

HYPERCONECTED
Can software
really get any more?

KAACHOO!
Mystery of the
phobic mess

COIN AND HEIN
The downside
of clean energy

NewScientist

Four seasons of gravity

Why apples might
weigh less this summer



Silencing the voices is no cure for schizophrenia

“Brain training” offers new hope, but we still need to recognise the condition for what it is

AN ENCOUNTER with untreated schizophrenia can be a deeply unsettling experience that leaves no doubt about the debilitating nature of the condition. Who hasn't averted their gaze from a person engaged in an agitated conversation with someone who isn't there?

Psychiatric medicine has lessened the frequency of such encounters. Where people with schizophrenia have access to medical care, their hallucinations can now be well controlled with antipsychotic drugs.

That's progress, but it helps those afflicted with the condition less than it may appear: even after the voices in their heads are silenced, their ability to function in society remains blunted by cognitive deficits that make it hard to process information, learn, remember and plan. Too often, despair brought on by a lifetime of struggle ends in suicide.

That's why the latest, extremely promising results from a “brain training” approach to treating schizophrenia (see page 13) are so welcome. If the computer-based tools can be further refined, there is real hope of restoring patients' cognitive abilities to the healthy range, and maybe even safeguarding them against decline in the first place.

The key test will be whether the lab results translate into significant improvements in quality of life. Particularly important will be a trial led by Bruce Wexler of Yale University, who is testing whether such training improves performance in the workplace. This will be important in societies that marginalise those who are unable to hold down a job, particularly for people with genuine difficulties who are wrongly labelled lazy or stupid.

Alongside further developments in treatment, there needs to be a better public understanding of the problems faced by those with schizophrenia. Over the past decade or so, psychiatrists who specialise in

“Too often, despair brought on by a lifetime of struggle with schizophrenia ends in suicide”

the condition have come to realise that the cognitive deficits are more debilitating than the hallucinations.

Word of this revised understanding has been slow to get out, however, in part because the official criteria used to define schizophrenia – laid down in a volume published by the American Psychiatric Association called the *Diagnostic and Statistical Manual of Mental Disorders (DSM)* – do not include the cognitive symptoms.

That should change in the next edition of the *DSM*, due in 2012, but efforts to inform the public of the full nature of schizophrenia need not wait until then. Schizophrenia has been misunderstood and misrepresented perhaps more than any other disease. Rather than averting our eyes, we should do all we can to offer a helping hand. ■

It's more than just our world getting smaller

THE news that only 10 per cent of the world's land is more than 48 hours' surface travel from the nearest city (see page 40) prompts a question: is our high level of connectedness a good or bad thing?

There's little doubt that access to hospitals, schools and markets is good for people – and who would begrudge anyone the fruits of such development? For wildlife, however, the news is bad. Only 20 per cent of the Amazon is more than two days' travel from the nearest city, something that William Laurance of the Smithsonian Tropical Research Institute calls “alarming” because it leaves the forest increasingly open to human interference. With connectedness on an inexorable upward curve everywhere, it is clear that preserving biodiversity is only going to get harder. ■

Back to which future?

TERMINATOR, eat your heart out. Machine intelligences of the future could exploit quantum theory to help them wipe us out. If the machines learned of their impending doom, they could avoid destruction simply by resetting their memories (see page 11). This move, as a consequence of the “many worlds” concept, would allow a computer to “escape” to a parallel universe. Outlandish, perhaps, but a genuine attempt to explore the consequences of quantum theory – and a reminder that truth may be even stranger than (science) fiction. ■

What's hot on NewScientist.com

SPACE **Human sexuality - a guide for aliens** What do the drawings that were included on NASA's Voyager spacecraft say about human sexuality? One researcher reckons the images reflect cultural mores about homosexuality

COMPUTING **Science's most powerful computer tackles first questions** The supercomputer will be set to work on problems ranging from modelling climate change to the mysterious structure of water

TECH **Bionic-eye-cam to shine a light on society** A film-maker is trying to install a wireless camera inside his prosthetic eye and has already managed to fit in an LED and power source - see his progress so far in our online gallery

BLOG **Global warming has not really stopped** Two climate scientists have produced data showing that the current lull in surface temperatures does not contradict the fact that human

emissions of greenhouse gases are causing long-term warming

BIOLOGY **All the leaves are brown - but why?** A new study of thousands of breeds of apple trees bolsters a claim that reddish foliage evolved as a warning signal to insects in search of a winter home.

PSYCHIATRY **Savant skills may be widespread in people with autism** Savant-like abilities such as total recall and perfect

pitch may be much more common among people with autism than previously thought

NEUROSCIENCE **Chameleon project to capture emotions** An artist-neuroscientist collaboration has produced interactive portraits that change according to the viewer's emotional response - watch our video of the process

For breaking news, video and online debate, visit www.NewScientist.com

Arctic food is poisoned

FOR Arctic peoples, global warming is not just transforming their land, it is also poisoning their food. Mercury levels in seals and beluga whales eaten by Inuit in northern Canada have reached levels that would be considered unsafe in fish. Now, Gary Stern of Canada's Department of Fisheries and Oceans in Winnipeg, Manitoba, and colleagues have found that seal meat contains more mercury in low-ice years, suggesting the problem will only get worse.

The team sampled ringed seals caught by traditional hunters in the western Canadian Arctic between 1973 and 2007. Mercury levels were higher after summers with less sea ice. They think this is because Arctic cod flourishes in low-ice years. Because Arctic cod is higher up the

food chain than the seals' other food, their tissues accumulate more mercury (*Environmental Science and Technology*, DOI: 10.1021/es803293z).

Arctic residents may well be exposed to other pollutants, too. Melting ice releases chemicals such as DDT and PCBs that leached from the atmosphere decades ago and became entombed in ice and permafrost, warns Philippe Grandjean of Harvard University. As the ice melts, its contaminants flow into streams, rivers and the Arctic Ocean.

It may already be too late to prevent a surge of pollutants from polar ice, says Grandjean. However, he notes, policy-makers can try to prevent the same thing happening again by reducing pollutants still in use, such as flame retardants.



Tainted meat

CHRIS WATTE/REUTERS

Diabetes still at bay

DAZZLING but controversial claims about a stem-cell treatment for diabetes now seem to have been borne out. The latest results indicate that the initial positive response was indeed due to the treatment and not simply to better care, as critics suggested in 2007.

The treatment is designed to stop the immune systems of people with type 1 diabetes from destroying the pancreatic islet cells that make insulin, the hormone which regulates sugar concentrations in blood. A team led by Júlio Voltarelli of the Regional Blood Centre in Ribeirão Preto in southern Brazil took blood from 15 patients and saved

that attack islet cells. Then they reinserted the saved stem cells, which quickly grew into a new immune system.

In 2007, Voltarelli's team announced that some of the patients were able to live without injections of insulin for months – in one case for three years. Others, however, put this down to the “honeymoon” period after a treatment, in which patients receive better care as they are being monitored.

The latest results, which cover the initial 15 patients plus eight more who have received the same treatment, seem to put such fears to rest. Twelve now live free of insulin injections, eight need less insulin than before and only three have not benefited at all. All who benefited had drastically raised concentrations of C-peptide, a by-product of insulin production, which indicates that they were making the insulin themselves (*Journal of the American Medical Association*, vol 301, p 1573).

“It's the first time treatment has made patients insulin-free,” says co-researcher Richard Burt of Northwestern University, Chicago.

“Twelve of 23 patients now live free of insulin injections and eight need less insulin than before”

the CD34 stem cells from it.

Next, they gave the patients drugs to destroy what remained of their immune systems, effectively obliterating the cells

Death from above

AERIAL bomb attacks that kill civilians in Iraq are as lethal as suicide bombers on foot.

Madelyn Hicks of Kings College London and colleagues analysed 60,481 deaths between March 2003 and March 2008 from the Iraq Body Count (IBC), a project that records violent civilian deaths.

Suicide bombers on foot killed nearly seven times as many civilians as aerial bomb attacks (without ground fire). However, where an aerial bombing did kill civilians the

number of deaths was comparable (*The New England Journal of Medicine*, vol 360, p 1585).

While no one is suggesting the US and its allies intentionally target civilians, the study highlights the indiscriminate nature of aerial bombs. “It is a predictable consequence of using this type of weapon,” says study author Michael Spagat of the Royal Holloway, University of London. “Once you understand that, you can't completely say this is unintentional, in that it is understood that this is going to happen.”

Fight the flab, tax sweet drinks

TAX sugary drinks just like booze and cigarettes. That's what two US states are proposing, but are such taxes key to fighting flab or an unjustified attack on consumer choice?

Most US states impose a small tax on junk food, but recently Maine and New York have proposed hefty taxes on sugared drinks. Now Kelly Brownell of Yale University and Thomas Frieden, health commissioner for the City of New York, estimate that a proposed

“penny-per-ounce” tax on sweet drinks in New York state would reduce each person's annual energy intake by 8000 calories and their weight by a kilogram (*The New England Journal of Medicine*, DOI: 10.1056/nejmp0902392).

John Krebs, former head of the UK Food Standards Agency, points out that it may be harder to justify taxing sugary drinks than cigarettes and alcohol, which have “passive” health impacts on others.

Missile U-turn

THE US is scaling back some of its more exotic projects to fend off enemy missiles, amid thorny technological problems.

The plan, announced by US

“You don’t want a missile defence system that gives you a false sense of security”

defence secretary Robert Gates last week, includes cuts in funding for an aircraft-mounted laser to heat and destroy missiles. It has been difficult to build a laser powerful enough for the job yet light enough to fly (*New Scientist*, 15 December 2008).

All work would also cease on an advanced interceptor missile that releases multiple “kill vehicles” to stop a missile and any decoys it may have released. The idea is to have sufficient interceptors to destroy all the incoming objects, but critics point out that it would be easy to overwhelm simply by increasing the number of decoys.

Laura Grego of the Union of Concerned Scientists in Cambridge, Massachusetts, welcomes the cuts, but would like to see the missile defence programme curtailed further. Given its severe technical problems, it is unlikely to be reliable, she says. “You don’t want a missile defence that gives you a false sense of security.” The plan awaits approval by Congress.



A personal choice?

CSF/NASA



More gravitas than gravity

ISS: five more years

THE International Space Station is poised to receive a new lease of life, after international partners agreed to keep the \$100 billion outpost going until at least 2020.

The ISS was originally set for decommissioning in 2015, but industry officials have assured policy-makers that it is structurally fit to last the additional years.

The extension is good news for researchers hoping to take advantage of the space station’s

“The extension will allow further research on how organisms withstand the harsh conditions of space”

microgravity environment. Scheduled research includes an experiment due to begin in a few months into gravity’s effect on biofuels, and a device called the Alpha Magnetic Spectrometer will launch to the ISS in a few years to search cosmic rays for evidence of dark matter and antimatter.

The extra five years will also allow further research on the psychological performance of teams during long-term space missions, and on how organisms withstand the harsh conditions of space, says Jeremy Curtis of the Rutherford Appleton Lab in Didcot, UK. Other research will focus on the

development of new materials.

Arguments are rumbling on over how US astronauts will get to the ISS, though. On Monday, NASA announced that in May it will resume plans to dismantle its shuttle fleet, despite calls to extend its life beyond 2010. After the shuttles are retired, NASA will pay the Russian space agency for seats on its Soyuz craft.

Climate hot potato

THE White House and US Congress are playing a game of hot potato with emissions regulation.

Congress will debate a draft energy and climate bill put forward by congressmen Edward Markey and Henry Waxman next week. If passed, it will require companies to buy and trade pollution permits.

But green groups fear Congress may drag its feet if the White House does not make moves to instruct the Environmental Protection Agency to limit emissions. “I think Congress is going to need a push from the EPA,” says Frank O’Donnell of Clean Air Watch.

At a meeting on Monday in Cambridge, Massachusetts, Carol Browner, director of the White House Office of Energy and Climate Change Policy, gave no signs of pursuing such a push: “It is the strong preference of this administration that we secure [Congressional] legislation.”

60 SECONDS

Martian twin study

NASA’s Martian rover Spirit left its operators puzzled after rebooting its computer twice last week. One explanation could be a bug in on-board software that was upgraded last month to add new capabilities for the mission. However, its twin Mars rover, Opportunity, received the same upgrade and has shown no problems so far.

One-child aftermath

The effect of China’s one-child policy on gender ratios is becoming clear. In 2005 there were 32 million more males aged under 20 than females (*BMJ*, DOI: 10.1136/bmj.b1211). The gap was widest in the 1-4 age group, where there were 124 boys for every 100 girls. Gender-specific abortions are blamed for the skewed ratio.

Autistic and skilful

Savant-like skills such as perfect pitch or the ability to multiply high numbers together may be more common among people with autism than thought. Almost one-third have skills that stand out compared with both their other abilities and those of the general population (*Philosophical Transactions of the Royal Society B*, DOI: 10.1098/rstb.2008.0328).

Future’s orang-utans

There are more orang-utans in the wild than conservationists dared to hope. Researchers found 219 nests in the Indonesian rainforest. The discovery could add 5 per cent to estimates of the global population.

Reason to be cheerful

All it took was some antibiotics. Two honeybee colonies were successfully treated after it was determined that the parasite *Nosema ceranae* was responsible for their collapse (*Environmental Microbiology Reports*, vol 1, p110). This is the first time *N. ceranae* has been found responsible for the collapse of a colony. Colonies in Europe and the US are suffering from numerous, mostly poorly understood, pathogens.

JR/REZAC/EVERETT



The new face of tar sands

One of the world's dirtiest fossil fuels may someday be transformed into its cleanest

Bob Holmes, Fort McMurray, Alberta

IN THE Canadian province of Alberta the ground is skinned and gutted. Rising oil prices and dwindling reserves have pushed oil companies to exploit what was once considered unexploitable: tar sands, the dirtiest oil on Earth and the most expensive to extract.

This strip-mined landscape is bad enough, but another method of extracting the oil is on the rise, and it is even more damaging to

the environment. Yet new technologies offer hope that tar sands could one day be transformed into one of the cleanest fossil fuels.

The Canadian tar sands contain an estimated 170 billion barrels of recoverable oil, second only to Saudi Arabia's reserves. As the name suggests, the fuel must be separated from sand. Today, most operations dig up the tarry bitumen in gigantic open pit mines, then separate and refine it. The process destroys habitat and

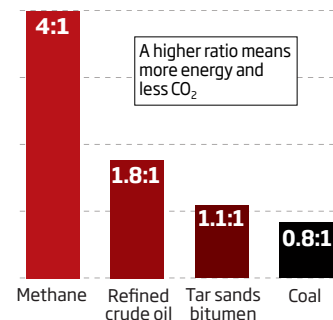
creates vast lakes of toxic residues. Worst of all, processing it requires large amounts of energy. The Canadian government estimates that oil from tar sands takes three to five times as much energy to produce as conventional oil.

That carbon cost is likely to get even higher. Only about 20 per cent of the tar sands lie shallow enough to be mined. If you drive an hour south of Fort McMurray in Canada's gigantic Athabasca Tar Sands, you leave behind the vast strip mines and enormous processing plants where sandy bitumen is shovelled out of the bowels of the earth and turned into oil. The boreal forest once again dominates the landscape. In a bulldozed clearing amid the spruce trees, accompanied by the gentle hum of pumps and turbines, you will find a few low, metal-clad industrial buildings surrounded by a tangle of piping.

This is ConocoPhillips's Surmont production site, the new face of the Athabasca Tar Sands. Within a few years, most plants will probably look more like this than the strip mines. At first sight, that seems a good thing, and it is, if you live nearby. But Surmont's benign appearance belies the fact that from a global perspective, it

How dirty is dirty?

The hydrogen:carbon ratio of a fuel gives an idea of how much energy and CO₂ it produces



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A typical day at the Athabasca Tar Sands

is even worse than the strip mines.

The facility pumps huge amounts of steam at 305 °C several hundred metres underground to separate fuel from sand in situ, a process called steam-assisted gravity drainage (SAGD). At room temperature the bitumen is more viscous than peanut butter, but after several months of heating it becomes as runny as heavy cream and can be pumped to the surface.

Generating all that steam takes energy – more than mining, says Simon Dyer of the Pembina Institute, an environmental group based in Calgary, Alberta. In fact, if you include the energy needed to upgrade and refine the fuel, every three barrels of oil extracted with SAGD consumes nearly a whole extra barrel, says Pedro Pereira, a chemical engineer at the University of Calgary.

Matt Fox, who manages oil sands operations for ConocoPhillips,

is optimistic that improvements can be made as engineers gain more experience with SAGD, which has only been in commercial use for eight years. But he admits that the process will always consume more energy than pumping conventional oil. "The oil sands have got nowhere to hide on the greenhouse gas

issue," says Fox. "We have a major challenge we have to address."

There's hope on the horizon. Nascent technologies may further reduce the greenhouse gas cost of tar sands extraction. Pereira is leading a team that is trying to transform the bitumen into lighter oil underground, before it is pumped to the surface. The process requires higher temperatures than SAGD, but compensates by saving more energy further down the line when the fuel is processed. And many of the toxic sulphur and nitrogen compounds remain underground, which removes the surface pollution.

So far, the team has developed a catalyst for use in the underground deposits and is working on proving the concept in the lab. Eventually, they hope to complete most of the refining process underground, yielding usable oil at a carbon cost comparable to conventional crude oil.

A much cleaner and truly inventive solution, though, can be found in the laboratory of Stephen Larter, also at the University of Calgary. Together with colleagues at Newcastle University, UK, he thinks it might be possible to induce bacteria to digest the bitumen into methane, which could be extracted just like conventional natural gas. The process occurs naturally underground: bacteria called *Syntrophus* digest the oil and release hydrogen as a waste product. A second group of archaeobacteria called

methanogens then converts the hydrogen to methane. "They're already there. All you do is add fertiliser," says Larter.

Last year, Larter's team showed that by adding nitrogen, phosphorus, vitamins and trace minerals to oil-field samples in the lab, they can convert the hydrocarbons to methane in about 600 days (*Nature*, DOI: 10.1038/nature06484). Their newly founded company, Profero Energy, is about to begin field tests to see whether the method can produce methane economically from a

"It might be possible to induce bacteria to digest bitumen into methane, and extract it like natural gas"

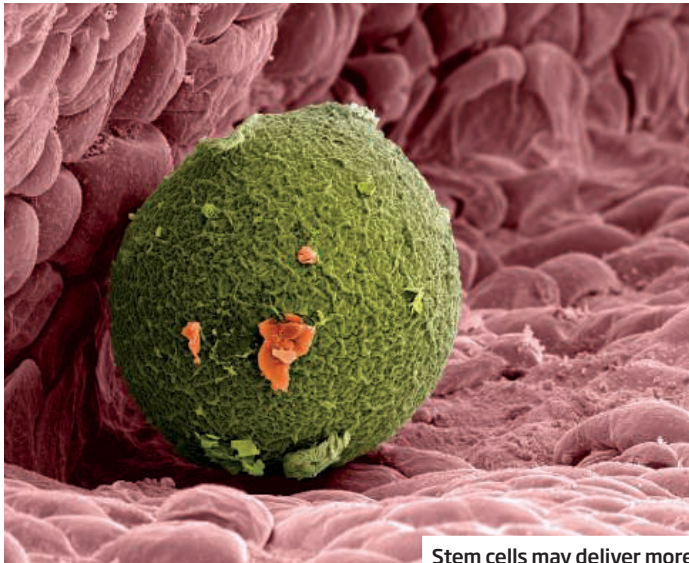
natural underground reservoir. "If it's an economic success, it is a game-changer. You have suddenly got a huge amount of a relatively clean fuel, methane," says Larter. "But it has absolutely not been proven in the field yet."

Even if Larter's microbial conversion proves practical, of course, no amount of technological trickery can get around the fact that burning any fossil fuel adds carbon dioxide to the atmosphere. But, "the oil industry is not going to disappear overnight", says Larter. "Cleaning up the tail end of the industry is a crucial thing, otherwise we'll have really serious problems." Burning methane provides more useable energy per tonne of CO₂ emitted than any other fossil fuel (see chart), making it the best choice for weaning society off fossil fuels altogether.

In the long run, Larter notes, a similar process could someday offer the ultimate in clean energy: a hydrogen economy. Methanogens are very efficient at using up the hydrogen *Syntrophus* produces, so it does not last long enough to tap. But if the researchers could find a way of inhibiting the methanogens, their system would offer the possibility of producing immense quantities of hydrogen, a zero-carbon fuel. ■



Steam extraction looks clean...



Stem cells may deliver more

Could women grow brand new eggs?

Linda Geddes

STEM cells placed in the ovaries of sterilised adult mice have apparently given rise to fresh eggs and healthy offspring, reigniting the debate over whether women are born with all the eggs they will ever have.

If the finding can be replicated in women, it would revolutionise reproduction, opening the door for later child-bearing and providing a source of eggs for infertile women. But despite early signs that similar egg-producing cells may exist in women, there are doubts over whether the mouse and human cells are what they seem.

To isolate ovarian stem cells in mice – dubbed female germline stem cells (FGSCs) – Ji Wu and his colleagues at Shanghai Jiao Tong University in China looked in the ovaries of adult and 5-day-old mice for cells producing a protein called MVH, which should be expressed both by egg cells and egg-producing stem cells. They then extracted those MVH cells that were also rapidly dividing,

a key characteristic of stem cells, and grew them in culture.

These cells were labelled with the gene for a fluorescent protein before being injected into the ovaries of mice that had been sterilised by chemotherapy. The team found that this led to the ovaries being repopulated with eggs. The mice subsequently gave birth to healthy pups, some of which carried the fluorescent protein, showing they had come from the injected cells (*Nature Cell Biology*, DOI: 10.1038/ncb1869).

“By producing live young, these cells have passed the ultimate test to prove their germline credentials,” says Evelyn Telfer of the University of Edinburgh, UK. “It’s very, very exciting.”

