children has a diagnosis of an autistic spectrum disorder.

But is this increase real? Perhaps not, because the range of conditions labelled as autism has broadened over the last 20 years. Doctors have also become much more aware of the condition. Many children once diagnosed with learning difficulties, say, are now considered to be on the autistic spectrum. Researchers say these factors have caused much of the increase. Although it cannot be ruled out that there has also been a rise in the underlying rate, the picture is murkier than suggested by

Yet cases of regressive autism have been documented for about as long as autism has been recognised as a clinical entity. Anyway, just because an illness arises in childhood as opposed to being present from birth does not mean the cause must be something in their environment. Law points out that there are other genetic conditions whose symptoms arise only later in life – sometimes even in adulthood, such as Huntington's disease. "Most genetic disorders are characterised by a period of normal development and then loss of function," says Law.

Opioids on the brain

Law, who has a son with autism, is concerned about the growing use of untested therapies. Four years ago he set up the Interactive Autism Network, an online database of information from parents about their children's diagnosis, behaviour, family, environment, and the therapies they receive, including biomed.

The network's preliminary figures show that the wheat-free and dairy-free diet is one of the most common biomed options. Of the 7021 families who have entered information about treatments, about 1 in 6 is now using some form of it. That's a staggering proportion considering controlled trials have failed to find any benefit.

The diet stems from the work of the late Robert Cade, who was a kidney specialist at the University of Florida. Cade is chiefly known for inventing the sports drink Gatorade, but he became interested in studies showing that South Pacific islanders, whose diets used to be free of wheat, had fewer psychiatric problems. It is known that if gluten, a compound in wheat, is improperly metabolised, proteins known as gliadinomorphins can build up in the body

and can activate the brain's opioid receptors. Casomorphins, metabolites of the casein in dairy products, have a similar effect. Cade speculated that some children with autism have problems metabolising gluten and casein, and that raised levels of opioid-like substances in their blood could be interfering with brain development.

The gluten-free casein-free (GFCF) diet is far from an easy option for parents or their children. In many cases, a child will find their



favourite foods off the menu. Bread, milk and normal cookies are out. Since dairy products are usually children's main source of calcium, parents need to find alternative sources or use supplements. Parents say they spend hours studying food packaging. "You have to be a food chemist to understand the labels," says Susan Hyman, a paediatrician at the University of Rochester in New York.

The biomed movement bombards parents with dubious claims about the GFCF diet. One popular website, gfcfdiet.com, compares giving wheat to a susceptible infant to "feeding your child poison". It is rarely acknowledged that children with autism have never been shown to have high levels of opioid-like substances in their blood.

Some trials have hinted at benefits from the diet, but none used the proper controls. Hyman presented results from the first rigorous trial at the International Meeting for Autism Research, held last month in Philadelphia. While the study was small, involving just 14 children, it failed to show a benefit.

The GFCF diet appears positively benign, however, beside some of the other biomed options on offer. Perhaps the most infamous is chelation therapy, promoted by those who say autism is caused by mercury from vaccines, or sometimes other heavy metals, such as lead from the environment.

"One in six US families with autistic children said they used some form of the wheat-and-dairy-free diet"

headlines about an autism "epidemic".

Still, these myths have an intuitive appeal, especially for one group in particular: families of children who have the regressive form of autism. As regression often occurs around the time of childhood vaccination, parents blame the shots, says Paul Law, a paediatrician at the Kennedy Krieger Institute in Baltimore, Maryland. "It's a very frightening experience to go through," he says. "It's an experience that demands an explanation."



Jenny McCarthy and her former partner Jim Carrey have spearheaded calls to "green our vaccines"

the medical website Quackwatch found that the Doctor's Data test gave results that were misleadingly high. Doctor's Data did not reply to a request from *New Scientist* for comment.

Another risky therapy is Lupron, a drug that lowers testosterone levels in men and oestrogen in women, and is sometimes used to delay puberty in children if it starts very early. The use of Lupron in autism is promoted by Mark Geier and David Geier, a father-and-son doctor team based in Rockville, Maryland, who say that the hormonal changes induced by the drug help protect the body against the toxic effects of mercury. Most doctors say there is no science to back up this claim, and that in older children the treatment may undesirably delay the onset of puberty.

There are many other kinds of biomed – too many to count – ranging from vitamins to antibiotics and even oxygen chambers. A host of websites exist where parents swap tips and tell stories. The Yahoo discussion group "Autism-Mercury", for example, has nearly 9000 members and gets hundreds of posts a week. One member estimated she had given 50 different treatments to her child.

Oprah appearance

Some parents are convinced that biomed works. They include the former model and actress Jenny McCarthy, who became the de facto spokeswoman for the idea that autism can be cured after telling her story to Oprah Winfrey. McCarthy's son was diagnosed with autism in 2005. After a barrage of biomed, she says he is now "recovered" from the most severe features of the condition.

"In 30 years of working with children with autism I have yet to see one cured," says Jennifer Elder at the University of Florida in Gainesville. Of the internet tales of cures, Elder says: "I don't disregard what they're saying, but they rely heavily on anecdotal reports."

How, then, to explain the apparent success stories? As with treatments for any condition,

the placebo effect may be playing a role. "When you try a new intervention you focus time and energy on them," says Alison Singer, president of research charity the Autism Science Foundation. "You have this natural tendency to ascribe causality."

Singer, whose daughter has autism, tried the GFCF diet and vitamins but she has now turned her back on biomed. "You're exposing your child to risk with no evidence it will help," she says. "I have a daughter, not a guinea pig. She deserves better."

But the cure myth is also being fuelled by some of autism's unique characteristics. The condition can be tricky to diagnose, so some children may have been wrongly labelled autistic in the first place. A study published in the *Journal of Autism and Developmental Disorders* (vol 38, p 606) found that 20 per cent of children diagnosed with autism at 2 were given the all-clear, or diagnosed with a different disorder, two years later.

Even if the original diagnosis was correct, another factor to bear in mind is that autism delays development, so a child who was non-verbal at 3 could have good speech by the age of 5 without any intervention. A parent could easily assume it was all thanks to the biomed at age 4, say, but perhaps the child would have improved anyway. Autism is so variable that it is impossible to predict an individual's outcome with any accuracy.

And yet the tantalising possibility remains that something, somewhere out there, really does work, but that trials so far have lacked the sophistication to separate effective treatments from the duds. Autism is thought to encompass a range of conditions that cannot yet be differentiated. If a treatment helped only one subtype of autism, within a trial, the benefits would be hidden when the results were averaged across all subjects. "The fear is that we generalise," says Clara Lajonchere at the University of Southern California, Los Angeles.

Lajonchere, who helps manage the research funded by the US charity Autism Speaks, says that genetic tests and MRI scans might show that a subset of children benefit from a particular therapy. These "stratification" techniques are not yet in use, but discussions are under way to include them in future trials.