If Wu has identified FGSCs in adult mice, do other mammals also carry similar cells in their ovaries? There is early evidence that women might.

Irma Virant-Klun at the University Medical Centre Ljubljana in Slovenia and her team took cells that seem to express genes associated with embryonic

stem cells from the surface of the ovaries in post-menopausal women (*Differentiation*, DOI: 10.1111/j.1432-0436.2008.00268.x).

While growing these cells in culture led to the production of egg-like cells, it is not yet clear whether they are FGSCs, nor whether the “eggs” they produce are capable of yielding offspring. “Although they may look like eggs, that doesn’t necessarily mean that’s what they are,” warns Roger Gosden of Weill Cornell Medical College in New York.

If they are shown to be FGSCs, it would open the door to new fertility treatments, including growing eggs to implant into infertile women, or stimulating the generation of new eggs inside adult ovaries. It could also lead to a new way to create embryos for embryonic stem cell research.

Other research groups must first reproduce both sets of results. “Stem cell biology has been mired in the problem of replication,” says Gosden. “A very high standard of proof is needed.”

Some scientists have already pointed to several puzzling aspects of Wu’s work. For example, if the dividing cells Wu extracted from the mice really are FGSCs, why are mammalian egg supplies not kept topped up indefinitely?

“By producing live young, these cells have passed the ultimate test to prove their germline credentials”

Also, Wu’s team used antibody-coated beads to extract cells that express MVH, a technique that relies on a protein being expressed on the cell’s surface, but MVH is usually expressed inside cells, prompting some to question whether the cells extracted by Wu really are FGSCs.

“If there are cells that can give rise to eggs it would be fantastic, but it’s an extraordinary claim and the evidence needs to be cast iron,” says Robin Lovell-Badge of the National Institute for Medical Research in London. ■

SOUNDBITES

“I do actually get a chance to touch the Hubble and I can hug it when I get up there.”

Many fans of the Hubble Space Telescope call themselves “Hubble huggers”, including NASA astronaut **Mike Massimino**, who is due to lift off on 12 May on a mission to help upgrade the telescope (Space.com, 13 April)

“It is frightening. We can’t go on as we have been. We are seeing the consequences in terms of ecology, pollution, space and food production.”

Broadcaster **David Attenborough** on becoming a patron of the Optimum Population Trust, which campaigns to limit the number of people in the world (*The Times*, London, 14 April)

“The things we went through to get here. I was able to create a new life.”

Chris Biblis from North Carolina, on the birth of his daughter Stella from his sperm frozen a record 22 years ago, before he underwent chemotherapy for leukaemia (*ABC News*, 10 April)

“I can’t tell you how many people have spent the night in their bathtubs because they are so freaked out by bedbugs.”

Dini Miller, an entomologist at Virginia Polytechnic Institute and State University in Blacksburg, on the resurgence in bedbugs prompting the US Environmental Protection Agency to host its first ever bedbug summit (Associated Press, 14 April)

“The loss of forest elephants on the functionality of central African forests might be comparable to the loss of all vehicles for the functionality of Manhattan.”

Stephen Blake, whose team at the Max Planck Institute for Ornithology found that elephants in the Congo basin disperse the seeds of 96 plant species (mongabay.com, 9 April)

Avoid a future cataclysm: just forget the past

GREAT news, there may be a way to avoid a looming disaster. All you need to do is forget all about it by “resetting” your memory.

That’s the claim of physicist Saibal Mitra at the University of Amsterdam in the Netherlands, and it is predicated on the existence of parallel universes.

The “many worlds” concept is an interpretation of quantum theory – our best description of the microscopic world of atoms and their constituents. Many worlds takes literally quantum theory’s idea that a quantum entity like an atom can exist in many states at once, and posits the existence of parallel universes containing infinite copies of you with different histories and futures.

To understand how the many-worlds scenario could allow a future disaster to be avoided, says Mitra, consider a hypothetical

machine intelligence that regularly backs up its memory. If it encountered a glitch, for example, it could reset its memory to, say, the previous day’s state.

Imagine that on learning of an impending disaster – perhaps a catastrophic asteroid strike on its planet – the machine resets its memory. Now, an observer sat next to the machine can verify that the “same machine” will still face disaster after the reset. But from the perspective of the machine’s reset memory, the state of the universe in the many-worlds scenario becomes “undetermined”. After all, for all the machine knows, the reset probably occurred for a mundane reason, such as a crash of its operating system.

The next part defies our natural instincts: according to the many-worlds interpretation, all of these undetermined possibilities

actually exist and open up to the machine. Even though it followed one particular history up to its resetting, it can be dealt a new card, says Mitra. So, from its unwitting perspective, the machine could “switch” to a parallel universe. The probability of a memory reset due to a rare event like an asteroid strike would be far smaller than the probability of a routine reset due to a glitch,

“If we could find a way to reset our knowledge of an impending disaster, we could avoid it”

and so there will be many more universes in which the disaster does not occur. “Consequently, the machine will almost certainly find itself in one of these universes and avoid the catastrophe,” says Mitra (www.arxiv.org/abs/0902.3825).

“If we could find a way to reset our knowledge of an impending disaster, we too could avoid it,” he says. The downside of such memory resets, however, is that

there is a small chance you will “wake up” in a universe facing an even more cataclysmic disaster than the one you were trying to dodge. “You’d have to weigh up whether it would be worth the risk,” Mitra concedes.

“If correct, it’s an intriguing result,” says Max Tegmark of the Massachusetts Institute of Technology, “even if it may only apply to future beings whose minds are quantum computers and not beings like us with warm, wet brains where quantum superpositions get rapidly destroyed.”

David Deutsch at the University of Oxford, whose work has lent mathematical support to the many-worlds idea, points out that conclusions based on the probabilities of outcomes in parallel universes will be speculative, and therefore suspects Mitra is wrong. However, he notes that “probability is not yet sufficiently well understood to say so definitively”. **Marcus Chown** ■

Sunbirds are evolving on the wing

YOU can’t teach an old dog new tricks, but birds are a different matter. A bird species found in Africa has learned to hover so that it can collect nectar from flowers, just as hummingbirds do in the Americas. The bird has an unlikely trainer: an invasive South American plant that has made its way to South Africa.

Tree tobacco produces yellow, tubular flowers and, like other plants with flowers of this shape, it depends mainly on nectar-sipping birds for pollination. In its native South America it is pollinated by hummingbirds, which have evolved the highest metabolism of any animal in order to generate enough energy to hover near flowers for long enough to drink their nectar.

There are no hummingbirds outside



Make like a hummingbird

the Americas, something that has puzzled evolutionary biologists. Native Old World plants with tubular flowers usually produce some sort of perch to allow birds to sip their nectar. So when Sjikr Geerts of Stellenbosch University in South Africa noticed native malachite sunbirds hovering around tree tobacco flowers in the north-east of the country, he decided to investigate.

The birds were known to hover

occasionally before, says Geerts, but he has discovered that some sunbirds are now getting most of their winter food from tobacco tree flowers (*Oikos*, vol 118, p 573). “This is the first time we have observed them making a lifestyle of it,” he says. The sunbirds used to migrate out of the region in winter because there was no nectar. Now they stay put.

Geerts doesn’t yet know what effect this is having on sunbird-

pollinated plants elsewhere, or on sunbird numbers. But one thing is certain: the tobacco plant is benefiting. By putting netting over some tobacco trees Geerts found that plants pollinated by sunbirds set three times as much seed.

The discovery casts a new light on why hover-feeding evolved in birds in the Americas but not elsewhere. Geerts speculates that at some point in the evolutionary history of the Americas, there may have been many nectar-eating bird species competing for flowers. This would have put considerable pressure on birds to be better at hovering. In contrast, if there were fewer pollinators in the Old World, he says, all the pressure would be on plants to evolve ways to attract them, resulting in some with elaborate perches.

Geerts now wants to find out if sunbirds keep hovering during the summer, when they are expending most of their energy on raising young. **Debora MacKenzie** ■

SJIKR GEERTS/UNIVERSITY OF STELLENBOSCH

No need to worry about asteroid tsunami disaster

THE odds of encountering a tsunami kicked up by an asteroid strike have just plummeted. Best to hope, though, that you're not underneath the almighty splash such an impact could create.

Small impactors hit us far more frequently than larger ones: a 200-metre asteroid hits Earth about every 10,000 years on average, while 10-kilometre objects like the one that probably killed off the dinosaurs strike every 100 million years. Much of the worry over asteroids has centred on the more likely event of a smaller one splashing down in the ocean and triggering a powerful tsunami.

Now simulations to be presented at an asteroid hazard conference in Granada, Spain, this month suggest that small asteroids do not after all pose a major tsunami threat.

Galen Gisler of the University of Oslo, Norway, and colleagues used software originally written to simulate nuclear explosions to hurl a virtual 200-metre asteroid into an ocean 5 kilometres deep. The impact initially sends waves

hundreds of metres high spreading from the impact site. However, the very height of the waves makes them prone to collapse even in very deep water: they start breaking immediately, like ordinary waves on a beach.

By the time they are 30 kilometres from the impact site, they have shrunk to a height of less than 60 metres. The team did not simulate the waves' propagation much further, but extrapolating the shrinkage suggests heights of less than 10 metres by the time they have travelled 1000 kilometres.

That might not seem very

"The impact initially sends waves hundreds of metres high radiating from the impact site"

reassuring. Tsunamis with open ocean heights of less than a metre can still be very damaging because they rise up as they come ashore and penetrate far inland, but this is related to their long wavelengths and characteristic periods of 8 minutes or more.



Might not be so bad

Asteroid waves would have shorter wavelengths and periods of less than 2 minutes, says Gisler, and so far less penetrating power.

Steven Ward of the University of California, Santa Cruz, has conducted his own simulations and suspects methods in Gisler's calculations meant to smooth away errors are accidentally damping down the waves. Ward's own results suggest much slower wave decay. Gisler responds that his simulations are more realistic, pointing out that previous modelling leaves out fine-scale turbulent motion that helps dissipate wave energy.

A strike near a populated coastline would undoubtedly cause major damage, however.

"You don't want to be close to one of these things," says Gisler. "Local effects will include hurricane-force winds and enormous amounts of water falling directly from the sky." His simulations suggest that a 200-metre asteroid would make a splash of billions of tonnes of water, which would descend at up to 300 metres per second within about 20 kilometres of the impact site.

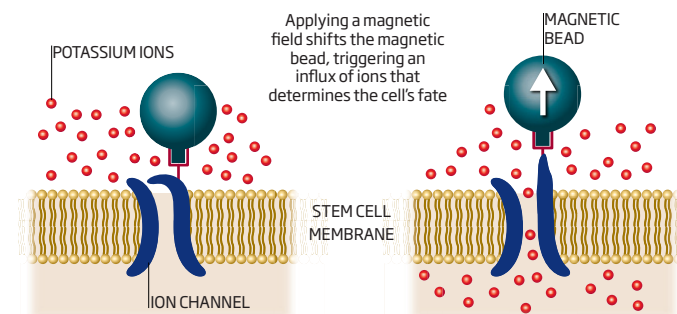
Brian Toon of the University of Colorado in Boulder says we should continue surveying for asteroids. "We probably have quite a while before we're going to get hit by a significantly sized [asteroid]," he says. "But nevertheless one of these is going to come at us." **David Shiga** ■

Stem cells get magnetic desire to be cartilage

MAGNETS are being used to control the transformation of stem cells into specific tissues. They could also be used to guide stem cells to target locations in the body, allowing arthritic joints and torn cartilage, for example, to be repaired without surgery.

Alicia El Haj of Keele University, UK, and her colleagues have created magnetic beads up to 2 micrometres across that bind to receptors on human mesenchymal stem cells, which are extracted from bone marrow or fat

Magnetic stem cells



tissue. When a magnetic field is applied, the beads move, deforming the surface of the cells and forcing open its pores. The resulting influx of potassium ions sets in motion a cascade of reactions inside the cell

that determine what kind of tissue it will turn into (see diagram).

The team implanted human mesenchymal stem cells studded with these beads into the backs of mice and used a magnetic field to

turn the cells into cartilage, El Haj told a stem cell meeting in Oxford, UK, on 7 April. Her team now plans to treat knee joints in goats with the magnetic stem cells, which were developed together with MagneCell, a spin-off company of Keele University. They hope a magnetic field will guide the stem cells to the joints, as well as prompting their transformation into cartilage.

The beads, which the US Food and Drug Administration has already approved for use as an imaging enhancer, degrade after a short time and the harmless products are excreted. By attaching the beads to other receptors, the stem cells might be made to turn into a range of other tissues, El Haj says. **Andy Coghlan** ■

Mind gym helps life with schizophrenia

Peter Aldhous, San Francisco

BRAIN training in a computerised mind gym could help people with schizophrenia cope with the debilitating cognitive problems caused by the condition.

The obvious schizophrenic symptoms – such as having animated conversations with people who aren't really there – can be controlled by antipsychotic drugs. However, people with schizophrenia find their difficulties with learning, remembering, making decisions and processing information even more problematic than hallucinations. These symptoms have proved hard to treat, making it difficult for people with the condition to hold down a job or deal with social situations.

Now there is hope. At the San Francisco Veterans Affairs Medical Center, a team led by Sophia Vinogradov has put 55 volunteers with schizophrenia through “brain fitness” training, using software made by the firm Posit Science, also in San Francisco.

The brain fitness software starts by giving volunteers basic tasks

such as identifying whether the pitch of various tones rises or falls (see “Can I hear that again?”) and ends with a comprehension test of a spoken narrative.

After the training, Vinogradov's volunteers performed better in cognitive tests, including tests of verbal learning and memory, compared with a control group who played simple computer games. The improvements were about twice as great as those seen

“The big test will be whether these gains lead to an improved ability to deal with social situations”

in previous trials of cognitive training, Vinogradov's team reports in a paper to appear in *The American Journal of Psychiatry*.

Susan McGurk of Dartmouth Medical School in Hanover, New Hampshire, who has analysed the evidence from earlier trials, calls Vinogradov's results “exciting”.

This is not the first attempt to use computer tools to treat the cognitive problems that come with schizophrenia, but it is more intensive than earlier efforts. Each

volunteer did about 50 hours of brain training over 10 weeks.

The approach is also unusual because it initially focuses on improving a person's ability to process sensory information, before honing higher-level cognitive processing.

This “bottom-up” approach is crucial, says Vinogradov, who likens having the sensory difficulties that come with schizophrenia to trying to listen to a talk show on a badly tuned radio. Tuning the radio to remove the static allows the listener to hear the underlying discussion. Similarly, training sensory processing frees volunteers with schizophrenia to work on higher-level cognitive tasks.

The big test will be whether these gains lead to an improved ability to hold down a job or deal with social situations. One

encouraging sign has already come from a follow-up study on some volunteers, who six months after the training had improved their scores on a questionnaire that assessed quality of life (*Schizophrenia Bulletin*, DOI: 10.1093/schbul/sbn170).

Vinogradov hopes to improve the results further by adding training on visual information and the processing of social cues such as those from facial expressions. She is also testing whether the training can help protect the brains of young people who show early signs of psychosis. This may be important because cognitive decline sets in before a first psychotic episode.

“The way we treat schizophrenia now is the equivalent of waiting until someone has metastatic cancer before starting to treat,” she says. ■

CAN I HEAR THAT AGAIN?

The software now being used to treat people with schizophrenia would give anyone's brain a workout.

As you improve, tasks get more demanding, keeping you on your toes. If errors stack up, however, the tasks get easier again. Such adjustment is important, as the brain is best at forming new connections when error rates on a task hover at around 15 per cent.

In the first task, you are played two sounds in quick succession. Each slides in pitch to either a higher or a lower frequency and you are asked

to indicate which way each slides by clicking “up” or “down” arrows on a computer screen. The task is repeated, and as your performance improves, the sounds, and the spaces between them, get shorter.

Later tasks are more demanding. In one, a screen displays up to 32 boxes. When clicked, each plays a spoken syllable. The goal is to identify boxes with matching syllables. To make them hard to discern, the sounds are distorted. Our reporter had an especially tough time distinguishing “bag” from “pag”.

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Climate change and extinction

Public lecture

Monday 27 April at 6.30pm

Dr Richard Leakey FRS
Stony Brook University, USA

National parks were established in order that nature might be preserved for the enjoyment and benefit of current and future generations. Today, countless ‘protected areas’ are maintained at huge public and private expense. Richard Leakey will discuss whether our ‘protection’ strategies actually protect when the real threats are related to the current climate change – and mass extinctions may be the consequence.

Richard Leakey has had several careers that engaged him in palaeontology, anthropology, museum administration, conservation, politics and government administration. He has published a number of books as well as presenting television documentaries. He is also Chairman of WildlifeDirect.

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JEREMY HORNEN/PANOS



Earthquake rumble time warns of dangerous tsunamis

TSUNAMI warnings could reach vulnerable coastlines within minutes, thanks to an early-warning system that gauges how long an earthquake rumbles.

Most tsunami-warning systems work by measuring an undersea earthquake's magnitude, because those above magnitude 7.5 are considered highly likely to generate a tsunami. However, it takes at least 30 minutes to measure this accurately.

Previous studies have shown that quakes that shake for a long time are more likely to produce a tsunami. Now Anthony Lomax, a consultant seismologist based in

Mouans-Sartoux, France, and Alberto Michelini of the National Institute of Geophysics and Volcanology in Rome, Italy, have developed a way to spot this signature quickly.

The pair studied the seismic waves from 76 underwater earthquakes. Sure enough, rumbles that produced high-frequency waves for more than 50 seconds had a high probability of generating a damaging tsunami wave. Using this information, they developed an algorithm to filter out quake duration from seismic data. If adopted in an early-warning system, "it could provide a warning within 10 to 15 minutes", says Lomax. The work will appear in *Geophysical Research Letters*.

"Used alongside other methods it could be promising," says Emile Okal, a seismologist at Northwestern University in Evanston, Illinois.

One gene may be keeping this girl a girl

A SEVEN-year-old girl with a Y chromosome is providing new clues about a possible "master switch" of maleness.

Other children who have the male sex chromosome but do not appear to be boys have been found to have gene mutations that temper the Y chromosome's effects. They generally have indeterminate gender characteristics such as ambiguous

gonads, shrivelled testes or other developmental abnormalities.

This child has the physical attributes of a girl, however, with a normal vagina, cervix and ovaries, according to a team led by Anna Biason-Lauber of University Children's Hospital Zurich, Switzerland (*The American Journal of Human Genetics*, DOI: 10.1016/j.ajhg.2009.03.016).

She lacks the gene mutations

present in the other children but has mutations in a gene on chromosome 17 called *CBX2*.

CBX2 has aroused interest as a possible master switch for maleness because tests in human cells suggest that mutations in it can shut off a gene on the Y chromosome critical for male sexual development.

If so, it would explain this girl's lack of male physical characteristics despite her having a Y chromosome.

Brown dwarfs spring a surprise

FAILED stars may be more common than anyone thought. If so, it would change our idea of how stars form.

In 2007, a star near the centre of our galaxy appeared to brighten because another object had focused the star's light onto Earth. From the way the object bent the light, Andrew Gould of Ohio State University in Columbus and colleagues have now found that it is a brown dwarf – a "failed star" with too little mass to sustain the nuclear reactions that power stars.

Current estimates of how common brown dwarfs are suggest this finding is improbable – so either Gould struck lucky or brown dwarfs are more abundant than previously thought (www.arxiv.org/abs/0904.0249).

If so, our models of how gas clouds collapse to form stars may be wrong, says Sebastien Lepine of the American Museum of Natural History, New York.

Laser beam goes round the bend

HOW do you "curve" a laser beam without using mirrors?

The intensity of a laser beam is normally concentrated in a central region, but Pavel Polynkin at the University of Arizona, Tucson, and colleagues have built a device that splits a straight laser pulse into certain constituent parts. They used this to create a beam with an intense region on its right-hand side and less intense regions on the left.

As such a pulse travels, energy flows between these regions and causes the beam to bend roughly 5 millimetres to the right over 60 centimetres. The team says such beams could be useful for guiding laser energy around small objects (*Science*, DOI: 10.1126/science.1169544).

The trouble with denominators

FRACTIONS may be written as the ratio of two whole numbers, but that's not how our brains process them. Instead it seems we respond to fractions directly, without processing whole numbers along the way. This suggests that kids, who often dread fractions, could be taught them more intuitively.

Previous tests have shown that specific groups of neurons respond to different whole numbers, with the number one altering the firing patterns of different neurons than the number three. Now Simon Jacob and Andreas Nieder of the University of Tübingen in Germany have shown that we have fraction-specific neurons too.

The pair scanned the brains of adults as they were shown a variety of different fractions - either as numerical ratios or in words. In both cases, specific groups of neurons altered their firing patterns. Crucially, control experiments showed that the volunteers weren't responding first to whole numbers, and then calculating the ratio, but were reacting to the fraction itself (*The Journal of Neuroscience*, DOI: 10.1523/jneurosci.0651-09.2009).

Fractions tend to be taught as ratios of whole numbers, but Nieder says this may not tap our neural machinery in the most constructive way, making fractions harder to grasp than they need to be.

It's life, Jim, and pretty much as we know it

WILL alien life forms resemble living things here on Earth? We can't know, but now there is evidence that at least the basic building blocks will be the same.

All terrestrial life forms share the same 20 amino acids. Biochemists have managed to synthesise 10 of them in experiments that simulate lifeless "prebiotic" environments, using proxies for lightning, ionising radiation from space, or hydrothermal vents to provide the necessary energy. Amino acids are also found inside meteorites.

Paul Higgs and Ralph Pudritz at

McMaster University in Hamilton, Ontario, Canada, point out in a paper to appear in *Astrobiology* that all the experiments created a subset of the same 10 amino acids, and calculate that these 10 require the least amount of energy to form. This, they argue, suggests that if alien life exists it probably has the same 10 amino acids at its core.

They show how the other 10 may have been added one by one as early life on Earth became more sophisticated. More controversially, they go on to argue that this process dictated

the evolution of the genetic code, suggesting it too is universal.

Darren Griffin, a geneticist at the University of Kent, UK, suggests Higgs and Pudritz are pushing their conclusions too far. "Laws of physics govern the universe, and it seems reasonable to suggest that there are laws of molecular biology that may also be universal," he says. "But it seems unlikely that the very same genetic code would arise on another planet, even if there are similarities in the fundamental molecules such as amino acids."

'Vicious' dog, vicious owner?

ARE you right to trust your instincts if you cross the street when you encounter a snarling pit bull with an equally forbidding owner? A new study suggests that the owners of so-called "vicious" dogs commit more crimes than those who do not own such a dog.

Laurie Ragatz and her colleagues at the University of West Virginia in Morgantown examined whether owners of vicious dogs - those classed by the American Kennel Club as breeds with a high risk of causing injury to humans - were different in personality and behaviour to others. Their online questionnaire of 758 students, 563 of whom owned dogs, revealed owners of vicious dogs were significantly more likely to admit crimes such as vandalism, illegal drug use and fighting than other dog owners and those without dogs (*Journal of Forensic Sciences*, DOI: 10.1111/j.1556-4029.2009.01001.x).

It's not just a dog's breed but also the character of its owner that may make the dog aggressive, points out Clive Wynne, a psychologist at the University of Florida in Gainesville. "It takes both nature and nurture to make a bully," he says.



EVERETT COLLECTION

Parasites mobilise as world warms

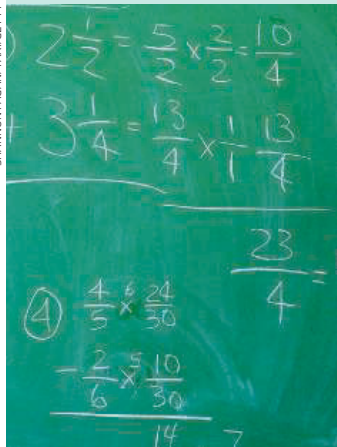
PETS are normally sheltered from the environment's harsh realities. But across Europe, rising temperatures due to global warming will expose pets to infectious diseases spread by ticks, fleas and flies, warns new research published in a special issue of *Veterinary Parasitology*.

Tick populations are increasing thanks to climate change, and shorter, milder winters mean they are becoming active all year round. The European dog tick (*Dermacentor reticulatus*) is moving northwards, transmitting canine babesiosis into countries where it was once rare,

including Belgium, Poland and Germany. Meanwhile higher densities of *Ixodes* ticks are increasing the risk of horses and dogs picking up tick-borne encephalitis.

Another study warns of a notable reservoir of leishmaniasis in dogs in southern Britain, acquired from travelling to the Mediterranean area, where the parasite is endemic. If climate change allows the sandfly vector to colonise the UK there is a real danger the disease could spread, say Susan Shaw and colleagues at the University of Bristol, UK (DOI: 10.1016/j.vetpar.2009.03.025).

SHANNON FAGAN/TAXI/GETTY





A way to deal with roadside bombs?

Defuse bombs from a distance

THE next weapon in the US army's arsenal could be a laser-guided microwave blaster designed to destroy explosives.

The weapon, called the Multimode Directed Energy Armament System, uses a high-power laser to ionise the air, creating a plasma channel that acts as a waveguide for the stream of microwaves. The device could destroy the electronic fuse of an explosive device or missile, such as a roadside bomb, or immobilise a vehicle by disabling its ignition system.

Further work on the weapon, being developed by the US army's Armament Research, Development and Engineering Centre (ARDEC) at the Picatinny Arsenal in New Jersey, could also allow it to be used against people, delivering electric shocks, though Picatinny spokesman Peter Rowland says: "the focus of this

programme is on developing a mobile system for anti-materiel purposes".

The weapon's range will depend on the laser-generated channel. Previously such channels have been limited to tens of metres, but the ARDEC team believe it may be possible to extend this to a kilometre

"The weapon uses a high-power laser to ionise the air, creating a plasma channel"

or more. "The concept is solid and the only issues are with engineering - the physics works," says Carlo Kopp, who researches electromagnetic pulse weapons at Monash University in Melbourne, Australia.

The army expects to have a prototype weapon working outside the lab by 2011.

Commercial space deliveries blast off

PRIVATE launch company Space X is set for the first commercial flight of its Falcon 1 rocket next week.

Falcon 1 is a two-stage rocket powered by liquid oxygen and kerosene, which last September became the first privately built launcher to reach orbit. In next week's launch the rocket will place the Malaysian Earth observation satellite RazakSAT into an almost equatorial orbit.

The launch represents a major step towards routine commercial operations for Space X, which was created in 2002 by PayPal founder Elon Musk with the aim of slashing the cost of access to space. The company's heavy-lift Falcon 9 rocket is also due for launch later this year, as part of an agreement with NASA to demonstrate commercial cargo flights to the International Space Station.

56

kilometres per hour. The top speed of the Puma, a two-seat electric vehicle being developed by GM and Segway

Table seeks long-term relationship

DO YOU pay enough attention to your gadgets and possessions - even when they are no longer new and shiny?

James Pierce at Indiana University in Bloomington is designing ways for objects to periodically make their presence felt, forcing us to "reflect" on them more often. He believes that this will increase our sense of attachment to our possessions, helping to end our unsustainable habit of constantly buying new things and dumping the old.

For instance, he has designed a table with an embedded digital

counter that displays the number of heavy objects that have been placed on it during its lifetime. The counter becomes blurry or erratic if someone drops a heavy object on the table, only later returning to the correct count.

Another approach is cheeky misbehaviour, such as a lamp that dims if you leave it on for too long; shaking the lamp "wakes" it again. Or a clock that occasionally shows the wrong time, only to correct itself and display a message that it was just joking.

Such attention-seeking objects will "discourage thoughtless consumption of things", Pierce claims. He presented his ideas last week at the Computer Human Interaction conference in Boston.



"Studying the walls is like turning the pages of a book"

Juan Castilla of Spain's Higher Council for Scientific Research, who is heading a team using 3D laser scanners and image-recognition software to record and translate the Arabic inscriptions carved into the walls of the Alhambra palace in Granada, Spain (*The Guardian*, London, 7 April)

Protecting pedestrians from killer cars

As the number of driver and passenger deaths from road traffic accidents declines, attention turns to cutting the pedestrian toll

Nic Fleming

PITY the poor pedestrian. While vehicle drivers and their passengers are cocooned in a crash, people hit by a car have no such protection. Now that could change, thanks to a variety of systems that when built into a vehicle will improve a pedestrian's chances.

Every month approximately 3400 pedestrians are killed in traffic accidents on the roads in the US, and a similar number die in Europe. Some 30 per cent of the injuries sustained by this group are caused by an impact with a windscreen or its frame.

A Europe-wide collaboration led by Roger Hardy of the Cranfield Impact Centre at Cranfield University near Bedford in the UK has developed an experimental system for cars that aims to cut this death toll and reduce the severity of injuries. When the system detects that the car is about to hit a pedestrian, it automatically raises the rear of the bonnet (hood), releasing a giant airbag in front of the windscreen.

The raised bonnet absorbs some of the energy of the impact, reducing the risk of serious injury to the pedestrian, says Hardy, whose project forms part of the European Union-funded

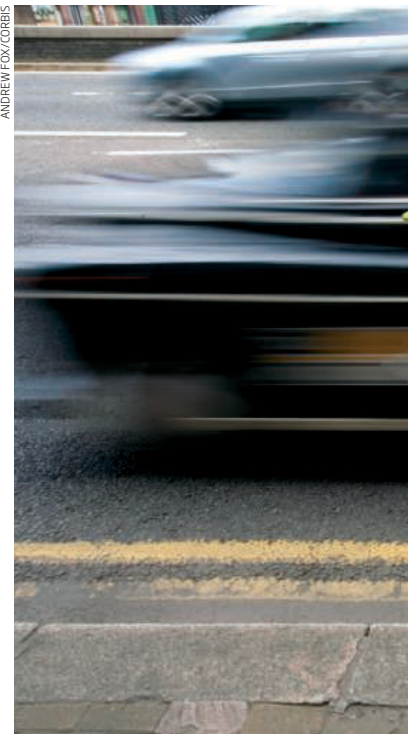
Integrated Project on Advanced Protection Systems (APROSYS). "If it's a large pedestrian or on a small town car, the airbag also provides a cushioning effect around the stiff peripheral regions [of the windscreen]," he says.

The airbag system used by

"This system could have as great an impact on pedestrian deaths as seat belts had on driver deaths"

Hardy was developed by the German company Takata Petri. To test its efficacy when combined with the raised bonnet, they were incorporated into a prototype Fiat Stilo by engineers at the Fiat Research Centre in Turin, Italy. The team then assessed the severity of head injuries in collisions with a dummy pedestrian.

A standard Stilo hitting a pedestrian at 40 kilometres per hour, so that their heads struck the back of the bonnet, would have a score of around 1000 on



ANDREW FOX/CORBIS

the Head Impact Criterion (HIC) scale – corresponding to an 18 per cent chance of a life-threatening injury. For pedestrians hitting Hardy's bonnet, the scores were reduced to between 234 and 682, while the windscreen airbag scores ranged from 692 to 945.

Hardy's team has also helped to design a windscreen-mounting system to cushion impacts with the edge of the windscreen. This consists of a flexible Z-shaped section of metal, up to 15 millimetres wide, separating

How not to hit the car in front

"Our aim for 2020 is that no one should be killed or injured in a Volvo car," says Thomas Broberg, a senior safety specialist at the company.

When Volvo launched its new XC60 car in November, it included as standard an automatic braking system it claims could prevent half of all low-speed rear-end collisions.

Called City Safety, the system uses a laser sensor to check the distance between the car and vehicles up to 10 metres ahead. Measuring the speeds of both cars 50 times per second, it calculates the braking force required to avoid a crash. If the driver does not react when the vehicle in front slows, the system applies the brakes.

The Volvo S60, which launches next year, is planned to be the first car to be fitted with full automatic

braking to avoid collisions with pedestrians. The system uses a combined camera and radar sensor to monitor any obstacle in front of the car. The radar measures how far away it is, while images from the camera are analysed by image-recognition software to determine what the object is.

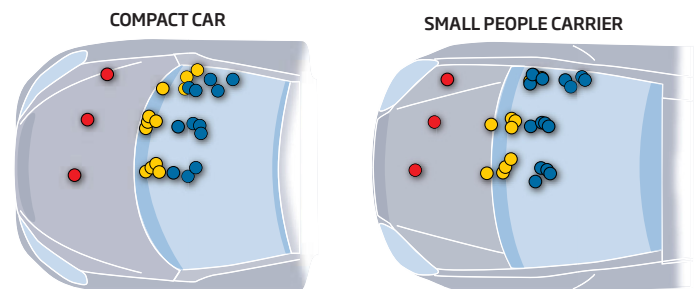
Drivers get an audible and visual warning of a potential collision, and if they do not respond the system automatically applies the brakes.

Volvo says its system could totally prevent collisions with pedestrians in cars travelling at 19 kilometres per hour or less, and reduce the impact of collisions above that speed by 75 per cent. Unfortunately it does not work as well in darkness and in poor weather, when accidents are particularly likely.

Making cars safer for pedestrians

Most serious injuries to pedestrians are caused by their head hitting the bonnet (hood) or windscreen

● 6-year-old child ● Small woman (<150 cm) ● Average man





Can we stop it happening?

the windscreen from its frame so that it can flex inwards to absorb energy in a collision. The team say it could reduce HIC scores by more than 50 per cent.

Another APROSYS collaboration, led by Jürgen Gugler at Graz University of Technology in Austria, studied how changing the shape of the front of a truck could reduce harm to pedestrians. Computer simulations of 20 accident scenarios showed that a smooth sloping surface with a central bulge reduces the likelihood of a pedestrian involved in a front-end accident being run over by 80 to 90 per cent. "A pedestrian is deflected to the side, rotated and pushed towards the ground," says Gugler. "You are out of the path of the oncoming truck."

Fiat researchers led by Roberto Puppini have also had some success in early tests of an adaptive bumper system. Four gas springs kick in at speeds between 4 and 80 kilometres per hour to move the bumper forward so that it will absorb energy in an impact. So will manufacturers actually

build any of these safety innovations into their cars? Over the next two years, the European car safety watchdog Euro NCAP will be phasing the results of pedestrian safety tests into its main rating system. Poor Euro NCAP test results are credited with helping to get some less safe car models withdrawn from sale. This suggests that buyers and manufacturers can be persuaded to take the safety of drivers and their passengers seriously, although it remains to be seen whether the welfare of pedestrians is as persuasive a selling point.

There is, for now at least, little else to encourage car-makers to adopt these safety devices. "From the legislative point of view, there is not a huge incentive for manufacturers to use this technology currently," says Hardy. Perhaps ultimately the law will have to step in so that external airbags and energy-absorbing bodywork improve pedestrian safety as dramatically as seat belts and internal airbags have reduced driver and passenger deaths. ■

Setting sail to bring used rockets back down to earth

THE risk to spacecraft from a collision with space debris could be reduced by equipping launchers with a gossamer-thin "sail". The idea is to deploy the sail after the rocket has released its payload to amplify the drag of the last vestiges of the atmosphere, and so force the rocket out of orbit.

Rocket stages are a particular risk to spacecraft because they often contain large amounts of unused fuel, which can explode when sunlight heats the tank. Leaking fuel can also act like a mini-thruster, pushing the rocket into an orbit where it may cause a collision. One way to tackle the problem is to vent unused fuel in a controlled way, and drain power from the battery, but this is unlikely to eliminate all collisions.

Now space-flight engineers Max Cerf and Brice Santerre at the European aerospace firm EADS Astrium are devising ways to build a sail that would quickly remove a spent rocket from orbit. The sail or "aerobrake" would be deployed after a rocket has delivered its satellite into low-Earth orbit, slowing it down by friction with the thin atmosphere so that burns up in around 25 years, much earlier than conventional rocket stages, some of which are expected to survive for at least 100 years.

For the final stage of an Ariane 5

launcher, the conical sail would need to have an area of about 350 square metres and be supported by an inflatable mast 12 metres long. Cerf and Santerre propose a number of possible ways to build the mast. The simplest envisages a woven polymer and aluminium tube that is kept inflated by nitrogen gas. Another uses a tube made of polymer composite, which after being inflated with nitrogen is set hard by the sun's ultraviolet rays. A third design uses epoxy resin that is set hard by solvent evaporation.

The pair revealed their designs at this month's Fifth European Conference on Space Debris in Darmstadt, Germany, organised by the European Space Agency.

It's a good idea, says Peter Roberts,

"The aerobrake would be deployed after the rocket has delivered its satellite into low-Earth orbit"

a space-flight engineer at Cranfield University in the UK, who is working on similar technology for small satellites. "The risk of fragmentation of end-of-life spacecraft due to impacts from other debris can be greatly reduced by deploying a drag sail." Paul Marks ■



Beware exploding rockets

Blurry images reveal high-speed balls in a spin

FAST-moving balls can appear as blurry streaks in photographs and video stills. That is a problem for commentators examining disputed line calls and coaches studying how well golfers and table-tennis players control balls. Now a group of scientists in Italy have worked out how to determine a ball's path and spin from a single blurry image.

Motion-blurred images contain far more information about a ball's trajectory than frozen ones, say Alessandro Giusti and his colleagues from the Polytechnic of Milan, who have developed a way to extract this data.

Looking at the blurred streak of a moving ball in a photograph, it's easy enough for software to detect the angle at which the ball is moving left or right and up or down in relation to the camera. The difficulty comes in working out how the ball is moving towards or away from the camera. This can be done by measuring the changing width of the blur,

since the ball will appear smaller when it is further away. Existing software cannot do this because a motion-blurred image has transparent edges, confusing edge-detection algorithms.

Giusti and his colleagues have developed a new algorithm based

on the idea that a blurred image is equivalent to a series of sharp images added together. They calculated what a series of brief exposures would look like and were able to work out a formula that describes the transparency of the blur towards its edges.

The new algorithm uses this formula to determine where a ball's edge is and then to calculate the change in its distance from the camera (*Computer Vision and*

Image Understanding, vol 113, p 590). Exploiting information such as the colour of the ball and its background, the software can compensate for variations in lighting, which may affect how transparent the ball appears.

Knowing the exposure time and the size of the ball, the team can work out the speed and direction of a ball from relatively short smears. If the ball has some surface pattern, their software can even determine how it was spinning. This capability could be a useful training aid for sports such as golf in which players use the spin of the ball to control its trajectory. It should also be cheaper than existing devices, because it uses only one stills camera while other systems need coordinated video cameras to follow a ball's motion. "This would be great. 3D is very expensive," says Chris Swanner of Sports Motion in California, which develops video training systems.

Giusti says that a commercial application such as judging disputed line calls may still be some way off, as the team has yet to test its method on real sports in the field. **Stephen Battersby** ■



Spot the ball

House of straw stands firm in trial by earthquake

CHEAP houses built from straw bales could dramatically improve building safety in earthquake zones. That's the conclusion from tests in the US in which a simple straw bale house withstood shaking equivalent to a major earthquake.

Originally developed a century ago in Nebraska, homes with straw-bale walls are enjoying a revival in the US and Europe because they use green materials and provide excellent insulation. But the technology could also provide protection in quakes.

Civil engineer Darcey Donovan was designing straw-bale houses in Truckee, California, when she heard of the quake that had just killed more

than 75,000 people in the Kashmir region of northern Pakistan in October 2005. Most died when their homes collapsed. She volunteered to help with the recovery, and in May 2006 spent a month in the devastated area building a women's community centre made of straw bales. She was struck by the number of people who were homeless or living in tents yet who were afraid to return to or rebuild traditional stone-and-mud homes. "I had helped build one building, but I needed to do more," she says.

Realising that straw-bale houses might help, Donovan came up with a design that could be built cheaply with local materials. The foundations

are made with sacks of gravel, while the building's base uses clay and sand mixed with cement. Straw bales form the walls, which can then be covered with a plaster made from clay, sand and chopped straw. The roof is made of corrugated sheet metal. In western designs, the bales serve as insulation while a wooden frame supports the load, but Donovan was

"In the final test, which was stronger than the Kashmir quake, the plaster cracked but the house survived"

able to use the straw walls for structural support by keeping the houses to a single storey. Not only are the buildings sturdier than stone, they are much lighter, so a collapse is less likely to kill anyone inside.

Donovan has since founded the

Pakistan Straw Bale and Appropriate Building organisation to promote the idea. PAKSBAB has already helped local workers build nine homes in Kashmir, all of which are now occupied.

To test how the houses would fare in an earthquake, Donovan built one on a quake simulation table at the University of Nevada in Reno. In tests late last month, it stood through a series of eight quakes of increasing intensity. The plaster cracked and flakes crumbled off in the final run, when the accelerations reached 0.82 times the force of gravity - stronger than the 7.6-magnitude Kashmir quake - but the house survived.

"The structure did exceptionally well," says Ian Buckle, who runs the Reno test lab. Given refinements to speed up construction, he thinks the design has a great future in quake zones around the world. **Jeff Hecht** ■

What price civilisation?

Selling permits to emit carbon dioxide is fine in theory, but there's a fatal flaw that means it can never avert climate catastrophe, says **Andrew Simms**

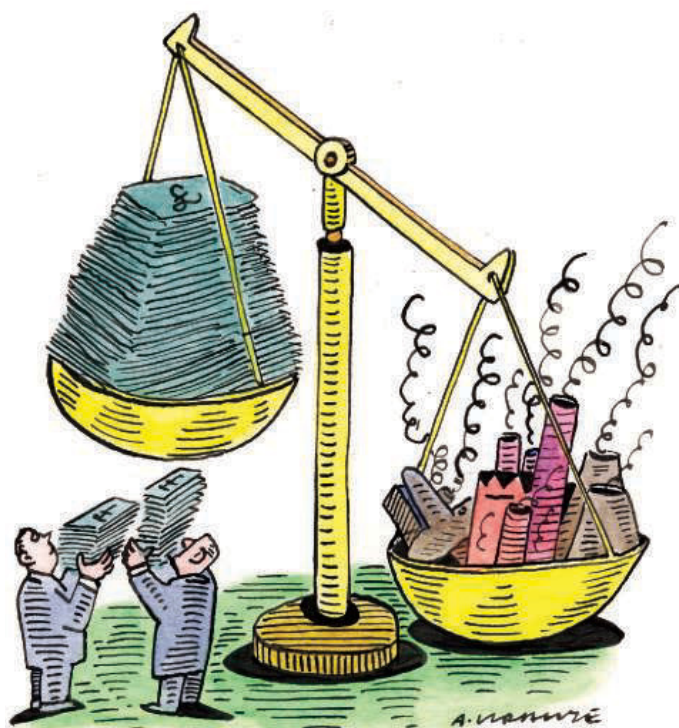
ONE day renewable energy looks like a sunrise industry, the next, tumbleweeds are blowing around a setting solar panel. What has changed? The price of emitting carbon dioxide.

In 2005 the European Union created the world's first proper carbon market, the EU Emissions Trading Scheme (ETS), which compels highly polluting industries to buy permits to emit CO₂. The number of permits is limited, so the idea is that supply and demand set a price that encourages the development of a low-carbon economy. A rising price with no wild fluctuations sends an economic signal to invest in clean energy. But it's not working.

The price of a tonne of CO₂ on ... the ETS has had a roller-coaster ride – soaring one minute, plummeting the next. In the past year it has lurched from over €30 to €8, and now languishes at around €10. Disastrously, such low and unpredictable prices for CO₂ remove the economic incentive to decarbonise economies.