In the meantime, parents will continue to take whatever steps they feel are necessary. "I didn't have any knowledge of scientific research at the time I put my son on the diet," says Milik. "I just felt I needed to try it." ■

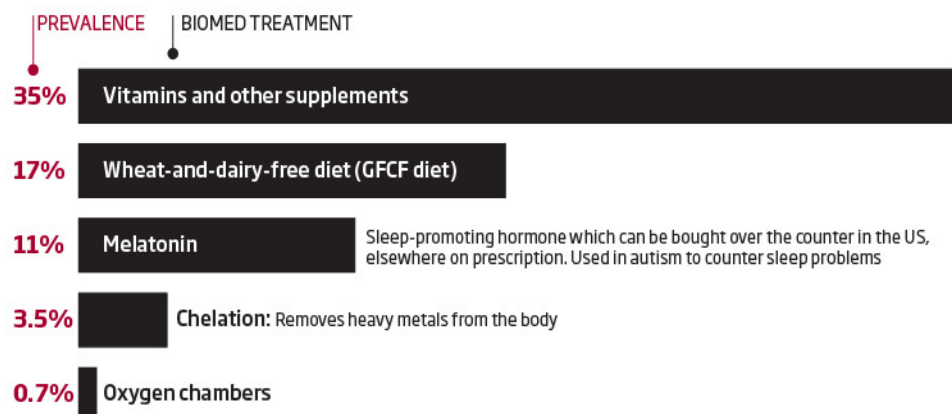
Jim Giles is a correspondent in New Scientist's San Francisco office

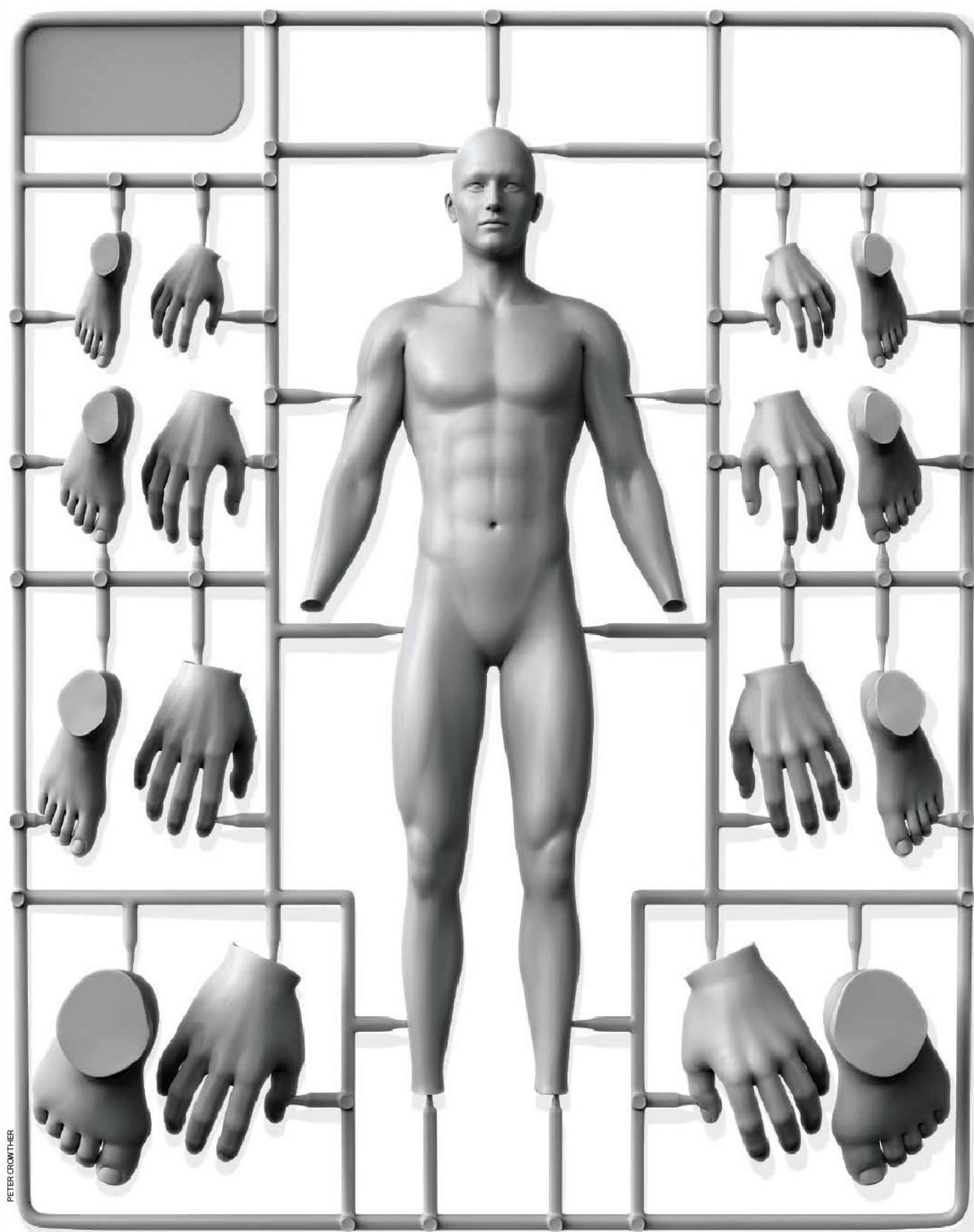
Chelation involves injecting a drug such as dimercaptosuccinic acid, or DMSA, which flushes heavy metals from the body – it is usually used only to treat heavy metal poisoning. Side effects can include temporary damage to the liver and bone marrow.

A parent wondering whether to try this drastic treatment may struggle to separate fact from fiction. Doctor's Data, a private lab based in St. Charles, Illinois, sells a test that parents can use to measure the levels of heavy metals in their child's urine. But an investigation by

Biomed by numbers

Over 7000 families have provided figures to the Kennedy Krieger Institute's Interactive Autism Network about what kind of therapies they are giving to their autistic children





PETER GROWTHER

Hidden forces are pushing and pulling on the levers of evolution. **Dan Jones** reports

Winning combinations

THE remarkable diversity of life on Earth stands as grand testimony to the creativity of evolution. Over the course of 500 million years, natural selection has fashioned wings for flight, fins for swimming, and legs for walking, and that's just among the vertebrates. The capacity for evolutionary innovation – or, in buzzword form, “evolvability” – is built into the fabric of life.

Can evolvability itself evolve, with species becoming more or less evolvable over time? And if so, what factors affect evolvability and can they be studied in the natural world? Few questions are more fundamental to evolutionary theory, yet evolvability didn't enter biological parlance until 1987, when arch-pharse-maker Richard Dawkins coined the term. In the intervening decades it has become a hot topic, though only recently has real-world evidence begun to put flesh on the bones of the theory.

Now there are studies aplenty to shed light on the factors that might constrain and enhance an organism's capacity to evolve. They are also explaining crucial events in human evolution, such as the switch to walking on two legs and the emergence of our highly dexterous, tool-using hands.

One of the first hurdles had been to define exactly what “evolvability” means. The aim is to capture the capacity of a species or population to respond to natural selection. Since genetic variation is the raw material on which selection acts, the extent of this variation in a population provides a crude measure of evolvability.

When most researchers talk about evolvability, however, they mean something more subtle – not just how much genetic

variation is present, but whether this variation translates into adaptive changes in the organism's outward appearance and behaviour that could be shaped by natural selection. Günter Wagner, a pioneer in the field who is based at Yale University, therefore defines evolvability as “the capacity to generate heritable phenotypic variation”. That is to say, variation in an organism's body-type that can be passed from generation to generation.

The real question, of course, is what determines this capacity. Two factors are key. Perhaps the most fundamental of these is an organism's “mutational robustness” – the capacity to develop normally despite the

“Evolutionary pressures on the feet might have prepared our hands for tool use and manual tasks”

presence of genetic mutations. Since genes rarely act independently, a particular mutation could have a positive, negative or neutral effect on the organism, depending on the overall genetic background. Greater robustness could therefore be achieved by mechanisms that dampen the impact of mutations in any particular gene. In principle, that should increase an organism's survival because it reduces the chance of potentially harmful changes to the organism's body plan. But this buffering effect would also be the enemy of change, masking potentially beneficial variation and putting the brakes on the organism's evolvability.

Or so it might seem. In fact, by neutralising the effects of otherwise harmful mutations, robustness preserves genetic variations that might otherwise be weeded out. That means organisms accumulate a wealth of hidden mutations within the population. Further genetic or environmental changes might then remove the buffering mechanisms and unmask the effects of these stored mutations, providing ready-made variation in the organism's make-up. What might the mechanisms behind this robustness be?

The main players seem to be “heat-shock proteins”, according to studies led by Susan Lindquist at the Massachusetts Institute of Technology. HSPs ensure that other proteins always fold in the same stable three-dimensional shape, which is vital for their role within the cell. Under harsh conditions like scorching temperatures or high salinity, proteins can fold wrongly, preventing them from carrying out their function. It is here that the HSPs step in, acting as chaperones to guide the protein into the correct shape and allowing it to function properly even under troublesome circumstances.

Crucially, HSPs also ensure a protein folds into the same stable shape even in the face of genetic mutations that shuffle the protein's sequence of amino acids. That permits hidden variation to build up over time without getting in the way of the protein's everyday activities.

The structure and function of proteins govern all kinds of processes in the development of an organism. So when Lindquist's team knocked out the HSPs in thale cress and fruit flies, the stored mutations suddenly became apparent in physical ➤

changes to the organisms, including new leaf shapes for the cress and changes to the shape of the flies' eyeballs. The genes that code for HSPs don't routinely stop functioning in natural populations but occasionally changes to the environment, like a radical change in diet, can overwhelm the HSP system and lead to similar effects, providing variation that can respond to the new evolutionary pressures precisely when it is needed most.

Lingering connections

HSPs are not the be-all and end-all of robustness. Some proteins are intrinsically more robust than others, even without the help of HSPs. This too can affect an organism's evolution. In 2006, for example, Jesse Bloom and colleagues at the California Institute of Technology in Pasadena showed that more robust proteins can pick up useful additional functions from new mutations without losing their basic structure and collapsing into a useless tangle (*Proceedings of the National Academy of Sciences*, vol 103, p 5869). And in 2008, Robert McBride and colleagues at Yale University showed that viruses bred to produce more robust proteins adapted to new evolutionary pressures, like higher temperatures, more quickly than less robust strains (*BMC Evolutionary Biology*, vol 8, p 231). In other words, they were more evolvable.

Robustness is only half of the story of evolvability, however. The second key factor concerns a phenomenon known as integration—the way different body parts or traits appear to vary and evolve together. Integration between traits often results from their shared evolutionary history. Body parts like limbs, teeth, ribs and vertebrae that are repeated along the body axis, for example, arose through the direct duplication of certain genes way back in evolutionary history. The two copies will not be completely independent of one another because the expression of both will ultimately be governed by the same regulatory genes at a different point in the genome, meaning the two body parts would still tend to vary and evolve together.

Integration is also likely if the different parts are involved in the same function. The four fingers and thumb, for example, work together for grasping and manipulation. To preserve the optimal use of the hand, changes in one part—a longer finger, say—need to be complemented by corresponding changes in the other digits. Selection therefore favours a developmental system in which



SUPERSTOCK/GETTY

“Environmental changes can unmask hidden mutations, providing ready-made variation when it’s needed”

genetic changes affecting digit length produce a coordinated shift in all digits.

Like robustness, integration can be a double-edged sword. On one hand, it increases the capacity to generate coordinated, adaptive changes in body structures, which surely help to increase an individual's chances of survival. On the other, it also constrains the possible evolutionary avenues an animal could take—capping its evolvability, in other words—since a potentially beneficial change to one trait could have a disastrous impact on the other traits to which it is linked.

Luckily for life on Earth, integration is not an all-or-nothing affair. It is becoming

clear that the traits can be integrated to varying degrees (see “Evolvable dogs”, right). Sometimes existing integration can be uncoupled altogether, making each trait an independent “module” that is more evolvable.

Consider the evolution of wings in mammals. The fore and hind-limbs of mice and other rodents are very tightly integrated, so that changes in one limb pair, such as an increase in length, correlate almost perfectly with changes in the other pair, says James Cheverud, a biologist at Washington University in St. Louis, Missouri, who studied the link.

Bats, however, use their modified fore-limbs for flying and their hind-limbs for grasping—two very different tasks, which would hint that the limbs are quite loosely integrated. Sure enough, Benedikt Hallgrímsson of the University of Calgary in Edmonton, Canada, and Nathan Young of the University of California, San Francisco, have recently found that the co-variation in the length of bones in

The hind-limbs
don't mind what the
fore-limbs get up to

the bat's fore and hind-limbs tends to be much lower than in other mammals. The implication is that the ancestors of bats must have lost the genetic integration between fore and hind-limbs somewhere along the evolutionary path, opening the door for the evolution of wings (*Evolution*, vol 59, p 2691).

A similar story could explain various stages of primate evolution, too. Campbell Rolian at the University of Calgary, for example, has compared quadrupedal primate species such as macaques, in which the hands and feet share similar roles, with species like the great apes (humans, chimpanzees, gorillas and orangutans), in which the hands and feet perform independent functions.

As expected, Rolian found greater integration between the hands and feet of quadrupeds than in the great apes (*Evolutionary Biology*, vol 36, p 100). Another analysis of the entire fore and hind-limb, rather than the individual hands and feet, found a similar result, with roughly 40 per cent less co-variation in the ape limbs compared with the quadrupeds (*Proceedings of the National Academy of Sciences*, vol 107, p 3400).

The result was that "arms and legs could respond to natural selection with a greater degree of independence, thereby increasing their evolvability", says Hallgrímsson. Ultimately, this enabled early humans to evolve longer legs adapted to walking and running while leaving arm length relatively unchanged. By the same logic, a shortening of the forearm, which would have facilitated tool use, was not constrained by corresponding changes on the lower leg that might have reduced their walking power.

Importantly, integration comes in degrees. Even though the integration between the arms and legs has been significantly weakened over the years, some developmental connections linger that are strong enough to have changed the course of evolution in intriguing ways. For example, Rolian and Hallgrímsson, working with Daniel Lieberman of Harvard University, have recently discovered that evolutionary pressures on the feet might have prepared humankind's highly dexterous hands for tool use and manual tasks. The team's discovery came from a detailed comparison of the length of the bones making up each toe and corresponding finger (*Evolution*, vol 64, p 1558). They found that sufficient integration remain between the fingers and toes for them to have co-evolved to a certain degree.

Evolutionary pressures shaping the feet could therefore have changed the hands, or vice versa – but which way round? Using

EVOLVABLE DOGS

The faces of man's best friend come in an astonishing range – from the short, squashed face of a Pekingese to the slender snout of a collie. Studies by Abby Duke and Christian Klingenberg at the University of Manchester in the UK have shown that diversity in dog faces is comparable to the diversity apparent between all carnivore species.

But the remarkable variation in dogs has been achieved in just a few thousand years of selective breeding, and was possible thanks to a limited integration between the face and brain – a lack not normally found in other mammals. Intriguingly, this modularity is also found in wolves, coyotes and jackals, suggesting dog faces were always this evolvable – they simply needed the right evolutionary pressures to shape their snouts.

computer simulations to estimate the possible evolutionary pressures and corresponding changes to primate anatomy, the team suggests that natural selection acted primarily on the toes, enlarging the big toe and reducing the outer digits to stabilise the feet for walking.

The result, of course, was that as the big toe evolved, the thumb also grew accordingly. Completely by chance, that meant that the tips of the thumb and the fingers could now meet each other for the first time in evolutionary history, providing our ancestors with greater dexterity and precision gripping that became the key to the successful use of tools.

Evolvability through the ages

The take-home message is that animals are made up of a "nested hierarchy" of modules and integrated traits, says Hallgrímsson. So while the bones of the arms and hands show reduced integration in humans (and great apes generally) compared with quadrupedal monkeys, integration was nonetheless strong enough between human hands and feet to have profound evolutionary consequences. It is these specific patterns of integration and modularity, rather than either factor independently, that ultimately determines evolvability, he says.

Indeed, looking deeper into prehistory, it is easy to see how these factors could have played a crucial role throughout animal

evolution. About 540 million years ago, the Cambrian explosion led to the emergence of the basic body plans of the 35 or so phyla of animals recognised today. Their common ancestor had not achieved a high level of integration or robustness, making it developmentally flexible and primed for evolutionary innovation. Evolution cashed in on that flexibility but soon pushed for greater developmental integration, more or less fixing the 35 body plans in the process.

That's not to say evolvability has taken a nosedive since then. Although the developmental processes that produce the basic body plans of animals are too tightly integrated for fundamental change, a further drive towards greater modularity among parts of animals has increased their individual evolvability. It is this tinkering with bits and pieces of animal bodies, rather than radical re-invention of the body, that has fuelled the astonishing biological innovation among arthropods and vertebrates in particular.