This is the partly the result of the economic downturn. As heavy industries mothball factories, energy use drops and demand for permits goes down. At the same time businesses try to raise cash by selling their unused permits, flooding the market and further depressing prices. French energy company EDF recently complained that carbon markets were failing just like the market for subprime mortgages. As a result, all kinds of green energy schemes are grinding to a halt.

So how do you set a meaningful



price for carbon? The reality is more complicated than the ETS might suggest, which is a problem for those who advocate using market forces to reduce emissions. As NASA climate scientist James Hansen points out, getting it right or wrong could determine whether or not we can avert irreversible climate change.

Apart from the ETS, there are many ways to put a value on carbon. You can, for example, work out what it costs per tonne to reduce emissions. But calculating this “marginal abatement cost” is complicated by doubts over the effectiveness of carbon offsetting and the true impact of some supposedly green technologies.

Another method is the “social cost of carbon”, which estimates the cost of the damage from emitting a tonne of carbon over its whole lifetime in the atmosphere. This has been used by the UK treasury, and the Dutch government and the World Bank have experimented with it. But with so many variables to account for, estimates range from £35 to £140 per tonne. The UK has now dropped it for a new “shadow price of carbon”, an approach supported by the French

“If you needed a camel to cross a desert, what is a fair value for the straw that breaks its back?”

government and some members of the European Commission.

The shadow price is similar to the social cost but includes “other factors that may affect willingness to pay for reductions”, to use the UK government’s own words. It is “a more versatile concept”. In other words, it gives politicians some scope to rig the price. Although well intentioned, it is vulnerable to abuse.

Each of these methods has its advantages and disadvantages, but there is one problem that none can solve. I’ll call it the paradox of environmental economics, in which worthy attempts to value natural resources hit a wall.

The paradox is this. All these methods of pricing carbon permit the creation of a carbon market that will allow us to pollute beyond a catastrophic tipping point. In other words, they require us to put a price on the final “killing” tonne of CO₂ which, once emitted, tips the balance and triggers runaway global warming. How can we set such a price? It’s like saying, how much is civilisation worth? Or, if you needed a camel to cross a desert alive, what is a fair value for the straw that breaks its back?

The paradox reveals the fatal shortcoming of market solutions to environmental problems. Unless the parameters for carbon markets are set tightly in line with what science tells us is necessary to preventing runaway warming, they cannot work. That palpably did not happen with the ETS, which initially issued more permits to pollute than there

were emissions and now, in the recession, is trading emissions that don't exist – so-called hot air.

Carbon markets cannot save us unless they operate within a global carbon cap sufficient to prevent a rise of more than 2°C above pre-industrial temperatures.

Governments are there to compensate for market failure but seem to have a blind spot about carbon markets. They could counteract the impact of low carbon prices by spending on renewable energy as part of their economic stimulus packages, yet they have not done so. The UK, for example, has spent nearly 20 per cent of its GDP to prop up the financial sector, but just 0.0083 per cent in new money on green economic stimulus.

Price mechanisms alone are unable to do the vital job of reducing carbon emissions. They are too vague, imperfect, and frequently socially unjust. To prevent over-consumption of key resources such as fuel during the second world war, the UK government rejected taxation in favour of rationing because taxation unfairly hit the poor and was too slow to change behaviour. Rationing was the quicker, more equitable option. Carbon rations calculated in line with a safe cap on overall emissions provide a more certain way of hitting emissions targets.

Is there an answer to the paradox of environmental economics that could make the market approach workable? I can't imagine one, but am open to suggestions. Even if you could price the killing tonne, it is a transaction that should never be allowed. Economics becomes redundant if it can rationalise an exchange that sells the future of humankind. ■

Andrew Simms is author of *Ecological Debt: Global warming and the wealth of nations* (Pluto Press), and policy director and head of the climate change programme at nef (the New Economics Foundation)

VIEWFINDER

"Dealing with plastic bags is easy... It threatens no one, makes money for the shops and ensures that everyone feels better about themselves, while continuing to trash the biosphere just as we did before."

George Monbiot on Guardian.co.uk, complaining that making plastic shopping bags environmental enemy number one is distracting us from the real tasks we face

"The International Space Station, which serves no useful purpose anyway, should be given to China and the crew sent home on the Soyuz."

An open letter to President Obama from physicist **Bob Park** on his widely read *What's New* listserv

"The central myth which shields our failed drug laws from challenge and scrutiny is that decriminalization or legalization will cause an explosion of increased drug use. That is patently false."

Glenn Greenwald on Salon.com acknowledges the success of drug decriminalisation in Portugal



CHRIS COLLINS/CORBIS

Essential number

48

per cent of Americans think religion will help answer the US's problems, a *Newsweek* poll has found – the lowest proportion ever

The word

AGNOTOLOGY

The study of deliberately created ignorance – such as the falsehoods about evolution that are spread by creationists

Action on climate

From Les Carter

Gaia Vince discusses how we will cope if the Earth's temperature rises (28 February, p 28). It's time to face facts: if we don't reduce global greenhouse gas emissions by at least 70 per cent within five years, we will have blown it. Of course, what stands squarely in the way of what we must do is the will to do it.

Is it possible? The fundamental rule when managing complex systems is to supply the right information at the right time, which points the system in the right direction. At present, the world's people don't have this information. If they are going to make the right decision in time, our scientists, politicians and media need to stop lying to them. We don't "need" more energy, we don't "need" economic stimulus, we don't even "need" jobs. What

we do need is a stable climate. *Rosslund, British Columbia, Canada*

From Nelson Dale

My view on climate change is radically different: there is a growing body of experience and interest in low-tech, systems-based, ecological approaches to the global climate crisis. It is possible, and not technically difficult, to sequester carbon in living ecosystems, such that large areas of currently desertified land could be transformed into productive rangeland.

While most technological fixes seem to imply incalculable side effects in unexpected areas, the effect of this kind of approach is increased land productivity, something that will be desperately needed in the coming years. Rather than merely surviving the coming century, let's restore its promise. *Bedford, Massachusetts, US*

Saltwater power

From Richard Durrant

Peter Fournier writes that proposals to produce electricity in Norway by osmosis of fresh water into seawater are impractical (4 April, p 23). Like so many "green" ideas, it suffers from remote location and low power density.

However, the idea could be applicable in Australia: an evaporating pond in inland Queensland could produce very salty water which could be used to produce high-pressure brine by uptake of water from brackish groundwater resources. The pressurised water could generate electricity and then return to the evaporating pond.

Some water in Queensland is alkaline due to the sodium bicarbonate content. This would help protect the osmotic membranes by keeping other metal ions out of solution. *St Albans, Hertfordshire, UK*

There are researchers who share some of Siegel's concerns with regard to a dogmatic view of the risks of smoking. However, a constructive attitude to criticism would be more helpful when contributing to the debate about this health problem, which kills more people than any other single risk factor. *Sydney, Australia*

Cold fusion

From Steven Krivit

The article "Many happy returns for cold fusion" contained a subtle but significant ambiguity (28 March, p 10). The article mentions my scepticism of "cold fusion" as a theoretical explanation for the low-energy nuclear reaction experimental phenomena, but fails to mention other theoretical models for these phenomena which also propose nuclear processes, namely, neutron-catalysed weak interaction processes. According to several experts, at least one of these models appears to be a viable explanation. *San Rafael, California, US*

No smoke without

From Simon Chapman, School of Public Health, University of Sydney
Michael Siegel's claim of censorship as described in David Robson's article on tobacco policy (4 April, p 34) effectively casts him as the enlightened Galileo to tobacco control's blinkered church. In fact, the international tobacco control community not only tolerates debate on scientific and policy matters, but actively encourages it.

In the past year I have published a lengthy critique of outdoor smoking bans (see <http://tobacco.health.usyd.edu.au/index.htm>) and criticised the overmedicalised view of the smoking cessation process in *The Lancet* (vol 373, p 701). My argument against attempts to ban scenes of smoking in movies played an important part in overturning the Indian government's proposed legislation on the subject.

Converting Dawkins

From Reginald Le Sueur

Mary Midgley states that "many are anticipating [Richard Dawkins's] conversion with some interest" (21 March, p 22). I think it very likely that, when the time

Enigma Number 1541

Box clever

SUSAN DENHAM

Put a digit in each of the following boxes so that (counting all the occurrences of digits in this Enigma from here until the final question) the following statements are true.

- The number of occurrences of the digit 0 is
- The number of occurrences of the digit 1 is
- The number of occurrences of the digit 2 is
- The number of occurrences of the digit 3 is
- The number of occurrences of the digit 4 is
- The number of occurrences of the digit 5 is
- The number of occurrences of the digit 6 is
- The total number of occurrences of the digits 7, 8 and 9 is
- The average of the previous boxes is
- The highest of the number of occurrences of 0, 1, 2 and 3 is

Please list, in order, the digits in the boxes.

WIN £15 will be awarded to the sender of the first correct answer opened on Tuesday 19 May. The Editor's decision is final. Please send entries to Enigma 1541, New Scientist, Lacon House, 84 Theobald's Road, London WC1X 8NS, or to enigma@newscientist.com (please include your postal address).

Answer to 1535 Back to front: The lower 6-digit number is 109989

The winner Robert Crowe of Wallingford, Oxfordshire, UK



comes, evangelists will be queuing up to try to convert him on his deathbed, hoping to make Lady Hope-style conversion claims as they did with Charles Darwin.

Dawkins has, I believe, stated that he will have a running tape recorder secreted about his person – so such people should beware, lest they are caught in the act.

St Peter, Jersey, Channel Islands

Natural-born belief

From Sebastian Hayes

M. Bell argues that science is independent of great names while religion is not (7 March, p 24). Certainly, other intelligent beings would develop science of a kind, but there is no reason for it to have much in common with, say, Newton's billiard-ball vision of the universe. Newton's view was specific to the time and place where it originated. It was also erroneous: for instance, "atoms" are not indivisible.

By contrast, it is possible to claim a universality of religious attitude. Religion is more concerned with human behaviour than truth. All the major religions promote an attitude of awe towards the creator of the physical universe and an attitude of unselfish concern for our fellow human beings.

The extent to which believers actually put into practice these high principles is, of course, a different matter, but this is also true of so-called "scientific objectivity".

Shaftesbury, Dorset, UK

We need lab animals

From Leigh Jackson

Vicky Robinson claims that common ground can be found between scientists and opponents of animal research through the three Rs: the replacement, reduction and refinement of

scientific procedures on animals (7 March, p 22).

Unfortunately, many anti-vivisectionists reject two assumptions on which this approach is predicated: that knowledge gained from animal research can be applied to humans, and that alternative methods of gaining the same information are not always available. Instead, they claim that animal research is not relevant to humans because of species differences, and that alternatives already exist in all cases.

I wish Robinson well in her quest and in her capacity as chief executive of the National Centre for Replacement, Refinement and Reduction of Animals in Research (NC3Rs) in the UK. Animal research still has relevance to humans, and alternatives are not always available.

London, UK

Super power

From Jonathan West

I'd like to say "no thanks" to the intercontinental electrical supergrids discussed in the "Green grid" feature (14 March, p 42). Adopting them would make us more vulnerable than ever to the whims of countries from or through which the cables pass, and they would be easy targets for any would-be attacker intent on causing disruption.

Instead, the future of energy should lie in the use of multiple small-scale, local power plants using waste, solar and mini nuclear fission reactors.

Exeter, Devon, UK

Relativity rage

From Alice Poppleton

"I didn't notice hordes of physicists in a frothing rage when the line 'Why Einstein was wrong about relativity' appeared on your cover", Paddy Shannon wrote (14 March, p 24, regarding



1 November 2008 issue). While not frothing with rage, Brian Newham did point out that the problems in Einstein's theories were those of language rather than of physics (6 December, p 22).

It should be noted that the "Einstein was wrong" issue came with the subtitle "The speed of light is nothing special", which is rather less inflammatory than your subtitle to your "Darwin was wrong" issue, which was "Cutting down the tree of life".

While people have overreacted somewhat, it was a bit of a disappointment that the promised article about Darwin being wrong was just about his tree model being insufficient. This was the best he could possibly have done at the time, so really it wasn't about Darwin being wrong at all – it was a lot more interesting than that.

Sydney, Australia

Illness and the mind

From Joerg Hofmann

Simon Wessely's interpretation of certain medical conditions as having a psychological component makes perfect sense to me (14 March, p 26). We cannot blame our mind for everything, but it undoubtedly plays a major role in many illnesses, as I know from personal experience.

I suffered from irritable bowel syndrome (IBS) from early childhood, though at that time I did not know what was wrong with me. The constant worry

haunted me until my early 30s when, after many visits to doctors, someone finally suggested IBS. Reading up on the condition and realising that it was benign, I stopped worrying about it. Almost 11 years on, I haven't had any further bouts of IBS.

Sydney, Australia

Get knitted

From Robert Cailliau

Keith Tritton's suggestion of knitting patterns as a metaphor for DNA are indeed a much better analogy than a blueprint (21 March, p 22).

Some decades ago *New Scientist* published an article on random knitting patterns and I realised they could be used to encode anything into a sweater. I convinced my wife to knit the first 500 digits of pi for me,



resulting in an attractive, if erratically decorative, pullover. It strikes me, though, that the same technique would not be able to represent a great deal of my genome.

Preveessin-Moens, Ain, France

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The reason I chose that one is...

Suppose you were getting married and someone tried to switch your partner at the altar. Of course you'd notice the substitution, but prepare to be amazed at how easy it is to subvert other choices you hold dear, say **Lars Hall** and **Petter Johansson**

WE HAVE all heard of experts who fail basic tests of sensory discrimination in their own field: wine snobs who can't tell red from white wine (albeit in blackened cups), or art critics who see deep meaning in random lines drawn by a computer. We delight in such stories since anyone with pretensions to authority is fair game. But what if we shine the spotlight on choices we make about everyday things? Experts might be forgiven for being wrong about the limits of their skills as experts, but could we be forgiven for being wrong about the limits of our skills as experts on ourselves?

We have been trying to answer this question using techniques from magic performances. Rather than playing tricks with alternatives presented to participants, we surreptitiously altered the outcomes of their choices, and recorded how they react. For example, in an early study we showed our volunteers pairs of pictures of faces and asked them to choose the most attractive. In some trials, immediately after they made their choice, we asked people to explain the reasons behind their choices.

Unknown to them, we sometimes used a

PROFILE

Lars Hall and Petter Johansson lead the Choice Blindness Laboratory at Lund University, Sweden. Johansson is also affiliated with the ERATO Shimojo Implicit Brain Function Project and the University of Tokyo, Japan. Their 2005 *Science* paper on change blindness initiated wider interest in the field.

double-card magic trick to covertly exchange one face for the other so they ended up with the face they did not choose. Common sense dictates that all of us would notice such a big change in the outcome of a choice. But the result showed that in 75 per cent of the trials our participants were blind to the mismatch, even offering "reasons" for their "choice".

We called this effect "choice blindness", echoing change blindness, the phenomenon identified by psychologists where a remarkably large number of people fail to spot a major change in their environment. Recall the famous experiments where X asks Y for directions; while Y is struggling to help, X is switched for Z – and Y fails to notice. Researchers are still pondering the full implications, but it does show how little information we use in daily life, and undercuts the idea we know what is going on around us.

When we set out, we aimed to weigh in on the enduring, complicated debate about self-knowledge and intentionality. For all the intimate familiarity we feel we have with decision-making, it is very difficult to know about it from the "inside": one of the great barriers for scientific research is the nature of subjectivity.

As anyone who has ever been in a verbal disagreement can attest, people tend to give elaborate justifications for their decisions, which we have every reason to believe are nothing more than rationalisations after the event. To prove such people wrong, though,



or even provide enough evidence to change their mind, is an entirely different matter: who are you to say what my reasons are?

But with choice blindness we drive a large wedge between intentions and actions in the mind. As our participants give us verbal explanations about choices they never made, we can show them beyond doubt – and prove it – that what they say cannot be true. So our experiments offer a unique window into confabulation (the story-telling we do to justify things after the fact) that is otherwise very difficult to come by. We can compare everyday explanations with those under lab conditions, looking for such things as the amount of detail in descriptions, how coherent the narrative is,



Would you really notice if someone swapped your choice for an alternative you had rejected?

the emotional tone, or even the timing or flow of the speech. Then we can create a theoretical framework to analyse any kind of exchange.

This framework could provide a clinical use for choice blindness: for example, two of our ongoing studies examine how malingering might develop into true symptoms, and how confabulation might play a role in obsessive-compulsive disorder.

Importantly, the effects of choice blindness go beyond snap judgements. Depending on what our volunteers say in response to the mismatched outcomes of choices (whether

they give short or long explanations, give numerical rating or labelling, and so on) we found this interaction could change their future preferences to the extent that they come to prefer the previously rejected alternative. This gives us a rare glimpse into the complicated dynamics of self-feedback (“I chose this, I publicly said so, therefore I must like it”), which we suspect lies behind the formation of many everyday preferences.

We also want to explore the boundaries of choice blindness. Of course, it will be limited by choices we know to be of great importance in everyday life. Which bride or bridegroom would fail to notice if someone switched their partner at the altar through amazing sleight

of hand? Yet there is ample territory between the preposterous idea of spouse-swapping, and the results of our early face experiments.

For example, in one recent study we invited supermarket customers to choose between two paired varieties of jam and tea. In order to switch each participant’s choice without them noticing, we created two sets of “magical” jars, with lids at both ends and a divider inside. The jars looked normal, but were designed to hold one variety of jam or tea at each end, and could easily be flipped over.

Immediately after the participants chose, we asked them to taste their choice again and tell us verbally why they made that choice. Before they did, we turned over the sample containers, so the tasters were given the opposite of what they had intended in their selection. Strikingly, people detected no more

“Choice blindness drives a wedge between intentions and actions in the mind”

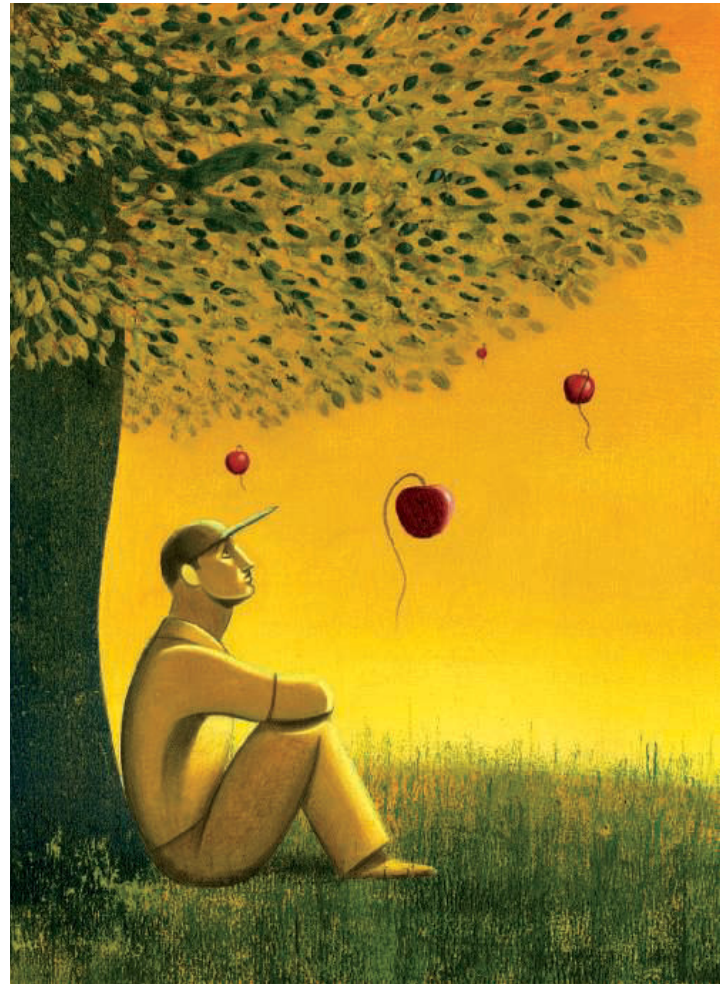
than a third of all these trick trials. Even when we switched such remarkably different flavours as spicy cinnamon and apple for bitter grapefruit jam, the participants spotted less than half of all switches.

We have also documented this kind of effect when we simulate online shopping for consumer products such as laptops or cellphones, and even apartments. Our latest tests are exploring moral and political decisions, a domain where reflection and deliberation are supposed to play a central role, but which we believe is perfectly suited to investigating using choice blindness.

Throughout our experiments, as well as registering whether our volunteers noticed that they had been presented with the alternative they did not choose, we also quizzed them about their beliefs about their decision processes. How did they think they would feel if they had been exposed to a study like ours? Did they think they would have noticed the switches? Consistently, between 80 and 90 per cent of people said that they believed they would have noticed something was wrong.