Exactly what triggers the dissociation of integrated traits, prompting them to become increasingly modular, is still a burning issue. "This is the next big question," says Wagner. It is possible that, in some cases, body parts become dissociated as a lucky accident that evolution then capitalises on. In the case of fore and hind-limb evolution, Wagner thinks it likely that selection for divergent functions in the arms and legs favoured any mechanism that could produce dissociation, but the issue is not settled. "Right now, we just don't know why," he says.

Getting a better handle on the process of dissociation will require a deeper understanding of the genetic mechanisms involved. Cheverud's lab has already made steps in this direction by mapping genes that determine the integration among various characteristics in mice, though exactly how these genes do this remains unknown (*Genetics*, vol 178, p 2275).

These are early days in the empirical study of evolvability. Further progress will depend on researchers drawing together data on diverse aspects of biology, says Christian Klingenberg, a biologist at the University of Manchester in the UK. A complete theory of integration, modularity and the developmental basis of evolvability will require connecting genetics and developmental biology with morphological studies in both experimental and natural settings. It will be a hard slog but, as Klingenberg says, "it's where the fun starts". ■

Dan Jones is a writer based in Brighton, UK

Conquering the world, friend by friend

Despite its sympathetic stance, this account of Facebook's dominance raises troubling questions

The Facebook Effect by David Kirkpatrick, Simon & Schuster, \$26

Reviewed by Jim Giles



HERE'S one of the scariest passages from *The Facebook Effect*: "In five years there won't be a distinction between being on and off Facebook,"

says a former Facebook employee who claims still to be "deeply involved" with the company. "It will be something that goes with you wherever you are communicating with people."

Facebook's plans for world domination are born of its mission to help people connect and share. It seems to be working. Its 400-million-plus users have an average of 130 friends each. Many websites, including *New Scientist's*, encourage readers to share content on Facebook. Users play games that exist only in Facebook. They send messages within the site rather than using email. Facebook is creating an infrastructure so useful that its customers rarely need to go elsewhere. More than half of its users log in every day.

Should we welcome Facebook's relentless expansion? Mark Zuckerberg, the precocious and intense 26-year-old who built the site during his first year at Harvard University, insists it exists to help people connect and share. It's easy to feel cynical about such pronouncements: Zuckerberg's share of Facebook is worth \$4 billion. But journalist David Kirkpatrick gained exceptional access to Facebook's founder and reports that Zuckerberg consistently puts these goals



of their personal information. Facebook describes these updates as steps in its mission for openness, but one can't help noticing that each change is attractive to advertisers, who can use the information to better target their messages.

Facebook also retains control over the content on its site. Pages relating to criticism of pro-Beijing

"We are wise to question whether a private company should control the world's communications"

political parties in Hong Kong were allegedly removed without reason this February. Around the same time, the Argentinian author of a satirical book about Facebook is reported to have had his profile removed, as did two others involved in the publication. According to critics, in all these cases Facebook reinstated the pages only after media protests, though the company says that the accounts were disabled in error.

If Kirkpatrick's account of the firm's ethos is accurate, it seems unlikely that the removal of the pages was part of a larger plan to censor criticism or bow to Beijing's will, but in a sense that does not matter. One day Zuckerberg will leave Facebook, and the company's moral compass may shift. Facebook may by then be even more central to our communications. Before that day comes, it would be worth asking whether we want to place a commercial organisation at the heart of our social interactions. ■

above short-term profit.

Kirkpatrick's account is convincing and engrossing. What is frustrating, however, is his decision to place Zuckerberg's pureness of ambition at the heart of the story, as if we should take the founder's sincerity as evidence that Facebook is a force for good, rather than question the impact the site has on our lives.

Zuckerberg, for example, is excited that political activists can utilise Facebook to rally support. Kirkpatrick cites a 2009 study showing that membership of political groups on the site encourages political participation in the real world, but he fails to mention that the same study

Thousands demonstrated in Colombia after organising on Facebook

also found that Facebook had no effect on people's political knowledge. Facebook might foster political engagement, but by exposing people only to their friends' ideas it could equally well encourage groupthink.

A more troubling question is whether a private company should be allowed to handle so much of the world's communications. Of course, we already trust private postal firms and telephone companies. But Facebook users are regularly confronted with unwanted changes to the site that many feel expose too much

JAMES SALLER/REUTERS

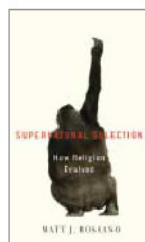
Jim Giles is a *New Scientist* correspondent based in San Francisco. He posts at twitter.com/jimgiles

Holy benefits

An intriguing account argues that religion has made us the sophisticated creatures we are

Supernatural Selection: How religion evolved by Matt Rossano, Oxford University Press, £17.99/\$29.95

Reviewed by Amanda Geffter



ABOUT 70,000 years ago a massive volcanic eruption ushered in disastrous climate change and drove our early human ancestors to near

extinction. From the few who survived came a population explosion along with the development of sophisticated tools and symbolic thought. Emerging from Africa, these humans became the most advanced species on the planet.

What sparked this remarkable turnaround? According to Matt Rossano, it was religion.

Religion is often portrayed as an evolutionary by-product: cognitive functions, such as symbolic thought, were selected for their survival benefits and religion

tagged along for the ride. Rossano, by contrast, argues that religion itself conferred survival benefits.

In order to survive amid scarce resources and harsh conditions, our ancestors developed complex social structures. These were facilitated by social rituals – which required brains with increased working memory that in turn paved the way for symbolic thought. Nature began selecting for imaginative children because they were better suited to navigating complex social relationships as adults. Their imaginary friends carried over into adulthood in the form of gods and spirits who watched over them and participated in social interactions.

According to Rossano, early religion was shamanistic and provided a kind of healthcare system through ritual healing practices. Humans who participated in healing rituals were healthier, thanks to the placebo effect, and more likely to procreate, keeping religion's

evolutionary march in motion. About 35,000 years ago, humans developed language and episodic memory – key abilities that led to the formation of narrative and religious mythologies.

For Rossano, religion has always been about relationships. Thinking about it in these terms, he argues, can help us in today's conflicts between atheists and believers. "Understanding religion as relational helps to explain why religious belief can be so tenacious even in the face of what seems to be contradictory evidence... The world often looks very different from 'inside' a relationship than from 'outside' it," he writes. In other words, using logic and evidence to talk someone out of their religious belief can be as frustratingly hopeless as trying to talk a love-blinded friend out of their bad relationship.

This exhaustively researched and intriguing book, though dry in places, is sure to get you thinking about the nature of religion. Rossano makes some potentially testable predictions – that ritual increases the brain's capacity for working memory, for instance – but elsewhere it's hard not to see this as merely another evolutionary just-so story. From so far away, the line between causality and correlation can look very blurry.

religious teaching. They claimed its constellations depicted the sky at the time it was carved and (wrongly) claimed it as proof the Egyptians had sophisticated astronomical knowledge as far back as 15,000 BC, in opposition to the Church's doctrine that the Earth was only 6000 years old.

The authors chronicle these debates against the backdrop of the French revolution and its Enlightenment ideals. The result is an impressive piece of scholarship, but the dense biographical details and lack of clear narrative make it a tough read.

Fishy legacy

An Entirely Synthetic Fish: How rainbow trout beguiled America and overran the world by Anders Halverson, Yale University Press, £20/\$26

Review by Gail Vines



IT SEEMED a brilliant idea in 1870: stock rivers and lakes with every angler's dream fish – rainbow trout.

A few decades on, the fish were being reared in vast hatcheries, and dumped from trucks and even aircraft across the US. In 1962, an entire river system was flooded with the poison rotenone to kill the native fish and clear the way for rainbow trout.

In California, the stocking trucks sounded a siren telling anglers to rush to the river banks and hook the new arrivals. Today alarm bells are ringing as ecologists begin to notice that competition, hybridisation and disease are devastating the native freshwater fauna.

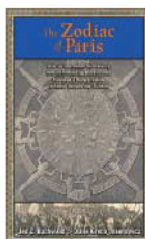
It is an enthralling and sometimes appalling story, charting the origins of an ecological disaster fuelled by political game-playing, fantasies of virility and the enduring delusion that for any problem there will always be a technological fix.



Egyptian plunder

The Zodiac of Paris by Jed Z. Buchwald and Diane Greco Josefowicz, Princeton University Press, \$35

Reviewed by Jo Marchant



IN APRIL 1820, a French engineer blasted the roof from an ancient temple at Dendera in Egypt and sailed it back to Paris. The blocks carried a bas-relief of a mysterious zodiac which ignited intense controversy in France, where scholars were keen to show the superiority of mathematical analysis over

NewScientistJobs

Incorporating ScienceJobs.com

To apply online visit www.NewScientistJobs.com

East Coast Office
225 Wyman Street
Waltham, MA 02451
Email NSSales@NewScientist.com
Phone 781 734 8770
Fax 720 356 9217

West Coast Office
201 Mission Street, 26th Floor
San Francisco, CA 94105
Email NSSales@NewScientist.com
Phone 415 908 3353
Fax 415 543 6789

Calls may be monitored or recorded for staff training purposes

BIOLOGY

Promotional Regulatory Affairs Reviewer (Assoc Dir/ Sr Mgr); 2 Positions

AstraZeneca US

DE - Delaware

Responsible for review, approval, and promotional regulatory compliance of all proactively disseminated marketing material and information used for commercialization purposes.

For more information visit
NewScientistJobs.com Job ID:
1400823342

Research Associate II - MOLECULAR PHARMACOLOGY / Job ID #50698

City of Hope

CA - California

A Research Associate II full time position is available for an HPLC triple stage quadrupole tandem mass spectrometer operator in a core facility setting that services a diverse group of researchers at a national cancer institute.

For more information visit
NewScientistJobs.com Job ID:
1400823293

Sr Biomedical Informatic - Molecular Medicine / JOBID: 51280

City of Hope

CA - California

He or she will work with the infrastructure team to actively participate in project discussions and user support among bioinformaticians, statisticians, project manager and researchers.

For more information visit
NewScientistJobs.com Job ID:
1400823278

Technical Manager - Biochemical (Experimental Station)-7637100524

DuPont US

DE - Delaware

We are seeking candidates who have successfully managed

interdisciplinary teams, drive to push scientific boundaries to achieve never seen before performance, and are energized by integrated and interdisciplinary scientific endeavors.

For more information visit
NewScientistJobs.com Job ID:
1400823299

Postdoctoral Fellow - Biotherapeutics

Pfizer US

MO - Missouri

A postdoctoral researcher is sought to conduct fundamental computational research to understand molecular origins of aggregation in protein therapeutics, especially monoclonal antibodies and antibody based therapeutics.

For more information visit
NewScientistJobs.com Job ID:
1400823119

Principal Scientist, Bioanalytical

Pfizer US

CA - California

As a member of the Analytical Science team you will work with Protein Science, Biology, & Chemistry team members to develop bioanalytical methods for the in vitro and in vivo characterization of antibody-based drugs.

For more information visit
NewScientistJobs.com Job ID:
1400823131

Research Associate (non-PhD) - Senior Associate Scientist / Scientist - protein biochem

Pfizer US

MA - Massachusetts

Work in a multidisciplinary team involved in the discovery of novel proteins mediating enhanced bone fracture and tendon repair. Develop and execute robust cell based assays (which drive decision making) for identifying and understanding the effects of proteins on mesenchymal stem cell

differentiation to osteoblasts.

For more information visit
NewScientistJobs.com Job ID:
1400823107

Engagement Manager (001QA)

Monsanto

MO - Missouri

The Engagement Manager will predict, define and develop high-level business scenarios that are projected in the 1-2 year timeframe in one of the R&D platforms and propose software solutions to implement those scenarios.

For more information visit
NewScientistJobs.com Job ID:
1400824658

Head of Metabolism Core Science Area

Pfizer US

NY - New York

he Clinical Scientist Lead will provide project level medical and scientific support to multiple projects (from Phase 1 through Phase 4) in conjunction with the Global Program Leader.

For more information visit
NewScientistJobs.com Job ID:
1400824447

Research Scientist II Bio

Pfizer US

NY - New York

Incumbent will provide support for animal modeling and immunological assays for evaluating bacterial vaccines. Animal experiments will be conducted to test the efficacy of vaccine candidates and to provide samples of in vivo grown bacteria for analysis of antigen expression.

For more information visit
NewScientistJobs.com Job ID:
1400824372

Sr. Research Scientist I

Pfizer US

NY - New York

The primary role of the incumbent is to provide expertise and support

in preclinical testing of vaccine candidates. The incumbent is expected to apply skills in immunology, and microbiology to evaluate vaccine candidates using a variety of in vivo and in vitro models.

For more information visit
NewScientistJobs.com Job ID:
1400824423

Foundation Seed Crop Specialist - Field (Vegetables division) (001Q1)

Monsanto

CA - California

This is an excellent opportunity to work with leading edge technology and talented cross functional scientists seeking to deliver the very best vegetable crop genetics.

For more information visit
NewScientistJobs.com Job ID:
1400825546

Lab Research Assistant - Vegetable Analytics (Vegetables Division) (001EQ)

Monsanto

CA - California

This position supports the Vegetable Analytics service lab. Responsibilities include various lab operations such as sample receipt and preparation, data entry, project tracking and sample extraction and analyses.

For more information visit
NewScientistJobs.com Job ID:
1400825794

Research Assistant - Trait Genetics (Vegetables Division) (001AE)

Monsanto

CA - California

We are looking for an enthusiastic individual to join a dynamic, diverse team working to identify and introduce valuable new traits in tomato and cucurbit crops.

For more information visit
NewScientistJobs.com Job ID:
1400825545

Postdoctoral Fellowship in X-ray Crystallography

Pfizer US

MA - Massachusetts

Use x-ray crystallography and protein engineering and modeling tools to explore the structural basis for TNF-family member ligand-receptor specificity. Determine ligand-receptor costructures and use mutational analysis to enhance specificity.

For more information visit
NewScientistJobs.com Job ID:
1400826012

Scientist, Antibody Library

Pfizer US

CA - California

The scientist position will be primarily responsible for working on all aspects of human antibody libraries including systematically developing technologies used for antibody library construction and selection, as well as the lead characterization and affinity maturation.

For more information visit
NewScientistJobs.com Job ID:
1400826039

Research AssistantPioneer Hi-Bred Production LP
HI - Hawaii

The Research Assistant performs all nursery duties associated with a year round production of high quality and sufficient quantities of seed in a timely manner to meet the expectations of the Waimea Research Center goals and their customers.

For more information visit
NewScientistJobs.com Job ID:
1400825703

Research Director, Agronomic TraitsPioneer Hi-Bred Production LP
IA - Iowa

Pioneer is seeking a Research Director to lead its Agronomic Traits Research Department. The department has primary responsibility for validation and optimization of transgenes to improve agronomic characteristics across Pioneer crops.

For more information visit
NewScientistJobs.com Job ID:

1400826679

HR Generalist - Biotechnology Trait Project Teams (001HL)

Monsanto

MO - Missouri

This exciting and challenging HR generalist position in the Biotechnology HR team serves as a key strategic business partner leading all aspects of human resources for the Biotech trait project team.

For more information visit
NewScientistJobs.com Job ID:
1400826752

Pathology Scientist (R3-R4) - Toxicologic Pathology

Pfizer US

CA - California

The position is within Toxicologic Pathology that is responsible for the conduct of pathology-related procedures within Drug Safety Research and Development (DSRD) in support of all phases of drug discovery and development.

For more information visit
NewScientistJobs.com Job ID:
1400826834

Product ScientistCell Signaling Technology, Inc.
MA - Massachusetts

We are committed to developing innovative new research tools to help define the mechanisms underlying cell function and disease, thereby broadly accelerating progress in biomedical research and medicine.