Imagine their surprise, even disbelief, when we debriefed them about the nature of the experiments. In everyday decision-making we do see ourselves as connoisseurs of our selves, but like the wine buff or art critic, we often overstate what we know. The good news is that this form of decision snobbery should not be too difficult to treat. Indeed, after reading this article you might already be cured. ■

PETERCADE/CONICA/GETTY



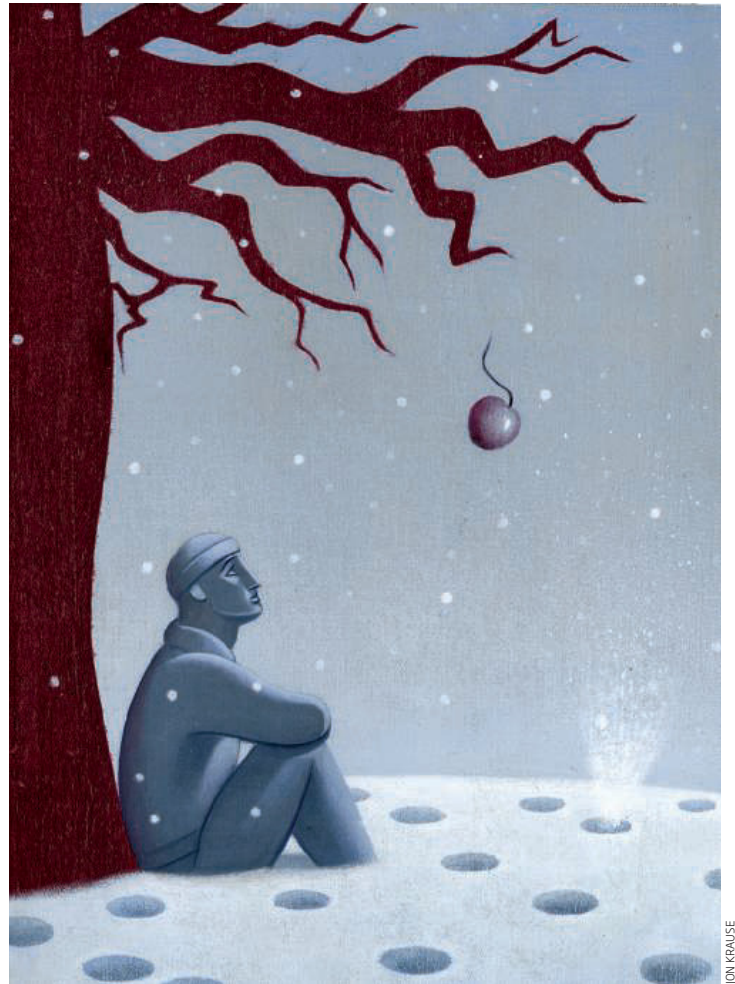
Gravity's seasons

Does an apple fall faster in the spring?
Marcus Chown investigates

EVERYONE has heard of Newton's apple. He watched it drop to the ground in the autumn of 1666, prompting him to ask a series of questions. "Why should that apple always descend perpendicularly to the ground?" Newton wondered. "Why should it not go sideways or upwards, but constantly to the Earth's centre?"

One question Newton didn't ask is whether apples or oranges fall differently. Or whether an apple would fall differently in the spring. They might seem peculiar concerns, but Alan Kostelecký, a physicist based at Indiana University in Bloomington, thinks they are important. He and his graduate student Jay Tasson have found that such flagrant violations of our best theory of gravity could easily have evaded detection for centuries.

What's more, in a paper published in *Physical Review Letters* (vol 102, p 10402), the pair have shown that investigating such unlikely-seeming possibilities could help us



JON KRAUSE

work out what makes the universe tick. “We have made a surprising and delightful discovery,” Kostecký says. “We might just catch a glimpse of the ultimate theory that underpins our universe.”

This is the culmination of 20 years’ work for Kostecký. In 1989, he began to think about how to find a glitch in our best understanding of how the universe works, as provided by two great theories. The first is general relativity, Einstein’s theory of how gravity works. The other is the standard model of particle physics, a quantum description of the matter around us and of all forces other than gravity.

At the moment, relativity and the standard model are incomplete. General relativity breaks down when gravity is very strong – when describing the big bang, for example, or the heart of a black hole. And the standard model has to be stretched to breaking point to account for the masses of the universe’s fundamental particles. The two theories are

also incompatible, having entirely different notions of time, for instance. This has made it impossible to unite the two in a single “theory of everything”.

The trouble is, despite their faults, relativity and the standard model are very good theories. Taken separately, they describe

“We might just catch a glimpse of the ultimate theory that underpins our universe”

perfectly almost all physical phenomena known to science. If we want to know what the theory that unites them is going to look like, we have to find things that they cannot explain. “The challenge is to find those phenomena,” says Kostecký. This is what he and Tasson think they might now be able to do.

They have begun by launching an attack on an almost sacred premise of physics, known as Lorentz symmetry. This says that the laws of physics appear the same for anyone moving at uniform speed relative to you, whatever their orientation in space.

One consequence of Lorentz symmetry is that the universe should be isotropic: whichever way you look or travel, everything seems pretty much the same and behaves in the same way. There is no “up” or “down”, and there is no direction in which light, people or planets can travel more easily.

So far, nothing in the universe has been shown to breach Lorentz symmetry. But that doesn’t mean that Lorentz symmetry is inviolable. It just means that we may have been looking in the wrong place so far, or that experiments that have looked for symmetry violations have not been sensitive enough.

Kostecký and Tasson have not picked on Lorentz symmetry at random. Various

attempts to build a theory of everything have all suggested that it might break down. Among the most well known are approaches called string theory and loop quantum gravity.

Kostelecký hasn't pinned his hopes to a particular theory of everything, however. Instead he has taken a more open-ended approach that he hopes will give us an idea of where to look for Lorentz symmetry violations and inform future theories.

He and his colleagues use general relativity and the standard model as their starting point, then suggest ways to violate symmetry. They do this by positing that the universe is filled with as-yet unknown force fields that impose a "preferred" direction on space and therefore violate symmetry. The result is a theory Kostelecký calls the standard model extension, or SME.

By including all known forces and particles, and how they might interact with the new force fields, the SME exposes an assortment of hitherto ignored phenomena that might provide an observable violation of Lorentz symmetry. "Currently, experimentalists are working their way through the list," says Kostelecký.

So far they have drawn a blank. Researchers have looked at whether clocks tick faster in certain orientations in space, or whether the magnetic field of a material, which is created

by the spin of electrons within it, changes with the orientation of the electrons' spin axis. So far, they have found nothing.

However, this doesn't mean we can assume that the force fields in the SME don't exist. Some fields may be invisible to photons, but visible to other particles like neutrinos. Or perhaps a field interacts strongly with gravity, but not with electromagnetism.

To see how the idea works, imagine one of Kostelecký's SME fields – let's call it the "X-field" – running through our solar system.

"It seems very likely that we are missing something huge in physics. It is definitely worth testing"

The X-field, like a magnetic or electric field, has an orientation that can be pictured as a series of arrows. What happens when a particle such as a neutron or proton passes through it?

For starters, the field might impose a subtle effect on the particle's spin, or create a small phase shift in its trajectory. Or it could be that different types of particle respond differently to the field.

We have never noticed any such effects, so we have never detected any such field. But

Kostelecký and Tasson point out that we may not have been looking in the right way. If the X-field and the sun's gravity affect each other, there may well be effects we haven't noticed.

Such interactions between the X-field and gravity could be a rich seam for scientists to mine. Kostelecký and Tasson's latest calculations show that these interactions could produce symmetry violations as much as 10^{30} times bigger than some of the ones that researchers have attempted to find so far.

That won't make the violations easy to detect, though: compared to the other fundamental forces, gravity is astonishingly weak, so variations caused by the X-field would still be very hard to measure.

One way we might find evidence of the X-field is to look for small differences in gravity's power at different times of the year. "Apples might fall at different rates in different seasons," says Kostelecký, though he can't predict when apples might fall faster. "It will be a cyclical effect."

This is because the gravitational pull of the sun could warp the X-field slightly. According to Kostelecký's calculations, gravity causes the X-field's arrows to tip towards the sun by an amount that depends on the strength of the gravitational field at that location (see diagram). Suitably designed experiments might be able to detect how a particle's behaviour varies as the Earth circles the sun, due to this variation in the X-field at different locations in space.

Another possibility that Kostelecký and Tasson raise is that the X-field affects different particles in different ways. For example, each type of quark might "feel" the X-field to differing degrees. Or perhaps the number of electrons in an atom will determine how that atom couples to the field, and thus to gravity. It could even be that a combination of factors – for example the constituent particles of atoms and their position in space – will shape the finer details of how different objects couple to the X-field and gravity, producing unexpected effects. "Apples and oranges may fall at different rates," Kostelecký says.

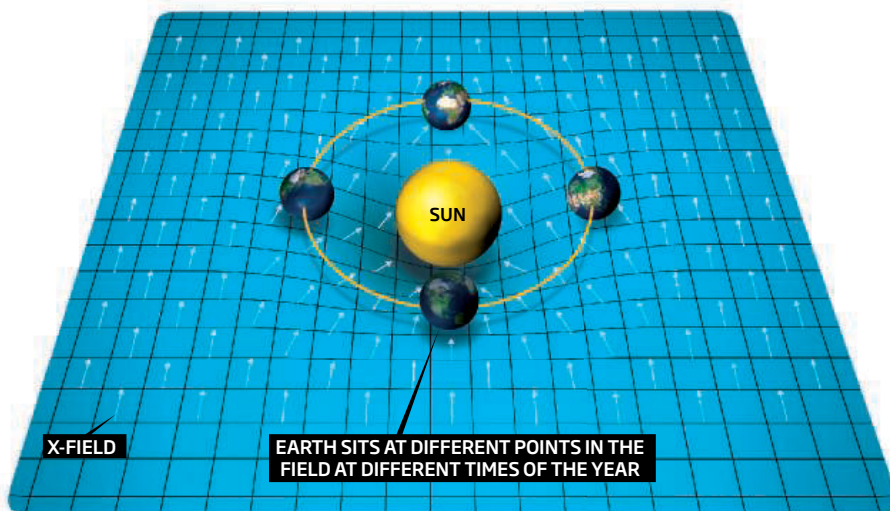
The search begins

Though it might sound like a long shot, Kostelecký and Tasson's paper offers an exciting new insight, says physicist Mike Tobar at the University of Western Australia in Crawley. "This is an important development," he says. Ronald Walsworth of Harvard University agrees: "I expect several experimental groups will now search

Can you feel the force?

The universe may contain an as-yet undiscovered force, dubbed the X-field. If this is affected by the sun's gravity, its orientation would vary at each point in space. This variation might be our best hope of discovering such a field

The field's influence could be exposed by carrying out sensitive experiments, such as how fast an object falls under gravity, which might give different results at different times of the year





JON KRPAUSE

for the effects Kostelecký is proposing.”

So where will they begin? As the effects will show up as anomalies in the way particles respond to gravity, Kostelecký and Tasson have proposed testing a modified version of Newton’s universal law of gravitation. The idea is to see whether it is consistent when applied to varying combinations of particles – protons, neutrons and electrons – at different times and in different places. So far, only a tiny fraction of this new range of possible effects has been investigated.

One such investigation, by Eric Adelberger’s group at the University of Washington in Seattle, searched for a difference in the ways titanium and beryllium respond to gravity.

“The Adelberger experiment does the analogue of comparing the fall of an apple and

an orange at the same time,” Kostelecký says.

No one is under any illusions. If there is a difference in gravity’s pull for these different elements, it is going to be very small. This is why the Washington researchers got involved: they are experts at using excruciatingly sensitive torsion balances, which measure the gravitational pull between two masses, to probe this kind of situation.

In order to carry out the experiment, they also had to shield their balance from electric and magnetic fields and vibrations from nearby laboratories, while also compensating for the varying gravitational pull of the underground water table as it rose and fell at different times of year.

In the end, however, they found that there was no difference in the coupling of

beryllium and titanium to gravity – to 1 part in 100 billion, at least.

Kostelecký is undaunted. Adelberger’s experiment tested only one kind of interaction between the hypothetical field and gravity. Kostelecký believes that experiments carried out at different times of year might expose another aspect of the coupling. With the changing seasons, the relative orientation of the Earth’s velocity and the X-field’s arrows would change significantly.

If that fails, there are other options, including scope for antimatter to unravel the symmetry of the universe. “Apples and anti-apples may fall at different rates,” Kostelecký says. This idea is even harder to explore: accumulating enough antimatter to make a body the mass of an apple, for instance, is beyond our current technological capabilities. Anti-hydrogen atoms have been made, though, and efforts are under way to see whether they fall differently to hydrogen atoms. “We may get results within the next decade,” Kostelecký says.

Kostelecký is outlining other experiments that might reveal the fields postulated by the SME. Superconducting gravity sensors, lasers that probe the distance to the moon, atom interferometers and upcoming satellite-based gravity experiments such as microSCOPE and STEP; any or all of these might help find where that infuriating symmetry breaks down, and where that elusive ultimate theory of the universe has to kick in.

Well, that is the hope. Though Walsworth agrees that such experiments are important, he is not yet convinced they will reveal any symmetry violations. “It is not in any way certain that they exist, or that we humans will ever have the ability to find them,” he says.

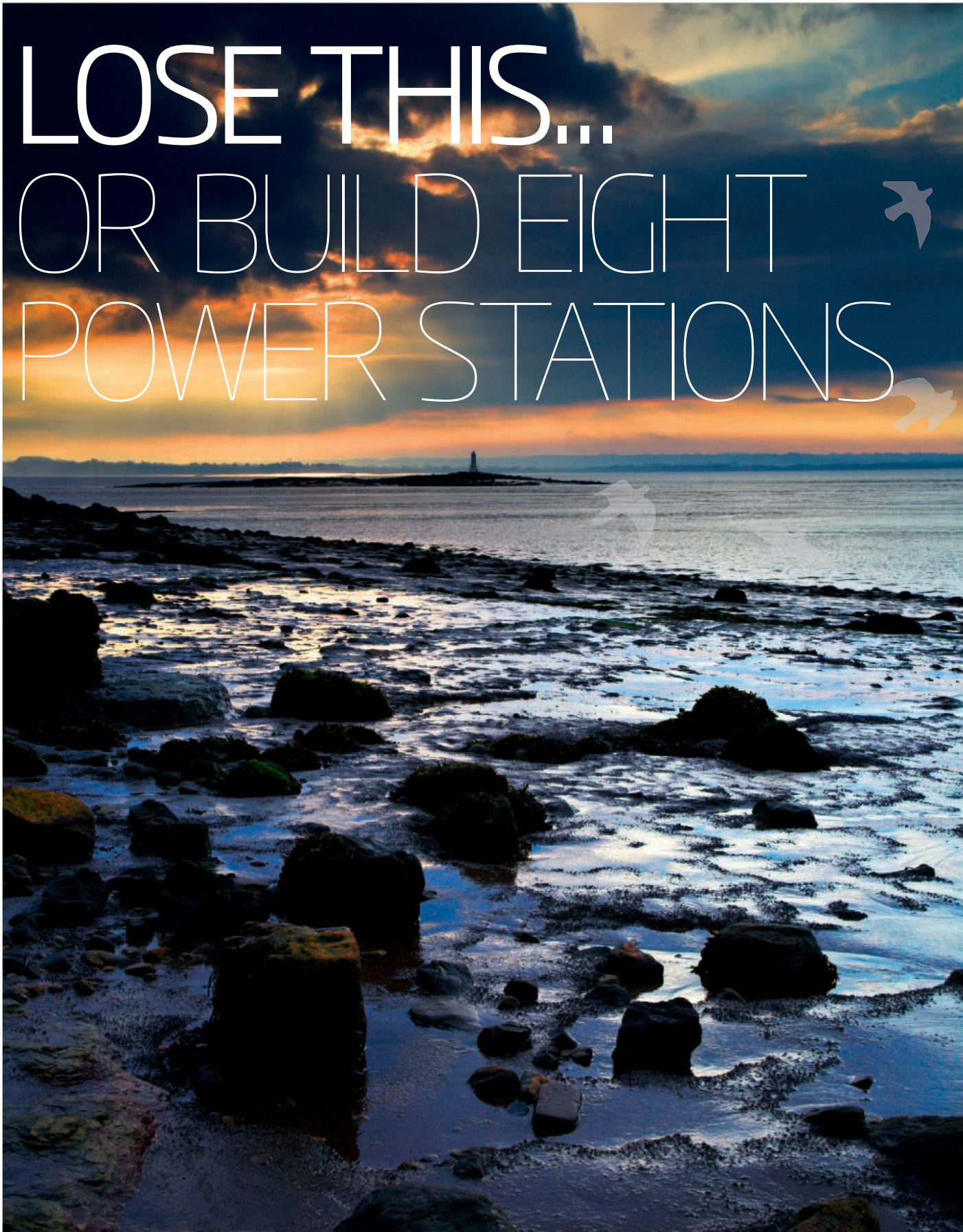
Adelberger is also cautious about the prospects, but thinks we should look anyway. He believes that the problem with reconciling relativity and quantum theory is so great that we cannot afford to leave any of our cherished principles untested. “It seems very likely that we are missing something huge in physics,” Adelberger says. “I would be surprised if large Lorentz-violating effects are present, but it is definitely worth testing to see if nature respects my prejudices.” ■

Marcus Chown’s latest book is *Quantum Theory Cannot Hurt You* (Faber, 2008)

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LOSE THIS... OR BUILD EIGHT POWER STATIONS



DAVID CHESHIRE PHOTOGRAPHY/PHOTOGRAPHERS DIRECT

As green tech scales up, environmentalists are facing some tough choices. Fred Pearce reports

YOU can understand the frustration on both sides. Environmentalists worldwide are clamouring for bold action to end the burning of fossil fuels and plug the world into renewables. Politicians throw their weight behind a \$14 billion scheme that would replace the equivalent of eight coal-fired power stations with tidal power. What do they get for their pains? Green outrage.

“This massively damaging proposal cannot be justified,” said Graham Wynne, chief of the UK’s normally staid Royal Society for the Protection of Birds (RSPB). Friends of the Earth said it was “not the answer”. What is going on here? Have greens lost the plot? Has environmentalism been hijacked by big construction companies? Or do we simply have to learn that even environmental energy comes at an environmental cost?

The project causing all the controversy is the Severn barrage on the west coast of Britain, but similar stories are playing out across the world. As greens gradually win the argument for switching to renewable energy, they are finding that they don’t always like the look of the new world they are creating.

The problem is one of scale. Bigness is often an issue for greens, many of whom grew up reading one of the movement’s key texts: E. F. Schumacher’s *Small Is Beautiful*. They liked biofuel while it was about recycling cooking fat, but not when it became growing millions of hectares of palm oil in former Borneo rainforest. Solar panels on roofs are good, but covering entire deserts with them is another matter. They like small wind turbines and even small wind farms, but get very jumpy as wind power reaches industrial scale.

Small may be beautiful, but it won’t change the world. You can’t generate vast amounts of green energy without large-scale



KEVIN ALLEN/LAMY

Is the Severn estuary more valuable for its green energy or its wildlife?

engineering projects, which inevitably do some damage to the natural environment.

Greens have been here before, to some extent. Once, long ago, they loved large dams. From the 1930s to the 1960s, hydroelectricity was regarded as the new, clean and cheap source of electricity. Nobody cared about climate change then, but they did care about the killer smogs from burning coal. From the Rockies to the Alps, from Scandinavia to the Tennessee valley, nature would be harnessed to provide clean power for the masses. Woody Guthrie once wrote a song about the splendours of the Grand Coulee dam on the Columbia river: *Roll along, Columbia, you can ramble to the sea, but river, while you’re rambling, you can do some work for me* he sang in 1941.

All that started to change in the 1960s after engineers tried to dam the Grand Canyon on the Colorado river and hikers rebelled. By the mid-1990s opposition to large dams had grown so intense that the World Bank stopped funding them for several years. Even after green projects became a major priority for most government aid agencies, none of them would touch China’s Three Gorges dam on the Yangtze river, even though it replaces some 20 large coal-fired power stations. Projects like the Severn barrage are now provoking similar opposition.

The Severn estuary is a natural marvel. The British coastline has some of the highest tidal ranges (the difference between high and low tides) in the world, and the long funnel shape of the estuary gives it a tidal range that peaks at more than 13 metres, the largest in the world apart from the Bay of Fundy on the east coast of Canada. The tidal surge is so strong that spring tides create a wave running upriver, known as the Severn bore.

In January, the UK government announced its intention to go ahead with a major project to extract energy from the Severn’s tidal range. The most likely option is a giant 16-kilometre barrage across the estuary, though the shortlist includes four smaller projects (see map and diagram, page 35).

First proposed 35 years ago, the full barrage would trap more than 400 square kilometres of tidal estuary behind a wall of concrete and sand. As the tide rises, sluice gates would be opened to let water in. At high tide the sluices would be slammed shut and the outrushing water forced through turbines. The barrage’s theoretical peak generating capacity would be 8.6 gigawatts, enough to supply 5 per cent of the UK’s electricity and 35 times as much as the largest existing tidal power plant, on the ➤

"A wind farm, a tidal barrage that turns a great river into a millstream, a carpet of solar panels on the Sahara... all are a desecration"

Rance estuary in France. Its lifetime might be more than a century, several times that of a conventional power station.

Ironically, the estuary's enormous tidal range is also key to what the RSPB calls its "truly exceptional ecological value" – hundreds of square kilometres of intertidal mud flats, sand banks and salt marshes, around half of which the barrage would obliterate.

In the parts of the estuary enclosed by the barrage, low tide would be about 5 metres higher than before, meaning that much of the intertidal zone would be permanently flooded, including 190 square kilometres of treasured wildlife habitat that is home to 70,000 birds in winter. The surviving flats might compensate by hosting more wildlife, but nobody can be sure. The barrage would also be a barrier to migrating eels and salmon. Even the famous bore might disappear. Friends of the Earth says the barrage will "wreck one of the most important wildlife sites in Europe".

Unfortunately there is nowhere like it for a tidal barrage. Engineers have identified other potential sites to tap the UK's exceptional tidal range, including Morecambe Bay, the Solway Firth and the Wash. But because the electricity-generating potential of tides is equivalent to the square of the tidal range, the exceptional range of the Severn estuary means it has about 80 per cent of the potential national resource.

One alternative is to ditch the full barrage and replace it with lagoons along the estuary's coasts, which would generate electricity while saving some habitats. Lagoons are on the

shortlist, but engineers advising the government say they would deliver less.

Or how about directly tapping tides for their strong currents? The idea is to create an underwater version of a wind farm, with turbines attached to the sea bed in areas where strong currents flow, such as through channels and around headlands. The engineering company Metoc has identified 20 coastal areas where this could be done around Britain, the best sites being the Pentland Firth between mainland Scotland and Orkney, and around the Channel Islands.