For more information visit
NewScientistJobs.com Job ID:
1400827797

Seed Technician I (001OK)

Monsanto

NE - Nebraska

We currently have openings for 4 Seed Technician positions. Seed Technicians are involved in all facets of seed production within a location. This may include crop production, harvest, conditioning, maintenance, packaging, or warehousing.

For more information visit
NewScientistJobs.com Job ID:
1400827772



UNIVERSITY OF
TORONTO
 SCARBOROUGH

FULL PROFESSOR in BIOLOGICAL INORGANIC CHEMISTRY

The Department of Physical & Environmental Sciences at the University of Toronto Scarborough invites applications for a tenured position in the area of bioinorganic chemistry at the rank of Professor commencing January 1, 2011, subject to negotiation. The successful candidate will already hold a position at the rank of full professor at an internationally recognized university and have a strong, externally funded research program in the area of biological inorganic chemistry. The successful candidate will also have demonstrated a high level of excellence in teaching at both the undergraduate and graduate levels. The position will have undergraduate and graduate teaching responsibilities in inorganic chemistry. The successful candidate will also be appointed to U of T's Graduate Department of Chemistry.

We are particularly interested in applicants with interdisciplinary research interests that complement and enhance the existing strengths in the Department in the areas of biological chemistry and environmental science.

Information about the Department can be found at:
<http://www.utsc.utoronto.ca/~physsci/>

The Department is at an exciting stage in its history. New space and funding growth is making it possible for unprecedented growth in faculty complement and program initiatives. The department has a newly established, state-of-the-art instrument facility, houses the Environmental NMR Centre and offers the opportunity for research collaboration with faculty in the physical, environmental, biological and medical sciences. The successful candidate will work with our existing faculty to reshape and strengthen our growing undergraduate programs in chemistry, and to continue to grow their own creative, high-impact research program based on external funding. Salary will be commensurate with qualifications and experience.

Applications will be accepted until September 15, 2010. Applicants should refer to the department's website for details about the application process.

The University of Toronto is strongly committed to diversity within its community and especially welcomes applications from visible minority group members, women, aboriginal persons, persons with disabilities, members of sexual minority groups, and others who may contribute to the further diversification of ideas. All qualified candidates are encouraged to apply; however, Canadians and permanent residents of Canada will be given priority.

Biochemist (R3/R4) - Andover, MA

Pfizer US

MA - Massachusetts

Primary responsibilities of the biochemist/molecular biologist role will be to provide expertise in the development of in vivo molecular probes (ie, targeted contrast agents for application with different imaging modalities) to be applied in molecular imaging studies.

For more information visit
NewScientistJobs.com Job ID:
1400829436

Imaging Sr. Scientist / Principal Scientist (R4/R5) - Andover, MA

Pfizer US

MA - Massachusetts

Primary responsibilities of the imaging scientist position will include liaising with collaborators throughout BioTherapeutics R&D in the planning of imaging studies, imaging methodology development, drafting animal use protocols, and conducting imaging studies in support of compound discovery efforts.

For more information visit
NewScientistJobs.com Job ID:
1400829380

Computer Scientist / Software Engineer (R4-R5), Pre-clinical Imaging - Andover, MA

Pfizer US

MA - Massachusetts

Advanced degree (PhD or equivalent) in applied mathematics, biophysics, biomedical or electrical engineering, computer science or related field

For more information visit
NewScientistJobs.com Job ID:
1400829410

PhD Immunologist- Post Doctoral Fellow

Pfizer US

MA - Massachusetts

We are seeking a highly motivated Postdoctoral Fellow with a strong training in basic immunology, molecular biology and cell biology to study the mechanisms of autoimmune disease/inflammation of the skin (psoriasis and atopic

dermatitis).

For more information visit
NewScientistJobs.com Job ID:
1400829444

**Post Doctoral Fellowship -
Biocorrections Research**

Pfizer US

MA - Massachusetts

The Biocorrection Research Unit within the Pfizer Worldwide R&D organization is seeking three highly motivated scientists to conduct research in the metabolic disease area.

For more information visit
NewScientistJobs.com Job ID:
1400829456

**Manufacturing Seed
Technician (001QW)**

Monsanto

HI - Hawaii

We currently have an opening for a Pre- Foundation Manufacturing Technician position. Manufacturing Technicians are involved in all facets of seed production within a location.

For more information visit
NewScientistJobs.com Job ID:
1400831729

CLINICAL

**Staff Scientist - CITI Job ID: #
51311**

City of Hope

CA - California

This position requires a background in radiation physics and medical imaging, especially in vivo imaging of internally administered radiopharmaceuticals.

For more information visit
NewScientistJobs.com Job ID:
1400823272

**Clinical Pathology Scientist
(R1-R2)**

Pfizer US

CT - Connecticut

The major responsibilities of the candidate will be to perform all clinical pathology techniques (hematology, biochemistry, coagulation, urinalysis, immunoassays, and cytological preparations) on biological specimens from animals and humans in a GLP and/or a non GLP

environment.

For more information visit
NewScientistJobs.com Job ID:
1400823125

**Associate Director Clinical
Research - Respiratory/
Inflammation TA**

AstraZeneca US

DE - Delaware

Primarily deployed to an Established Brands Team but may also be deployed to teams supporting emerging respiratory and inflammation therapeutics as determined by the TACD and project Medical Science Directors.

For more information visit
NewScientistJobs.com Job ID:
1400823327

**Director Clinical Research -
Cardiovascular**

AstraZeneca US

DE - Delaware

Key tasks include developing medical and commercial differentiation options for the brand versus the competition, review and sign off of publications and promotional material.

For more information visit
NewScientistJobs.com Job ID:
1400823333

**Director or Associate Director
- Health Economics &
Outcomes Research**

AstraZeneca US

DE - Delaware

They will have responsibility to support and interact with Value Demonstration Directors in advising on, and undertaking where appropriate, innovative and evidence based Health Economic and/or Outcomes Research solutions to optimize the price and value proposition.

For more information visit
NewScientistJobs.com Job ID:
1400823344

Director- Clinical Research-
Brilinta Brand Team**

AstraZeneca US

DE - Delaware

Key tasks include working closely

with the DBL and/or the Global Brand Director, in conjunction with Medical Communications and Promotional Regulatory Affairs, to help develop medical and commercial differentiation options for the brand, as well as review and approve publications and promotional material.

For more information visit
NewScientistJobs.com Job ID:
1400823341

**Principal Scientist - Cell/Lead
Biologist**

AstraZeneca US

MA - Massachusetts

We are seeking a senior PhD level scientist with cancer related drug discovery experience. The individual will become an instrumental member of a team involved in the discovery of novel anti cancer therapies.

For more information visit
NewScientistJobs.com Job ID:
1400823325

**Senior Director Clinical
Research- Respiratory/
Inflammation TA**

AstraZeneca US

DE - Delaware

The Senior Director of Clinical Research reports to TA Clinical Director- Late Development and provides medical input and leadership to all aspects of product development.

For more information visit
NewScientistJobs.com Job ID:
1400823329

**Senior Medical Director-
Respiratory; Inflammation
and GI**

AstraZeneca US

DE - Delaware

The Senior Medical Director ensures the ongoing safety evaluation of a product or group of products by providing Patient Safety medical expertise and judgment to safety surveillance and clinical development activities, including ongoing patient risk management.

For more information visit
NewScientistJobs.com Job ID:
1400823330

**Scientist/Sr. Scientist -
Biochemist/Enzymologist**

AstraZeneca US

MA - Massachusetts

The selected individual will become an instrumental member of a team applying cellular, molecular, and biochemical approaches to progress novel target opportunities in cancer drug discovery.

For more information visit
NewScientistJobs.com Job ID:
1400824839

**Director Vaccine Clinical
Research**

Pfizer US

NY - New York

The Clinical Scientist Lead will provide project level medical and scientific support to multiple projects (from Phase 1 through Phase 4) in conjunction with the Global Program Leader.