Jewel in the crown

The problem is, nobody knows for sure how much power might be generated from tidal currents. The upper theoretical limit from all 20 sites combined is about the same as from the Severn barrage alone, but the technology is at a much earlier stage of development, and the most promising sites are remote from the transmission grids that carry power to customers. Nonetheless, the Scottish government has singled out the Pentland Firth as the "jewel in the crown" for its plans to exploit renewable energy.

There appears to be no getting away from the fact that only big projects can deliver big quantities of renewable energy, and this inconvenient fact is dividing green opinion. The UK government's Sustainable Development Commission, chaired by the former director of Friends of the Earth Jonathon Porritt, has come out in favour

of the barrage. It concluded at the end of 2007 that, provided alternative habitat could be created for the birds, the barrage should be built. Porritt said "the enormous potential to reduce our carbon emissions" outweighed the environmental harm. He made some enemies that day.

Wind power is another front line. Studies of the windiness of onshore Europe have showed that most of the wind is in upland regions loved for their scenic beauty. This is particularly true in the UK, which has an estimated 40 per cent of Europe's exploitable wind and could make a big contribution to European Union targets for generating a fifth of its power from renewables by 2020. But most of this wind blasts into the Scottish Highlands, and tapping it means putting big turbines on highly visible hilltops.

Many say the solution for wind is to put it offshore. The winds are stronger, there are no neighbours, and turbines can be bigger. One bit of sea usually looks much like another. But even then the issues don't go away.

Again the UK exemplifies the problem. Plans for 10 wind farms off the coast of Scotland received a preliminary go-ahead this year. But Scottish waters have 45 per cent of Europe's breeding seabirds, many living around the reefs and shallows favoured for wind farm sites. Another concern is noise. There is good evidence that piledriving during turbine construction frightens away marine mammals and maybe fish too.

In the US, too, offshore wind farms are creating dilemmas. The 130-turbine Cape Wind project for Nantucket Sound, off the coast of Massachusetts, promises to be the US's first offshore wind farm – as soon as an already decade-long permit process is completed. The delay has been caused largely by objections from influential residents, including the Kennedy family, who say their view of the ocean will be spoiled. The battle has split the local environmental movement, culminating in Greenpeace organising street protests against Robert Kennedy Jr, an environmental lawyer and prominent opponent of the project.

Another emerging battleground is transmission. Scotland is debating whether to build a £300 million high-voltage power line linking the wind farms of the Highlands to the population centres of lowland Scotland and England. The cheapest way to do this would be to run overhead cables through the Cairngorms National Park. Undersea cables would be aesthetically preferable but would cost much more.

Scotland's dilemma will soon be writ large elsewhere. Most renewable sources of energy are intermittent. The wind is a byword for variability. The tides are predictable, but they ebb and flow to their own rhythm. Solar too comes and goes: the sun's rise and fall may be predictable, but clouds are not.

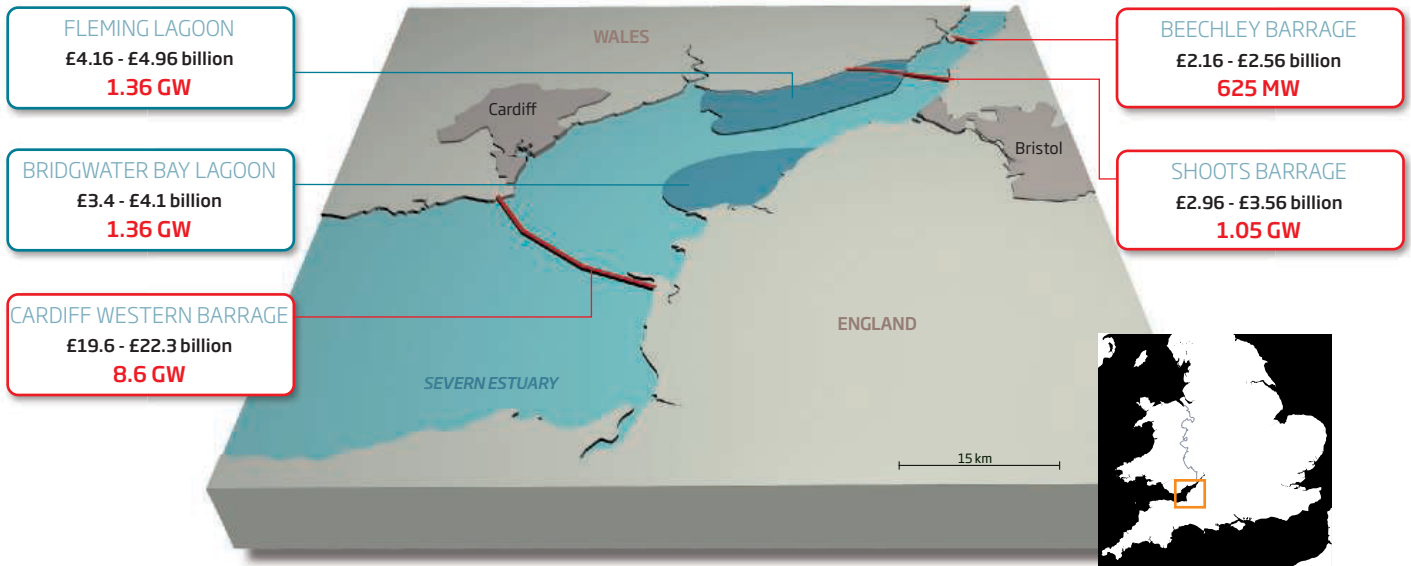


TOBY SMITH/CONSTRUCTION PHOTOGRAPHY

Green icon or blot on the landscape?

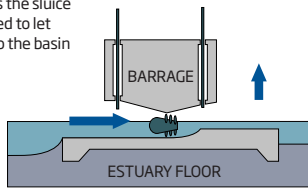
Hero or villain?

Five projects have been shortlisted for extracting energy from the tidal range of the Severn estuary on the west coast of Britain

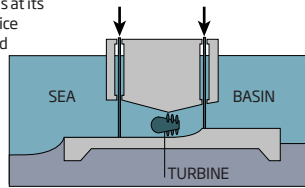


Tidal barrages exploit the potential energy stored in water

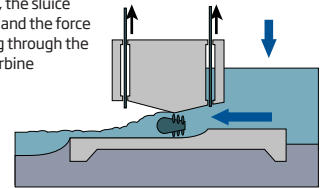
As the tide rises the sluice gates are opened to let water move into the basin



When the tide is at its highest the sluice gates are closed



When the tide is low, the sluice gates are reopened, and the force of the water draining through the barrage turns the turbine



If renewables are to be more than a niche source of power, this variability will have to be evened out to meet patterns of demand.

The only real solution is monumental transmission systems that link up renewable energy sources so they can substitute for one another. To work well, these systems need to be built on a continental scale.

One idea on the table is a European supergrid linking big population and industrial centres in countries such as Germany, France and the UK with the continent's great potential sources of green energy, which are mostly on the periphery. They include geothermal energy from Iceland, hydroelectricity from Scandinavia, wind power from the North Sea, and solar energy from the Iberian peninsula and even the Sahara desert (*New Scientist*, 14 March, p 42).

Such a network could guarantee renewable electricity for most, if not all, Europe's needs. When the sun goes down in the Sahara, Germany could switch to geothermal from Iceland. If the wind was blowing fiercely in the North Sea, spare power could be used to pump water uphill between reservoirs on Norwegian rivers, ready for release to generate energy when the winds dropped. But there could be huge battles ahead if local environmentalists object to the power lines passing through, and

watch out for a "save the deserts" campaign when the solar power people get serious.

"This could be a blueprint for India, too, or north-east Asia, southern Africa or North America," says Nick Dunlop, founder of e-Parliament, an online global network of parliamentarians that is backing the plan. In the US, President Barack Obama is already on the case. He has promised to devote tens of billions of dollars to a national electricity grid. The idea is to link up desert states like Nevada, with their huge potential for solar power, and the Midwest states with their wind, to the power-hungry markets of the east. Again, though, battles lie around the corner.

Green schism

All these recurring disputes have to do with scaling up cuddly green technology to the point where it makes a real difference to the climate. They expose an emerging schism in the environmental movement. On the one side are the "sustainable developers", for whom nature is a resource to be managed. On the other are the "preservationists", who hold nature sacrosanct and for whom any damage by mankind to natural ecosystems is a defeat. Radical British environmentalist Paul Kingsnorth, who cut his teeth opposing road

construction in the 1990s, now says: "To me, a wind farm on a mountain, a tidal barrage that turns a great river into a glorified millstream, or carpeting the Sahara with giant solar panels... are a similar desecration." For the preservationists, trade-offs are impossible. For sustainable developers, they are the essence of environmentalism.

There are many more disputes ahead. If more and more of the world decides to opt for renewable sources of electricity, the drive to do it faster and cheaper will grow. More large corporations with their eyes on the bottom line will get involved. More corners will be cut. Environmentalists will inevitably find themselves on the barricades defending the natural world from other environmentalists intent on generating clean energy.

The bottom line for greens is that these dilemmas and contradictions are the fruits of success. And the more successful their arguments for cutting greenhouse gas emissions are, the greater and more frequent will be the dilemmas. Rarely will there be a right or wrong answer. All visionaries imagine that once they get their way, it will be plain sailing. It rarely is. ■

Fred Pearce is *New Scientist's* environment correspondent

The strange phenomenon of sneezing when the sun comes out might shed light on just how muddled our brains can be, sniffs Richard Webb

WAS rounding the corner to the bus stop when it hit me – a bright shaft of sunlight smack between the eyes. My reaction was immediate: an unpleasant prickling in my nose, a quickening of my breath, an uncontrollable watering of my eyes. Then, almost as quickly as the sensation came, relief, blessed relief. Aaaaa-tisshoo! A sneeze.

It wasn't the first time. In fact, the same thing happens every time I go into the sun. For a long time, I thought it was a quirk all of my own. Then a friend mentioned she was similarly afflicted. Next my mother came out of the closet. With a bit of digging around I came to a startling realisation: not only am I not alone, but the "photic sneeze reflex" is actually common. Quite how common, no one knows exactly – but anything between 1 in 10 and 1 in 3 of us might be affected.

The more I looked, the more mysterious things became. Sunlight is the most widespread, but by no means the only, odd stimulus that sets off sneezing. Thinking about sex, eyebrow tweezing, eating chocolate or a mint, or drinking a glass of wine – all these activities can leave us groping around for handkerchiefs. Members of one Kuwaiti family were even reported to sneeze whenever they had a full stomach – a phenomenon dubbed "snatiation". Then there was the case of the medical student who sneezed with almost clockwork precision around 8.20 every morning.

All these oddities are faithfully recorded in the medical literature, almost always accompanied by an earnest call for further investigation. But a teensy problem has always stood in the way. Despite the fact that everyone does it, we still don't fully understand the way the nervous system

coordinates a normal sneeze, let alone a photic sneeze.

A sneeze, one of the most violent actions your body will ever perform, should be triggered by an irritant in the mucus-producing membranes of our nostrils. This stimulates the endings of the trigeminal or fifth cranial nerve, which mediates sensory inputs from all over our face. The result is a cascade of reactions throughout our body: mucus production in the nose, a momentary closing of the eyes, and a wave of motor impulses down into our torsos to generate

an explosive expulsion of air at up to 150 kilometres an hour – an extremely localised personal hurricane if you like.

The forces are considerable. Instances of whiplash through sneezing are not unknown, and a sneezing fit in 2004 threw Chicago Cubs baseball legend Sammy Sosa's back into spasm, knocking him out of the game for two weeks. I once gave myself a hernia during a pollen-induced sneezing fit in the bath.

Coordinating such a ferocious manoeuvre – together with the mucus production and blink reflex – is no mean feat. Sneezes are





orchestrated by the parasympathetic nervous system, that part of our subconscious control hardware that regulates reflex housekeeping activities from producing tears and saliva to moving the waste products of digestion down the gut to our bowels.

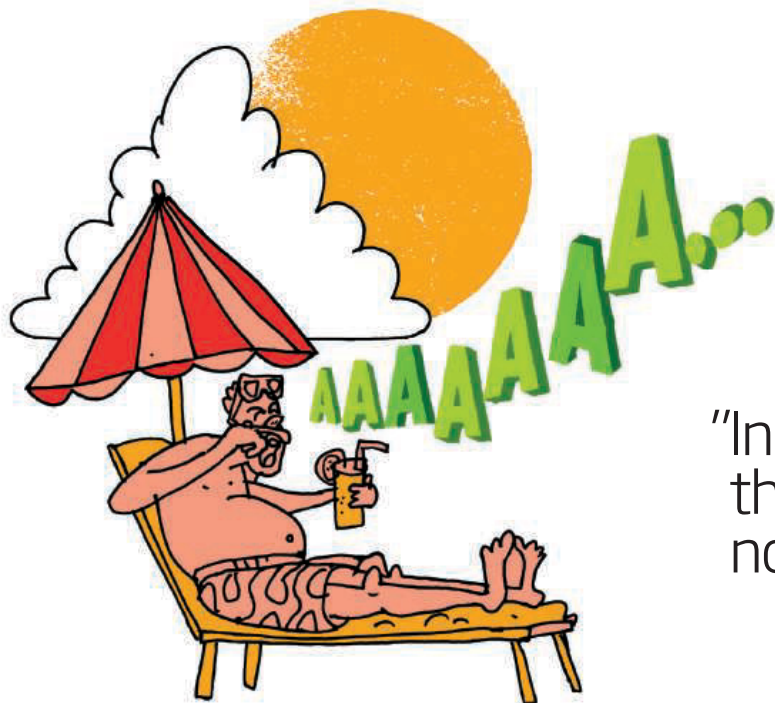
The nerves within the parasympathetic nervous system that coordinate sneezing feed into a part of our brainstem known as the medulla oblongata. A series of experiments conducted by researchers from Asahikawa Medical College, Japan, in 1990 showed this was the case for cats (*Brain*

Research, vol 511, p 265), and it seems to be true for humans too since some people with damaged medullas lose the ability to sneeze (*Neurology*, vol 56, p 138).

Unfortunately, current brain imaging techniques are not sensitive enough to pin down exactly which neurons within the medulla control the sneeze response. It is within this elusive “sneeze centre” of the brain that the mystery of photic sneezing lies.

This mystery has a long history. In the 4th century BC, Aristotle asked why the heat of the sun prompts us to sneeze, whereas

the heat of the fire does not. A partial answer came two millennia later, when the English natural philosopher Francis Bacon showed that his photic sneeze had nothing to do with heat at all: if he closed his eyes when going into the sun, he didn’t sneeze even though the heat was still there. While Bacon’s application of the scientific method was beyond reproach, his conclusions are distinctly iffy to a modern nose. “The cause is not the heating of the nostrils,” he asserted, “but the drawing down of the moisture of the brain.”



“Instances of whiplash through sneezing are not unknown”

Are you a sneezer?

Part of the problem in pinpointing the prevalence of the photic sneeze, says Louis Ptáček, a neurogeneticist at the University of California, San Francisco, is the question of degree. Many people will happily look into a bright artificial light to complete a sneeze, but are not necessarily true photic sneezers. Below are certain factors that he says are cast-iron indicators.

A PREDICTABLE RESPONSE

Photic sneezers almost always sneeze a set, unchanging number of times on exposure to light: most commonly just once, but sometimes twice or more.

THE THRESHOLD EFFECT

The sneeze depends on light contrast - only a sudden, sharp exposure, such as when entering bright sunlight from a darkened space, or when the sun moves out from behind a cloud, will do.

THE LATENCY EFFECT

The sneeze takes time to “recharge” - if you go back into a darkened space and then re-enter bright light within a certain time, you will not sneeze again.

THE GENETIC EFFECT

If you can pinpoint a close family member with the sneeze - a parent, sibling or child - you are on to a winner.

To find out whether you are a true photic sneezer, take part in our comprehensive online questionnaire at www.newscientist.com/section/in-depth

It took a long time, however, before modern science could better that explanation. Henry Everett, a consultant psychiatrist at the Johns Hopkins University Hospital in Baltimore, Maryland, was the first to make a systematic attempt to understand the condition. Noting in 1964 that six of the 18 junior psychiatric doctors at Johns Hopkins were photic sneezers, he questioned 75 of his patients and 169 of his students in detail about their sneezing habits (*Neurology*, vol 14, p 483).

In the group of patients, 18 per cent reported a photic sneeze reflex; among the students, it was 24 per cent. Small sample sizes in this study and subsequent research have made it difficult to work out with any certainty how common the condition is. About 35 per cent of my colleagues at *New Scientist* turned out to be photic sneezers, which is significantly higher than Everett’s findings but seems to fit the upper bound set by studies since.

Everett also thought to ask his volunteers about photic sneezing among their nearest and dearest. Whereas 80 per cent of sneezers reported other sneezers among their close relatives, only 20 per cent of non-sneezers did. As Everett perceptively observed, the results were likely to be skewed. People with the condition tend to be attuned to other people’s sneezing (apart from me, that is), whereas those without it often don’t notice when other members of their family are sneezers.

Nevertheless, the correlation was too significant to ignore, suggesting photic sneezing is an inherited rather than acquired response to environmental conditions, as had previously been assumed. Subsequent studies have borne out that hunch, with patterns of inheritance suggesting that it is carried on a dominant gene (*Birth Defects*, vol 14, p 361), so

anyone with just one copy would be afflicted. This is known as autosomal dominant transmission, giving scientists the unmissable opportunity to rename the condition “autosomal-dominant compelling helio-ophthalmic outburst” - ACHOO for short.

So it seems I can blame my genes for my photic sneeze. I don’t have to look far for the culprit: my mother, caught red-handkerchiefed.

But that was only half the answer. Now I wanted to know what exactly this aberrant gene was doing. How come it made both my mother and me sneeze when our eyes, not our noses, were stimulated?

Curious conditions

Clues might lie, I thought, in some of the other curious conditions. So I phoned Mahmood Bhutta of Wexham Park Hospital in Slough, UK. Together with his colleague Harold Maxwell, he caused a stir in December last year with his description of patients who sneezed at orgasm or even in response to having sexual thoughts (*Journal of the Royal Society of Medicine*, vol 101, p 587).

The connection between sex and sneezing is not a new observation. As far back as 1875, scientists had an inkling that the root cause was the erectile tissues common to both the nether regions and the glands of the nasal cavity. The theory was that nitric oxide released during arousal to dilate blood vessels in the genitals could diffuse through the body and excite the erectile tissue in the nasal cavity, triggering a sneeze.

Bhutta doesn’t have much time for this explanation - the diffusion would take far too long to explain the rapidity of symptoms,

he says. "The speed and involuntary nature of the response means the cause is likely to be neurological." That chimed with something I had read in Everett's paper, where he proposed a series of possible neurological explanations for photic sneezing.

It might be, for example, the result of confused signalling from a hyperactive trigeminal nerve as it gathers tactile information from across the face. Somewhere along the nerve the impulses from different nerve endings around the eye and in the nose may become scrambled, confusing the brain about the origin of the different signals. That seemed plausible enough, and since the nerve endings in the eyebrows also belong to the trigeminal, something similar might also account for sneezing when tweezing.

Alternatively, Everett suggested, the photic sneeze could be explained by a special connection between trigeminal and optic nerves. That was attractive, since it might also lie behind the mysterious phenomenon of sun-induced head-shaking in horses.

There was still something vaguely unsatisfactory about these explanations, though, since none can explain all those different types of sneezing at one fell swoop. What about orgasmic sneezing and snatiation, for example?

The answer to that, Bhutta suggests, might lie in another one of Everett's hypotheses: that the confusion arises in the way the medulla regulates our reflex actions. Everett originally proposed this idea to explain just photic sneezing, but Bhutta thinks it could explain all the strange sneezing conditions, since all of the triggers involve stimulation of a parasympathetic nerve response controlled by the medulla. When bright sunlight hits our eyes, our pupils contract involuntarily – a parasympathetic response. When our stomachs are full, the parasympathetic system kicks in to start our gastric juices flowing. When we think of sex, parasympathetic action stimulates blood flow to our genitals.

All these nerve responses flow to and from regions of the medulla close to where the sneeze centre is located. This suggests that far from being a neat system of discrete responses to individual stimuli, our reflex systems at their base in the medulla are often a tangled web of cross-talking nerve wires. Sometimes when bright sunlight hits our eyes, the parasympathetic system responds appropriately and our pupils constrict. But for certain people whose medullas are wired differently, sunlight triggers a

Sneezing: fact and myth

WHEN YOU SNEEZE YOUR EYES CAN POP OUT

False. The fluid bath around our eyes comfortably absorbs the considerable air pressure built up during a sneeze, and for added safety the blink reflex prevents our eyes from extruding.

YOU SHOULD NEVER STIFLE A SNEEZE

Partially true. While reports that a stifled sneeze can rupture blood vessels in the brain seem exaggerated, holding both your nose and mouth shut while sneezing forces the air to find another escape route – via the Eustachian tube to the ear, where its force can easily rupture an eardrum.

SOME PEOPLE NEVER STOP SNEEZING

Not quite: reflex sneeze responses lasting for

days and weeks have been recorded. The record seems to lie with a 12-year-old English girl called Donna Griffiths, who sneezed every few minutes for 977 days between January 1981 and August 1983.

THERE'S ACTUALLY NO POINT IN SNEEZING

Possibly, at least the way adult humans do it. Unlike our young, we develop the habit of sneezing almost entirely through our mouths – meaning it is less successful at clearing our nasal passages.

IGUANAS ARE GREAT SNEEZERS

True, but then in common with many other lizards they sneeze for quite a different reason – to expel excess salt stored in nasal salt glands.

different reflex response, such as a sneeze.

Nervous overkill is no deal breaker in the survival stakes as long as the right reflexes are also stimulated at the right time, so aberrant genes that cause confused reflexes in some individuals would have been conserved by evolution. "It's a mess," says Bhutta, "because it's never had to be anything else."

All this is just a hypothesis, not established fact, Bhutta emphasises, and is likely to remain so until we fashion better tools for studying the activity of individual nerve pathways in living humans. This is a sentiment echoed by Louis Ptáček, a neurogeneticist at the University of California, San Francisco. "People speak as if they know what the hell's going on," he says. "In reality, we don't."

That doesn't make Ptáček any less interested in the photic sneeze. On the contrary, he hopes work on the disorder could shed light on far more serious conditions, such as migraines and epilepsy, which are also caused by crossed wires in the nervous system. These disorders are diverse and often bizarre.

In a condition called paroxysmal dyskinesia, for example, a startle

or sudden voluntary movement can induce dance-like involuntary movements lasting for minutes on end; and there are instances of epilepsy induced by listening to music or reading.

Certain parallels between these conditions and photic sneezing are obvious. "We know, for example, that some people with epilepsy have

seizures if you flash strobe lights at them," says Ptáček. "But measure the brain waves of an epileptic with no strobe response when a strobe is switched on, and you still see sudden spikes in brain activity." That looks rather like just a more generalised version of photic sneezers' over-the-top response to a light stimulus.

The fact that photic sneezing is so common and is almost certainly also an inherited trait could provide an unparalleled opportunity to get to grips with these neurological confusions. Ptáček is hoping someone will study the condition in detail and pin down its pathology once and for all (see "Are you a sneezer?", page 38). "It would be just the thing for some ambitious young doc to make his or her mark with," he says.

The photic sneeze has long been overlooked because its effects are generally less than serious. The US military once studied it as a risk factor for fighter pilots, true, but otherwise reports have concentrated on more esoteric concerns such as its potential "to disrupt outdoor group photographs".

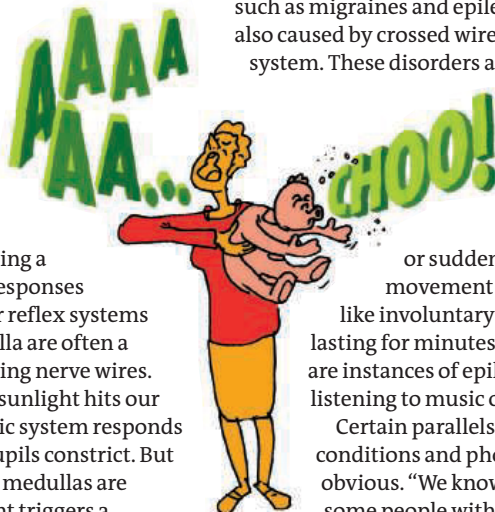
Ptáček thinks the connection to the kind of disorders he studies means that a change of perception is long overdue. "Sometimes to discover things that make you go 'wow' in science," he says, "you have to follow your nose."

From a darkened room I'll say "bless you" to that. ■

Richard Webb is a feature editor at *New Scientist*

MORE ONLINE

Find out if you are a photic sneezer at: www.newscientist.com/section/in-depth



In our hyperconnected world, getting away from it all is easier said than done. Caroline Williams joins the As to the Bs

It's a small world

SO YOU'VE hitch-hiked through Central America, stalked rare beasts in Madagascar and trekked your way through northern Chile. You're pretty well travelled, even if you do say so yourself. Before you get ideas about being an intrepid explorer, however, consider this. For all their wide open spaces and seeming wildernesses, none of these places can be described as remote in 2009.

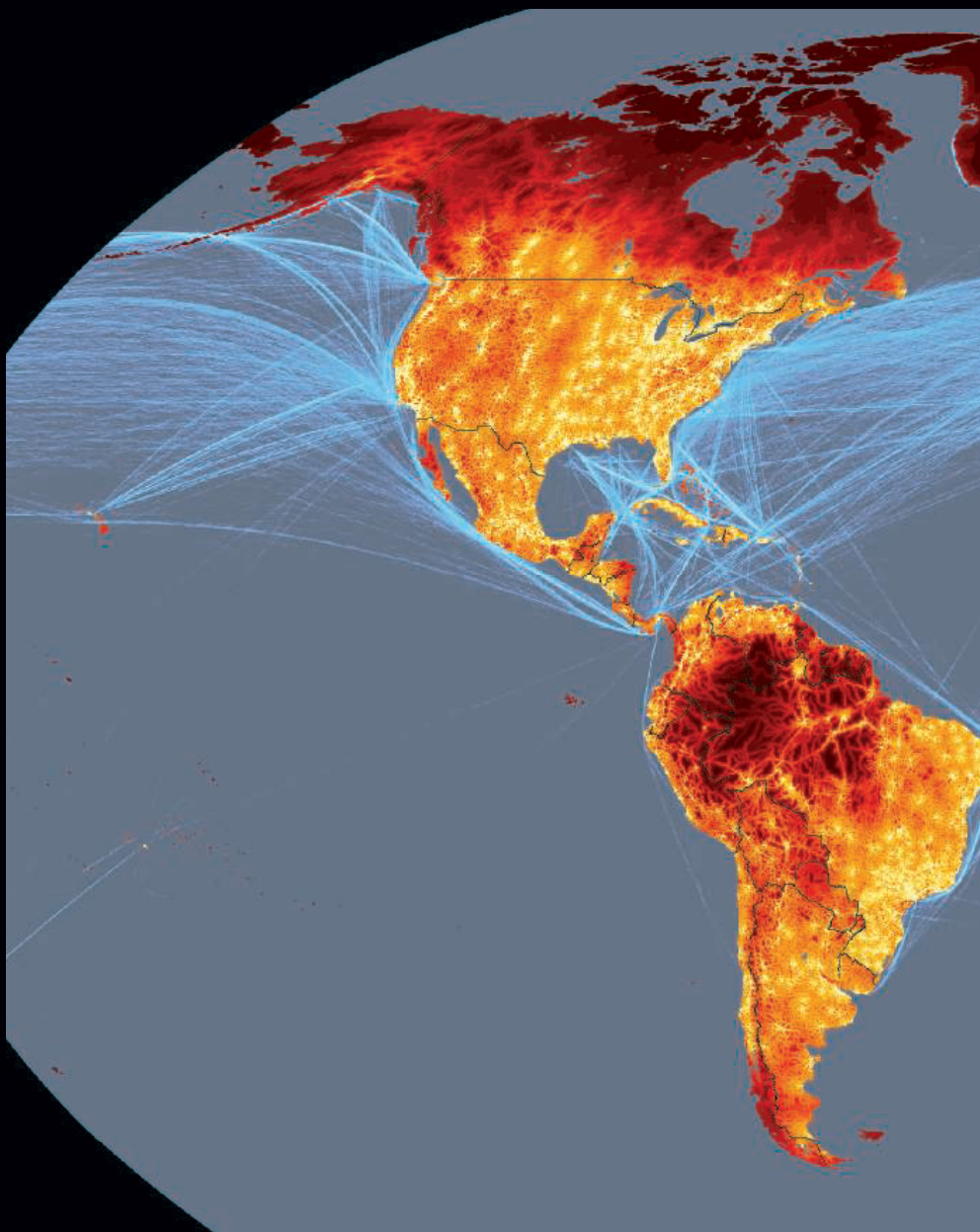
In fact, very little of the world's land can now be thought of as inaccessible, according to a new map of connectedness created by researchers at the European Commission's Joint Research Centre in Ispra, Italy, and the World Bank.

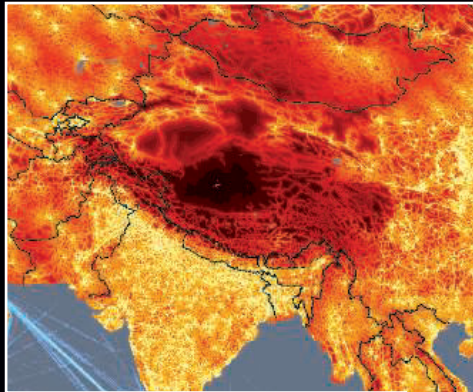
The maps are based on a model which calculated how long it would take to travel to the nearest city of 50,000 or more people by land or water. The model combines information on terrain and access to road, rail and river networks (see maps, page 42). It also considers how factors such as altitude, steepness of terrain and hold-ups like border crossings slow travel.

Plotted onto a map, the results throw up surprises. First, less than 10 per cent of the world's land is more than 48 hours of ground-based travel from the nearest city. What's more, many areas considered remote and inaccessible are not as far from civilisation as you might think. In the Amazon, for example, extensive river networks and an increasing number of roads mean that only 20 per cent of the land is more than two days from a city - around the same proportion as Canada's Quebec province.

The maps were created to show how the distribution of people affects their access to resources such as education and medical care, and how we are increasingly pushing wildlife out of even the wildest corners of our planet. And with this as a baseline, Alan Belward, who leads the project, hopes to follow how emerging economies will change the face of the world, for better or for worse: "The true value will be in doing the map again." >

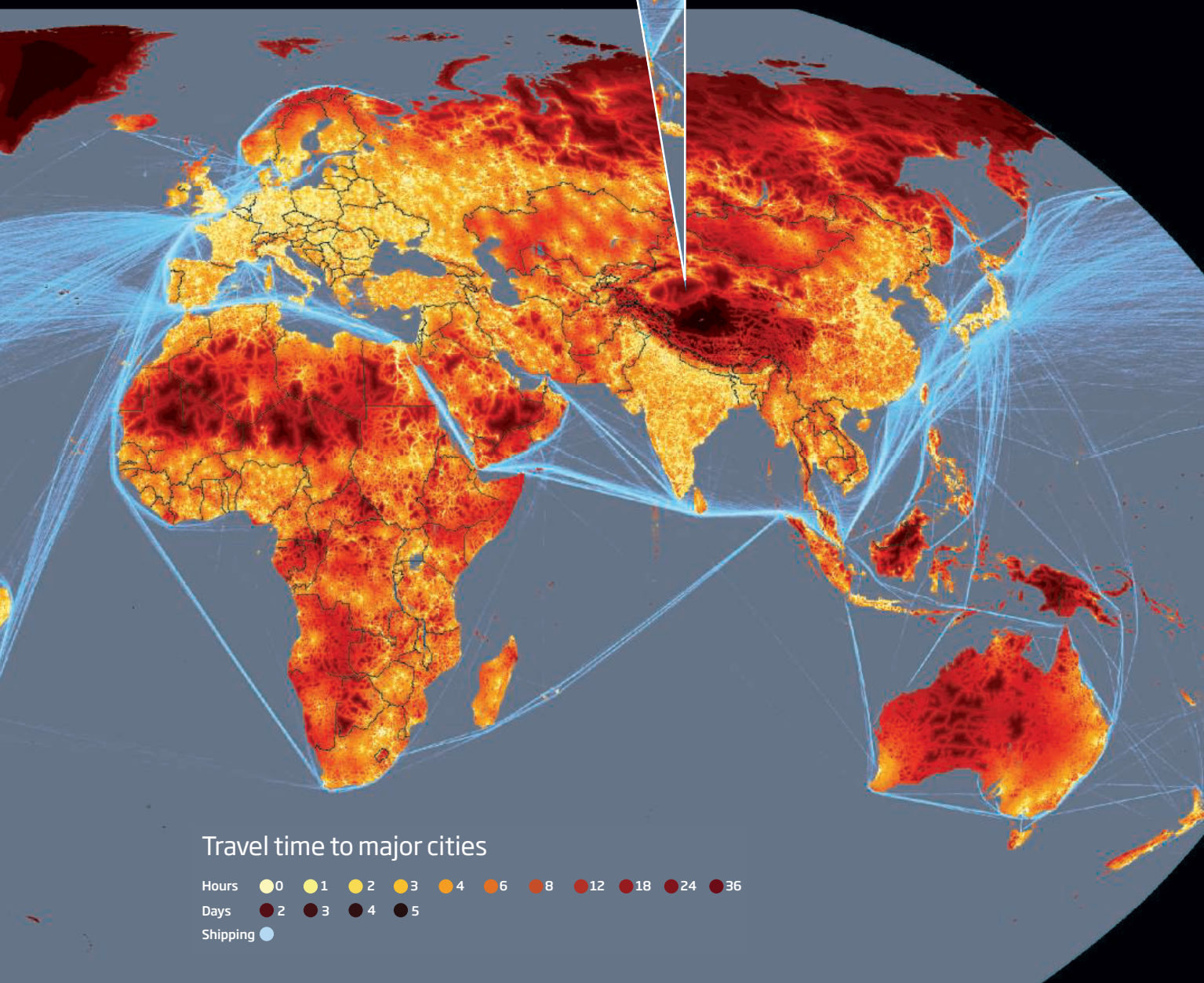
Caroline Williams is a *New Scientist* features editor

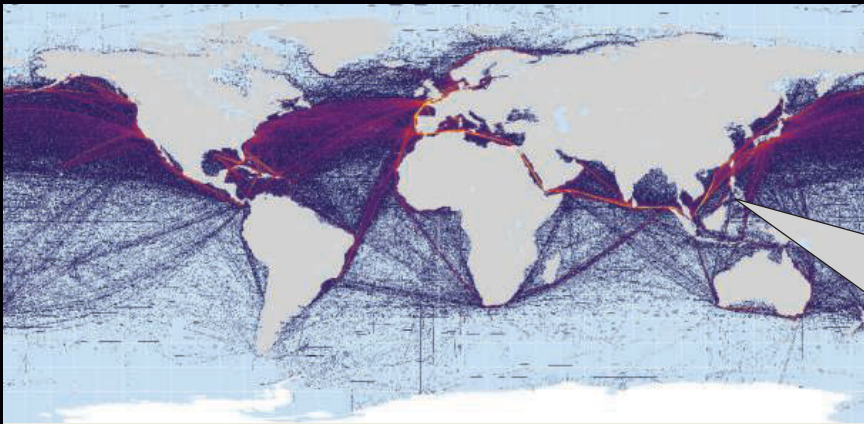




NOWHERE, THREE WEEKS FROM ANYWHERE

It's official, the world's most remote place is on the Tibetan plateau (34.7°N, 85.7°E). From here, says Andy Nelson, a former researcher at the European Commission, it is a three-week trip to the cities of Lhasa or Korla - one day by car and the remaining 20 on foot. Rough terrain and an altitude of 5200 metres also lend it a perfect air of "Do Not Disturb".

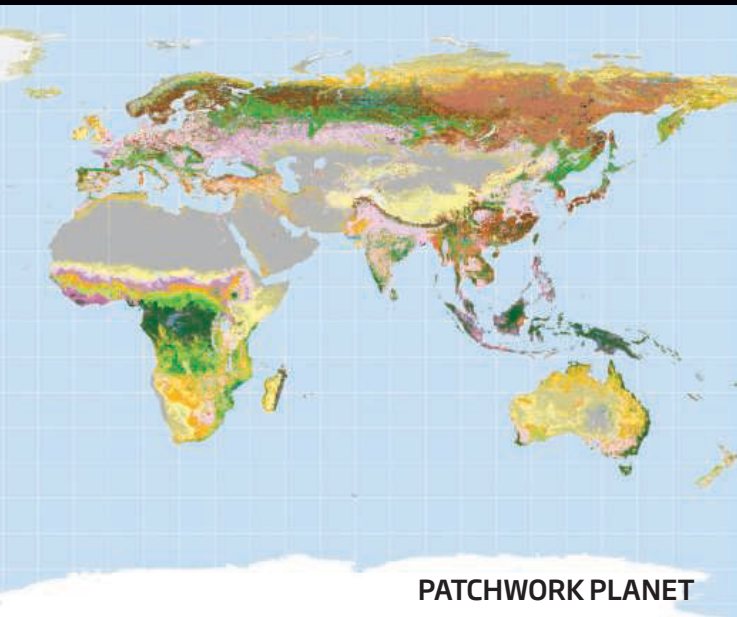
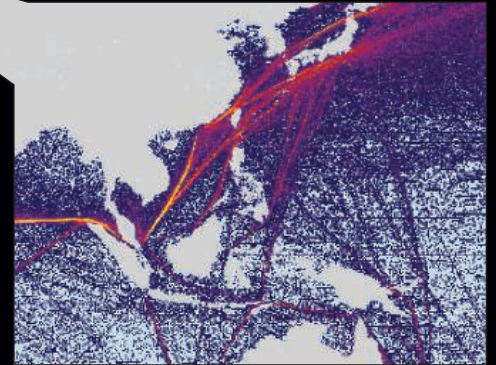




"China's flourishing export trade is clearly seen, with some of the world's busiest shipping lanes"

THE SHIPPING NEWS

With the brightest colours representing the busiest shipping lanes, the English Channel, Mediterranean and South China Sea stand out as major trade routes. Regions to the far north and south are left out in the cold, at least for now.



- Tree cover, broadleaved, evergreen
- Tree cover, broadleaved, deciduous, closed
- Tree cover, broadleaved, deciduous, open
- Tree cover, needle-leaved, evergreen
- Tree cover, needle-leaved, deciduous
- Tree cover, mixed leaf type
- Tree cover, regularly flooded, fresh water
- Tree cover, regularly flooded, salty water
- Mosaic: tree cover / other natural vegetation
- Tree cover, burnt
- Shrub cover, closed/open, evergreen
- Shrub cover, closed/open, deciduous
- Herbaceous cover, closed/open
- Sparse herbaceous or sparse shrub cover
- Regularly flooded shrub and/or herbaceous
- Cultivated and managed areas
- Mosaic: cropland / tree cover/other natural vegetation
- Mosaic: cropland / shrub and/or grass cover
- Bare areas
- Snow and ice
- Artificial surfaces and associated areas
- No data

PATCHWORK PLANET

WATER WORLD

The planet's navigable rivers provide not only food and water, but also a valuable way of getting from A to B. In areas where no roads penetrate, such as the Guiana region of eastern Colombia, river travel is simply the quickest way to get around. The mapping model assumes a river travel time of 3 minutes per kilometre, though its creators point out that this will vary with flow, season and political stability.





Playing chess with an unseen opponent, though common enough online today, has a long history: games by correspondence date back to 1119, when Henry I of England played Louis VI of France. Chess by mail thrived with the advent of the Uniform Penny Post in 1840, as expanding empires flung chess partners increasingly far apart. Yet these games had an intractable problem. They were, even for chess, agonisingly slow: one game between Brooklyn chess master Francis Brenzinger and his brother Karl, who lived in the German city of Pforzheim, dragged on from 1859 to 1875. So Victorian gamers sought a solution in their latest technology: the telegraph.

Past masters of online gaming

ON THE morning of 8 April 1845, an all-star team of chess players assembled at Vauxhall railway station in London. Instead of dashing for a departing train, they sat down at a chess board next to a Cooke-Wheatstone telegraph that inventor Charles Wheatstone had set aside for them. Discussing moves before a crowd of spectators were the chess writer George Walker, polymath Henry Thomas Buckle, inventor and avid player Walker Davies Evans, respected amateur William Tuckett and George Perigal, a veteran of chess by correspondence. At the other end of the line, 130 kilometres away in Gosport, on England's south coast, were two formidable opponents: British chess master Howard Staunton and chess writer Hugh Alexander Kennedy. The boards were set, and at 11 am the game was on.

As moves were wired in standard chess notation, Wheatstone's fellow inventor William Fothergill Cooke explained the telegraph to spectators at Vauxhall. It was his plan, he said, to allow the public to use it for transmissions between London and Gosport for a fee. One spectator immediately wanted a trial. He had a friend watching the game in Gosport, he said, and would the gentleman be back in London to dine that evening? Between moves, Cooke sent the query down the line. "Yes, at five," came the reply after a short

pause, and with that the crowd was sold.

The match proved less decisive. After seven-and-a-half hours, it ended in a draw and Staunton and Kennedy missed the last train back to London. All the same, the event itself was big news. One reporter pondered what else could be achieved now that human thought and action could be effected from far away by wire. "Instead of blowing up a ship at the moderate distance of six miles by one of [our] projectiles, we shall be enabled to do so at a distance of a thousand miles," he ventured,

"Telegraphed billiards was frustratingly slow - but not as slow as billiards by mail"

before speculating on more peaceful uses: "A galvanic arrangement might be made by which our accomplished pianist, Madame Dulcken, might [perform]... wherever a few wires could be conveniently transmitted."

By December 1848, telegraph offices at Paddington and Slough railway stations were advertising lines for hire for "chess and draughts played by telegraph" with any major city in Britain. As telegraph lines spread, so did intercity matches between chess clubs, first between Liverpool and Manchester in 1856,

and then across America and Australia. A match between London and Dublin in 1865 notched up 646 moves in one evening on 12 boards, and one Hungarian match telegraphed a game from city to city like a chain letter.

Cable chess truly came into its own, however, in 1896, when players in New York and London competed for a trophy proffered by the British MP George Newnes. Newnes was a savvy entrepreneur, who as publisher of *Tit-Bits* magazine had made his name giving away "*Tit-Bits* villas" to readers and promising £500 to the family of any man who died with a copy of *Tit-Bits* in his pocket. The transatlantic match was another stroke of PR genius.

Seated around eight boards in the Dime Savings Bank in Brooklyn were some of America's top players, including the young genius Harry Nelson Pillsbury. Some 1500 spectators watched play on eight giant duplicate boards that had been hung on the bank's walls as countermoves were relayed from Cannon Street Hotel in London.

Despite a surprising loss by Pillsbury, the American team prevailed. Newnes promised his compatriots would compete again the following year, and cable chess had its first regular event: the Newnes cup. A university tournament soon followed, with the Ivy League pitted against Oxford and Cambridge.



ANGLO-AMERICAN TELEGRAPH CO/NPL LEFT SCIENCE MUSEUMS/SP

British and American politicians were quick to realise the potential for online banter

MP and tireless advocate of both chess and cheap cable rates, issued a friendly challenge. How about a chess match between the House of Commons and the US House of Representatives?