For more information visit
NewScientistJobs.com Job ID:
1400825986

**Research Scientist, Clinical
Sample Management**

Pfizer US

NY - New York

The primary function of this position is to participate and manage specimens in the Clinical Sample Management operations within the Clinical Testing and Assay Development functions of the Early Phase Programs.

For more information visit
NewScientistJobs.com Job ID:
1400826043

**Agronomic Research
Associate - Fargo, ND
(001LA)**

Monsanto

ND - North Dakota

We currently have an opportunity for an Agronomic Research Associate to assist with the development and testing of agronomic system concepts for

our products. This position will be located in Fargo, ND.

For more information visit
NewScientistJobs.com Job ID:
1400826856

Research Associate

Pioneer Hi-Bred Production LP
IA - Iowa

The job will entail operating various liquid handling instruments while meeting rigid deadlines and throughput capacities in a timely manner. This position is open due to the growth and demands being placed on the genotyping platform.

For more information visit
NewScientistJobs.com Job ID:
1400826850

Research Scientist

Pioneer Hi-Bred Production LP
IA - Iowa

The Crop Genetics Research & Development (CGR&D) group at Pioneer Hi-Bred International, Inc. integrates cutting-edge science and technology into innovative products that help feed and fuel the world.

For more information visit
NewScientistJobs.com Job ID:
1400827182

Senior Research Associate

Pioneer Hi-Bred Production LP
CO - Colorado

Provide leadership and support to an inbred development program to identify new untested inbred lines and hybrid combinations, and evaluate pre-commercial hybrids.

For more information visit
NewScientistJobs.com Job ID:
1400827184

Research Associate - Field (Vegetables division) (001MB)

Monsanto
FL - Florida

We are seeking a highly motivated individual for our Field Research Associate. The Research Associate will primarily be responsible for supporting the activities of the on-site Breeders. This is an excellent

opportunity to work with leading technology and talented cross functional scientists seeking to deliver the very best vegetable crop genetics.

For more information visit
NewScientistJobs.com Job ID:
1400829417

MATHS&IT

Senior Automation Associate

Pioneer Hi-Bred Production LP
IA - Iowa

DuPont business Pioneer Hi-Bred seeks a driven and highly motivated individual to join a multidisciplinary technology integration team responsible for the design, development, and support of laboratory automation software and hardware solutions.

For more information visit
NewScientistJobs.com Job ID:
1400826739

Senior Information Management Associate

Pioneer Hi-Bred Production LP
IA - Iowa

The Senior Information Management Associate provides hands-on support, training, and troubleshooting of technical solutions for researchers who use DuPont and Pioneer proprietary research information management systems and Information Technology (IT) point solutions.

For more information visit
NewScientistJobs.com Job ID:
1400826740

Territory Agronomist (001JJ)

Monsanto
NY - New York

Effectively define and communicate technical advantages and positioning of DEKALB and Asgrow products. Product and agronomic dealer training. Participate and present at dealer and farmer meetings and field days.

For more information visit
NewScientistJobs.com Job ID:
1400816878

Senior Project Analyst

Pioneer Hi-Bred Production LP
IA - Iowa

POSTDOCTORAL FELLOW



The Barrow Neurological Institute is seeking a Postdoctoral Fellow to complement the preclinical neuroscience research in the laboratory of Nader Sanai, M.D. Qualified applicants holding an M.D., Ph.D., or equivalent degree will investigate the neurobiological basis of neural and glial central nervous system progenitors (see Nature 427:740-744, 2004), particularly in the context of brain tumors. Successful candidates will have skill sets in molecular biology, histopathology, biochemistry, tissue culture assays, and mouse models to characterize stem and progenitor cells. Preference will be given to those who also have experience in molecular imaging of neural precursors and applying high field-strength magnetic resonance spectroscopy. The Barrow Neurological Institute is a translationally oriented basic science research facility located in Phoenix, Arizona, adjacent to the state's largest tertiary care hospital. It is in an urban center of academic, biotechnology, and pharmaceutical research, neighboring Arizona State University and the University of Arizona School of Medicine. Initial appointment is for two years with the possibility of renewal, pending funding. Interested candidates should electronically send a statement of research interests, curriculum vitae, and the names and contact information for three references to: **Nader Sanai, M.D., Director of The Barrow Brain Tumor Research Center, Barrow Neurological Institute and St. Joseph's Hospital and Medical Center, 350 W. Thomas Road, Phoenix, AZ 85013. E-mail: nader.sanai@bnaneuro.net.**

Affirmative Action/Equal Opportunity Employer.

Project Management is a core discipline within the Regulatory department that enables successful planning, initiating, execution, control and closure of Regulatory projects that result in timely US and global approvals for biotechnology products.

For more information visit
NewScientistJobs.com Job ID:
1400826742

Global Regulatory Manager - Insect Control

Pioneer Hi-Bred Production LP
IA - Iowa

The Global Regulatory Manager, Insect Control, is responsible for the management and success of the regulatory efforts required to achieve global deregulation of traits and stacks in soybeans and corn.

For more information visit
NewScientistJobs.com Job ID:
1400828947

SALES

Area Business Manager -

Georgia/Alabama (001Q7)

Monsanto
AL - Alabama

The Area Business Manager is responsible for effectively building and managing a team of 10-12 Territory Sales Managers located in Memphis Tennessee that sells the value of Monsanto traits, DEKALB/Asgrow/DeltaPine brand products through appropriate channels.

For more information visit
NewScientistJobs.com Job ID:
1400825550

Sales Representative

Syngenta US
OH - Ohio

Responsible for the marketing, selling, and development of brand awareness of Golden Harvest Seeds, Syngenta products and programs in the trade area through delivery of the annual campaign plan while meeting established targets.

For more information visit
NewScientistJobs.com Job ID:
1400825761



THE oddest things can send Feedback on quests of epic work-avoidance. Take Julian Parmegiani's attempt to buy a professional video light on eBay, which led him to the LED 5001 at bit.ly/daLLIW and the seller's "How to use" instructions: "Install the battery into the battery jar, when heard a weak 'pyridaben carbazole' sound the installation is completed." Julian would like to know what a weak pyridaben carbazole sound is.

Surely, we thought naively, in this age of instant access to all the world's true facts (and even more of the other kind) it would take only a moment to find the answer. Or any answer. All, arguably, part of Feedback's job.

The search results we found to "pyridaben carbazole sound" directed us, with one exception, to the same instructions Julian found. But we did discover that carbazole is also known as dibenzopyrrole and diphenylenimine and several other things. Carbazoles in

general can be synthesised (though this is but a WikiFact) by reacting naphthols and aryl hydrazines using sodium bisulfite. Does this reaction make a sound? Is it squelchy? Crackly?

We found plenty of other references to "the carbazole sound". Examples include: the instructions for what appears to be a clandestine listening device from China; a description of an ailing knee-joint on a Chinese medicine website; and – perhaps importantly, for here's the exception mentioned above – a strange, oddly translated blog which contains this sentence: "He heard the guard outside of a person who asked, and then latch issued pyridaben carbazole sound, the door opened."

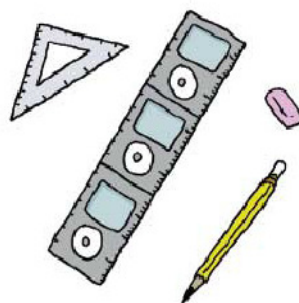
So we have a sort of triangulation on what it might sound like (if we use our imaginations). But are we, as the anti-intellectual but neurologically correct phrase goes, "over-thinking it"? Do the characters that say "carbazole"

in a Chinese language also stand for something like "graunch" or "bzzzt"? Could it merely be a typo in Chinese?

We even resorted to leaving the computer and asking, face-to-face, a video and lighting technician. She had never heard of pyridaben or carbazole. Surely someone can put us out of our misery? Perhaps, given the internet's failure to provide a satisfactory answer, a handwritten postcard would be the way to do so.

WHAT'S that in iPods? Following our reports on elephants (15 May) and blue whales (19 June) as units of measurement, Google has launched into the field with a unit of its own. Describing its new search index, called Caffeine, the famous web search engine starts off on familiar territory: "Caffeine processes hundreds of thousands of pages in parallel. If this were a pile of paper it would grow three miles taller every second."

So far, so ordinary – but then, as several readers have pointed out,



it breaks new ground: "You would need 625,000 of the largest iPods to store that much information; if these were stacked end-to-end they would go for more than 40 miles."

"That's 15,625 iPods per mile," Justin Bailey points out. "Will the iPod replace the foot soon?"

SEVERAL readers have questioned our assertion that most hole-nesting birds do not have internet access (5 June) by pointing out that they are able to tweet. We are ashamed that we hadn't thought of this ourselves.

Meanwhile, Richard King tells us that in Old Winchester Hill nature reserve in Hereford, UK, there are notices saying "Ground Nesting Birds please keep to the footpath". Richard says it is just as well that the birds can't read as their nests would get trampled underfoot.

"WITH every one of our notebooks subjected to 95,000 hours of rigorous testing," says HP in an advert Jon Gregory has copied to us, "we provide the latest and most reliable technology for small businesses today."

Jon points out that this would seem to mean that each notebook is tested for 11 years before being released for sale.

Jon is not clear on how this will help him "live life in the fast lane", as the advert proclaims.

FINALLY, you still have a week to send us your entry to our World Cup competition with the chance of winning an official Adidas World Cup football. You are invited to send us up to 50 words on the theme of: "What is your best scientific or technological excuse for having lost at sport?"

The winning entry will be the one the editors judge the wittiest and most inventive. You can enter by post to Feedback, by email to feedback@newscientist.com, or online at newscientist.com/article/dn18983. The winning entry will be chosen from entries received by 5pm GMT on 5 July 2010. No entries will be accepted after that time.

The winning entry and the best runners-up will be published in the 31 July issue of *New Scientist*. Come on you inventive losers!

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.

Seen on a pack of toilet tissues at Sainsbury's supermarket: "Sainsbury's supersoft quilted tlt tiss 4 x 170 shts." That's sheets, we presume

Topsy-turvy world

Why don't bats get dizzy when they hang upside down? Or do they?

■ Dizziness is a sensation humans describe when they feel a sense of motion, even when not moving. It can be associated with queasiness or nausea, and sometimes vomiting. Other types of dizziness include motion sickness and vertigo, which often manifests itself as a spinning feeling, or other sensations such as light-headedness or heavy-headedness.

It is impossible to know for sure whether or not an animal is dizzy because it cannot communicate such feelings. However, it is possible to infer an animal is dizzy from how it behaves. For example, if an animal is aimlessly walking in circles, it is probably dizzy.

Motion sickness occurs when there is excessive stimulation of the inner ear or from a conflict between sensory information from different sources, such as from the inner ear and the eyes. The balance mechanism of the inner ear is complicated, and includes sensors that detect both movement and orientation with respect to gravity, even when an individual is not moving. Bats have such a balance mechanism, and in addition use echolocation.

The parts of the inner ear that are important for orientation with respect to gravity are called the otolith organs: the utricle and the saccule. It is these parts of the inner ear that would be activated while the bat was hanging upside

down. Stimulating these parts of the inner ear, however, would not necessarily lead to dizziness, especially in a dark cave where there is no conflict between information from the inner-ear balance mechanism and vision.

The bottom line is that bats are used to hanging upside down without showing any behavioural changes that would suggest dizziness or motion sickness. But because we cannot ask a bat directly whether or not it is dizzy, we can't be certain about the effects of hanging upside down.

Joe Furman

Editor of the Journal of Vestibular Research, University of Pittsburgh Pennsylvania, US

■ When you think of bats, you usually think of them in one of two conditions: hanging upside down resting, or flitting about pulling high-*g* turns in the dark. So why don't they get dizzy?

Bats have evolved a number of adaptations to allow them to hunt and hang without the problems that humans would face.

First, some bats have specialisations in the vestibular portion of their inner ears – the portion that generates sensory signals for controlling balance. Their sacculus, which in humans acts as a gravity sensor to help us stand upright, is slightly rotated forwards. This lets it act more as a pitch detector, which is more useful in flight.

Second, their semicircular canals, which sense rotation of the head, have an internal structure

more like a bird's than a human's. This probably allows them to make high-speed turns without the fluid in the canals sloshing back and forth too much.

Lastly, if you photograph bats in flight with a high-speed camera, you notice that they keep their heads very stable except in the most violent turns.

But it is how bats sense the world that probably gives them immunity to dizziness. All the vestibular system does is tell you about changes in acceleration of your head. It requires other senses to pin down your position and motion in the outside world. We

"If you photograph bats in flight with a high-speed camera, you see they keep their heads very stable"

primarily use vision to do this, but vision is very slow. Anything you look at that takes a second or less to cross 30 degrees of your vision appears smeared. Echolocating bats, while not blind, rely more on biosonar, an especially precise form of hearing that lets them build up 3D images from echoes.

Echolocating bats emit brief sonar chirps from 30 to more than 150 times per second, and respond to changes in echoes of less than a microsecond. These bats integrate echolocation with their vestibular system, so they are working with a faster, more precise positioning system than humans do with vision. Because dizziness and motion sickness usually arise when signals from the vestibular

system conflict with those from other sensing systems, bats are less likely to show motion sickness than other mammals.

Seth Horowitz

Assistant professor, neuroscience Brown University, Rhode Island, US

This week's questions

BOUNCE BACK

I have a question about Geoff Hurst's famous goal in the final of the 1966 football World Cup, and it's not whether it crossed the line. His shot hit the goal's crossbar, deflected downwards, hit the ground and bounced out, away from the goal. I have seen similar shots since. Why does a ball that hits the underside of the crossbar nearly always bounce away from the goal after it hits the ground? The more powerful the shot, the more likely it is to do this.

Frank Horseman

Scarborough, North Yorkshire, UK

TREE HEALER

The trunk of a small fir tree in my garden broke, and the tree fell over. More in hope than expectation I pulled the top part back up, taped the halves back together, and screwed in metal plates to hold them in place. To my amazement the tree survived and, months later, when I removed the tape and the plates, the break had healed and the trunk was whole again. How do trees repair such trauma? Can all tree species do it?

Alan Crowther

Birmingham, UK

Questions and answers should be concise. We reserve the right to edit items for clarity and style. Include a daytime telephone number and email address if you have one. Restrict questions to scientific enquiries about everyday phenomena. The writers of published answers will receive a cheque for £25 (or US\$ equivalent). Reed Business Information Ltd reserves all rights to reuse question and answer material submitted by readers in any medium or format.

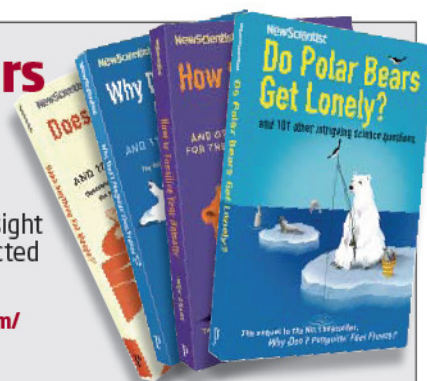
New Scientist retains total editorial control over the content of The Last Word. Send questions and answers to The Last Word, New Scientist, Lacon House, 84 Theobald's Road, London WC1X 8NS, UK, by email to lastword@newscientist.com or visit www.last-word.com (please include a postal address in order to receive payment for answers).

For a list of all unanswered questions send an SAE to LWQlist at the above address.

Do Polar Bears Get Lonely?

Our latest collection - serious enquiry, brilliant insight and the hilariously unexpected

Available from booksellers and at www.newscientist.com/polarbears





**CELEBRATE
SCIENCE**

USASCIENCEFESTIVAL.ORG

Bechtel Corporation
SpaceX
National Radio Astronomy Observatory
SciVee
Research in Motion
SchoolTube
Thirty Meter Telescope Project
Virginia Commonwealth University

THANKS TO OUR SPONSORS