The match took place on 1 June 1897 and was a truly international event, with Austrian minister Baron von Hengerver online in Vienna to adjudicate any disputes. The only hint of politics came when Arthur Balfour, the Conservative leader of the House of Commons, popped into committee room number 12, where five games were in progress, and cabled his greetings to the Americans.

“Mr Shaforth, of Colorado (board 2), is an ardent bimetallist, and is [now] naturally inclined to even greater exertions,” came the reply from Washington, alluding to Balfour’s controversial support for both a gold and a silver monetary standard.

Unusually for politicians, the two teams spent little time deliberating: moves flew back and forth at speed, with one exchange between Horace Plunkett (Unionist, South Dublin) and Richard Pearson (Democrat, North Carolina) flashing by in 13¼ seconds. The American team was widely considered the weaker of the two, but when the frenzied tapping ceased eight hours later, the MPs were surprised to find they had been held to a draw. Heaton was so delighted by the match that in 1902 he proposed one with the new Australian parliament, while in the US a national cable chess league was mooted, although the notion never quite caught on.

What ultimately held back telegraphic chess was its staggering cost. The Newnes cup matches, even at a discount newspaper rate of 10c a word, quickly ran up a huge bill. The cabled chess notation of “1 Kt 1 to KB 3” was charged as six words, or 60c. A typical game of 50 moves came to a bruising \$30.

The first world war and changing technology finally put an end to telegraphic chess, which was quickly replaced by wireless and telephone matches. Occasionally these were dogged by the same complications that had hindered cable chess. While playing a London-Moscow radio match in 1946, chess columnist Harry Golombek later recalled, the lapse of an hour between moves made him hopeful that he had flustered his opponent. “This dream was punctured,” he wrote, “by a message from Moscow asking why I had not played for over an hour.” Even the latest gaming technology could be checkmated by human error: Golombek reported that his move was later found on a scrap of paper under a cup and saucer. **Paul Collins** ■

Aside from a few short breaks – in one case because the cable itself broke – these matches became one of the highlights of the chess enthusiast’s year for the next two decades.

After the first Newnes match, the British humorous magazine *Punch* published what it claimed was an interview with a London telegraph office’s new “sport by wire” manager: “We cable over to the Associated Press full particulars of our imaginary [soccer] kickoff... [they] wire back their return kick with name, age, weight and address of the kicker... There’s our Ladies’ Inter-Varsity Stay-at-Home Hockey Contest... That’s the river editor, hard at work in that armchair, rowing against Yale by cable... But I must ask you to excuse me now, as I have a billiard

tournament, a yacht race and a cricket match with all Australia to manage simultaneously.”

Punch’s satire wasn’t so wide of the mark. A number of North American cities began to stage telegraphed intercity bowling tournaments, with one in 1911 pitting New York, Montreal, Pittsburgh, Cleveland and Seattle against each other simultaneously. The telegraph was rather less practical for other games. Telegraphed billiards matches used a gridded table that enabled players to cable the positions of the balls, but the system proved frustratingly slow – though not as slow as previous attempts at billiards by mail.

The possibilities of cable chess, however, remained alluring. After the Newnes cup match, John Henniker Heaton, another British

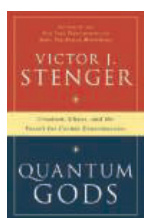
From decoherence to incoherence

Anyone tempted to replace religion with quantum mechanics should read this robust debunker

Quantum Gods: Creation, chaos and the search for cosmic consciousness

by Victor J. Stenger,
Prometheus Books, \$26.98

Reviewed by Amanda Gefter



QUANTUM mechanics is remarkably weird: even though it is well understood mathematically and can produce accurate, ultra-

precise predictions, nobody really knows what it means. This leaves lots of room for people in search of the spiritual – and who are not burdened by any knowledge of mathematics – to impose on it whatever quasi-religious beliefs or interpretations they like.

In this much-needed book, physicist Victor Stenger isolates and then debunks the claims of two kinds of “quantum belief”. One he calls “quantum theology” because it offers quantum physics as a way for God to act in the world without violating natural laws. The second is “quantum spirituality”, which is rooted in the even vaguer notion that quantum physics connects the human mind to the universe, allowing us to create our own reality.

This was the theme of the wildly popular film *What the Bleep Do We Know!?*, which grossed over \$10 million and was responsible for creating widespread misunderstanding of quantum physics. With Stenger in charge, though, we are on sure ground. He adds even more value by weaving a thorough beginner’s course in quantum physics into

Maharishi Mahesh Yogi tried to link his teachings to conventional physics

his debunking exercise.

Like most scientists, Stenger believes most religious claims can be dealt with scientifically, so beliefs such as creationism or astrology aren’t immune to science, they are merely wrong. Take the tale of Maharishi Mahesh Yogi, the Indian yogi (and physics graduate) who taught transcendental meditation and won a global following after the Beatles joined his Academy of Meditation in India. Maharishi claimed that transcendental meditation gave practitioners access to the “quantum field of cosmic consciousness”. This, he said, was identical to SU(5), the model physicists were then investigating in their search for

a grand unified theory. Sadly for cosmic consciousness, real experiments later falsified SU(5).

As for the notion of creating our own reality, this relies on brains in some sense operating quantum mechanically – and there is no evidence for this. As Stenger says, the scales of distance involved in brain processing are more than a thousand times too large for quantum effects to necessarily come into play. Likewise, physicist Max Tegmark has shown that the timescales of events in the brain are 10 or more orders of magnitude longer than the timescales of “decoherence”, the process by which quantum effects “leak” out of the quantum system.

Meanwhile, those looking for

generalised spiritual meaning tend to seek holism in quantum mechanics. Stenger cites the famous Einstein-Podolsky-Rosen paradox. This 1935 thought experiment outlined a known conundrum in quantum mechanics and concluded

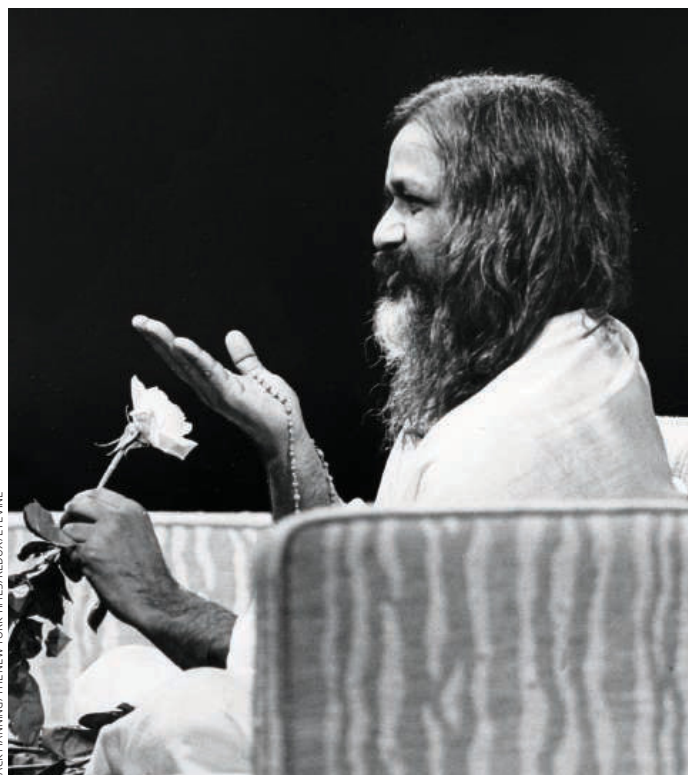
“The notion of creating our own reality relies on brains in some sense operating quantum mechanically”

that we must accept one of two explanations for it: either that quantum mechanics is a complete theory – despite its probabilistic dice-throwing; or that beneath it lies some deterministic reality, but one which is “non-local”, that is, one where signals can travel faster than light speed, thereby violating Einstein’s special theory of relativity.

Most physicists chose the first option, except David Bohm, who famously came to believe in a non-local universe. Stenger sees little of mystical import in these experiments. They are widely discussed in the literature of quantum spiritualism, but real physicists “are underwhelmed... Quantum mechanics... passed yet another empirical test. Ho hum.”

Even though he skips rather dizzily between traditional religious beliefs, quantum spirituality and quantum physics itself, Stenger is a pleasure to read. And, pleasingly, the title *Quantum Gods: Creation, chaos and the search for cosmic consciousness* sounds just crackpot enough to attract those readers who will benefit most. ■

Amanda Gefter is an opinion editor for *New Scientist* based in Boston



JACK MANNING/THE NEW YORK TIMES/REDUX/REVIEWE

Life story

If you think you've heard all there is to know about how life evolved, think again



DARRIN GULLIN/CORBIS

Life Ascending: The ten great inventions of evolution by Nick Lane, Profile Books, £18.99

Reviewed by Michael Le Page



THE story of how life evolved on Earth has been told many times, but in *Life Ascending*, Nick Lane comes at it from a fresh angle. He takes us

behind the scenes to look at the deep reasons and connections underlying 10 key evolutionary inventions, including sex, warm blood, photosynthesis and death.

What makes this such a great read is that Lane, a biochemist by training, does not simply rehash the standard evolutionary tales – unlike many books published recently. Instead, he is familiar with all the latest research and has made up his own mind about who is right. The result is an original and awe-inspiring account. The

first two chapters are the most coherent and convincing summaries of the dawn of life and of DNA that I have ever read.

Even if Lane hasn't got all the answers right, a possibility he openly acknowledges, he is asking the right questions. One of his many thought-provoking ideas is that we would make far more progress studying the underlying causes of ageing than by studying specific age-related diseases such as Alzheimer's.

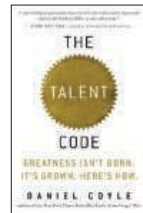
Lane's writing can be self-indulgent at times, so the book could have benefited from tougher editing. I also felt he bit off more than he could chew in the chapter on consciousness, which as a result is less satisfying than the other sections.

These quibbles apart, this is an exhilarating tour of some of the most profound and important ideas in biology. Anyone interested in life should read it. Highly recommended.

Success on the brain

The Talent Code by Daniel Coyle, Random House, \$25/£12.99

Reviewed by Michael Bond



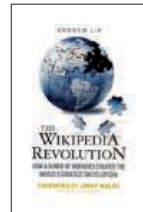
A GLANCE at this book might persuade you the author is onto something huge. It doesn't take long, however, to realise that his unearthing of a neurological mechanism for accelerating the acquisition of talent boils down to little more than "practice makes perfect". The exercise falls especially flat if you are up to speed with research into the origins of success popularised by Malcolm Gladwell and others.

Nonetheless, I'd buy the book for two reasons. Firstly, Coyle is a fine writer and makes an excellent pick of examples to illustrate his case. Secondly, he delves into an area few others have tackled: the neurophysiology of learning, or what happens to the architecture of the brain during practice. In a word, it's all about myelin. The theories he presents are sometimes contradictory, but that's hardly surprising: he's treading the borders of behaviour and biology, and the ambiguity seems to add to the intrigue.

Fount of all knowledge

The Wikipedia Revolution by Andrew Lih, Aurum/Hyperion, £14.99/\$24.99

Reviewed by Tom Simonite



WIKIPEDIA is not a technological innovation but a social one, declares its co-founder Jimmy Wales in the preface to this book. What follows

in this history of the online encyclopedia – the only one of the world's 10 most popular sites not run by a corporation – illustrates that nicely. The author, a senior community member of the

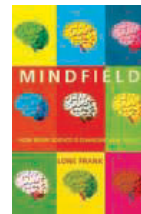
project, can't entirely ignore the technology that made it possible, but his book is mainly about people, whether visitors writing articles or Wales and others shaping a strategy that first made other encyclopedias laugh then stole their business. It describes the development of the community that made this turnaround happen.

It is at times too encyclopedic itself, with isolated fact-packed entries not linked into a wider story. Fortunately, Lih's final chapter on the future of Wikipedia has itself been wikified, giving readers the power to choose their own end to the tale.

The neuro revolution

Mindfield: How brain science is changing our world by Lone Frank, Oneworld, \$16.95/£10.99

Reviewed by Helen Thomson



IN THIS fascinating exploration of the most intriguing brain experiments so far this century, Lone Frank introduces us to a coming neuro revolution. She travels the globe meeting pioneers in psychology, neurology and philosophy to discover how our perceptions of happiness, law, morality and religion will be revolutionised by our understanding of the brain.

At first sight, the theories of these people seem like the stuff of fairy tales, but you soon realise that Frank's experts all present strong experimental evidence for their claims. Her attempt to engage us in her argument that our brains are far more malleable than we thought has a real resonance. Best of all, her hesitant participation in experiments – from having a neurologically induced religious experience to learning the secrets of empathy – along with brutally honest descriptions of the experts, add a welcome dose of humour.

Now it's personal

Among frontier cancer researchers, chemotherapy and whole-body treatments are falling out of favour as effective ways of fighting cancer. Instead, new techniques drawing on the Human Genome Project and advances in biology are being used to track, trick and outwit tumours. **Helen Thomson** discovers how life is about to change for cancer researchers

WHEN her two sisters died from an aggressive form of breast cancer, Gail Walters was anxious not to meet the same fate. She scheduled surgery to have both of her breasts removed. Walters (not her real name) had been identified as being in a “BRCA2 family”. In other words, she was likely to carry a mutation of the BRCA2 gene that would make her susceptible to breast cancer.

As luck would have it, a few weeks before her mastectomy, Mike Stratton at the Institute of Cancer Research in Sutton, Surrey, managed to sequence BRCA2. This meant that Walters could be screened – and quickly – for specific variants of the gene. Although both her sisters had the harmful variant, Walters did not, so her risk of developing breast cancer was no higher than average and the surgery was cancelled.

Translating research into action that helps patients doesn't always happen so quickly or dramatically, but Walters's tale shows how cancer research has shifted gear. Cancer is no longer seen as a uniform disease. Instead, researchers are focusing on the molecular abnormalities within a particular patient's cancer cells, often by exploiting the vast amount of information generated by the Human Genome Project.

“Before the HGP we had no idea where the genes were,” says Stratton's colleague, Colin Cooper,

who leads the section that made the discovery. “Now all we have to do is look it up on the internet.” Out of the 30,000 genes in a single cell, five or six go wrong to cause cancer, so the job of a cancer researcher is no longer one of gene identification, but gene selection, he says.

It doesn't end at the selection process, of course. You also need to identify important interactions. Identifying protein interactions helped Jason Carroll at the Cancer Research UK Cambridge Research Institute to discover how breast cancers become resistant to the

“Before the Human Genome Project we'd no idea where the genes were. Now we look them up on the web”

drug tamoxifen and to identify patients who are unlikely to respond to the treatment. “When you use the power of the human genome we can learn a lot about why treatments work and why they fail,” he says.

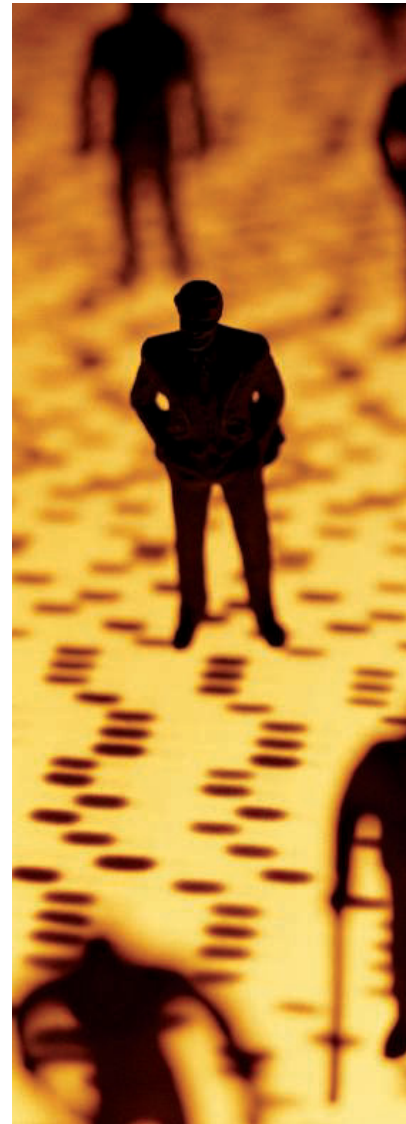
Looking at the interaction between proteins and the genome is a relatively new approach to cancer treatment. “It turns out that the human genome is much more complex than we thought,” says Carroll. “We knew what genes were involved, but we didn't know where the switches were that turn the genes on and off.” Until recently, he explains, scientists

had been looking for these switches at “promoter regions” biologically upstream of the genes involved in tumour growth. “Everyone assumed that was where the control switches were. Now people are seeing that these genes can be switched on and off from a great distance. In fact, we've found them in places that used to be called ‘junk DNA,’” Carroll adds.

This knowledge has led to a host of potential new cancer treatments – and with them, lots of new drugs to test. And while you can have a good idea about which drugs a patient may respond to through their genetic profile, checking out the reality relies on developments in another area – imaging.

“If you have good imaging techniques, you can know very quickly if your treatment is having a successful patient response,” says Kevin Brindle, a biochemist at the University of Cambridge.

Traditionally, doctors and researchers assessed the success of a treatment by looking at CAT or MRI scans, which allow you to visualise the internal structure of the body to see if tumours had shrunk. Now we're seeing more use of functional imaging techniques such as fMRI, says Brindle. Tumours use up a great deal of glucose, and fMRI is good at detecting the rate of glucose



Our genome is starting to give up its secrets to cancer researchers

uptake through increased blood flow at a particular site. A change in this activity is often obvious way before you see anatomical changes in the tissue, Brindle says.

These insights into human genomics are also changing the skills needed from a typical cancer researcher. The rapid pace of change has left many feeling ill-equipped to deal with the vast quantity of data they are now faced with. “I only survive in this area because I have a right-hand man who has a PhD in maths,”



says Cooper. The way cancer research is developing means that it pays to have strong links with bioinformatics scientists – mathematicians who can process your data and present it to you in a useful, simplified form.

So for anyone contemplating a move into cancer research, acquiring some mathematical skills could pay big dividends. “Cancer researchers need to become much savvier with bioinformatics,” Carroll says. “If my PhD applicants have some skills in this area that’s a major advantage.” Factor in computer programming skills,

or experience in imaging or microscopy, and you’ll stand out from otherwise top candidates. “Multi-talented researchers are the people who thrive now – they’re the next generation of cancer researchers.”

Branching out

It’s not only genetic research that is paving a way in the fight against cancer, though. Immunologists are also scoring some big successes. Because the immune system is always on the watch for anything unusual, including potentially cancerous cells, it can

be trained to halt cancer. So one leading strategy aims to work out which immune cells can fight the cancer, then isolate them from the patient, boost their numbers and re-inject them. This approach has been successful in animals: mice have been bred whose white blood cells can rapidly surround and destroy injected cancer cells. Work on human white blood cells is ongoing.

The breadth of new technologies means cancer research is open to scientists with a background in areas other than biology, says Martin Leach at the Institute of Cancer Research’s clinical magnetic resonance research group. Physicists and engineers are involved in developing instruments, computer scientists play an increasingly important role in generating and interpreting data, chemists and biochemists are developing probes, and then there are radiographers and doctors developing diagnostic techniques and treatment.

There will be opportunities in these areas and more in the 20 centres of excellence that Cancer Research UK is setting up around the country. Its ambitious five-year plan involves spending around £300 million a year on core areas of science to reduce cancer deaths, particularly those cancers where survival rates remain poor, such as pancreatic, oesophageal and lung cancer: these have a 10-year survival rate for less than 7 per cent of sufferers compared with breast and testicular cancer, melanoma and Hodgkin’s disease, which all have 10-year survival rates in more than 80 per cent of cases.

Personalised treatments may not ever cure cancer completely, but they might just offer a way of controlling the disease, perhaps indefinitely, while even more ground-breaking solutions are discovered. One thing is for sure, anyone wanting to delve deeper into the human genome is in for an exciting ride. ■

What’s hot?

Novel cancer treatments are developing all the time. Here are a few of our favourites

Nanobombs away!

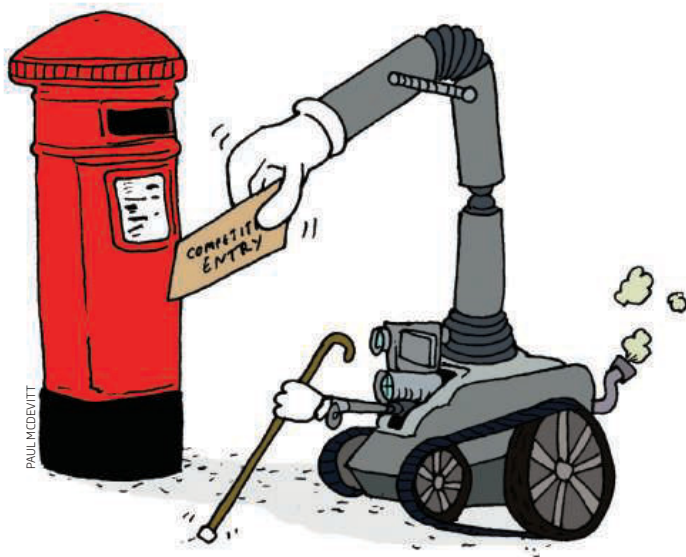
Water-filled nanotubes offer a new way to attack wandering tumours. These “nanobombs” are the inspiration of Balaji Panchapakesan at the University of Delaware in Newark. His idea is to fill carbon nanotubes with water, before injecting them into a tumour. The area is then zapped with laser light, which causes the nanotubes to boil and burst, killing nearby cells. The laser is of a wavelength and intensity that destroys the nanobombs rather than harming any healthy tissue.

Two for the price of one

While you’re focusing on a cure for cancer, keep your eyes open for solutions to other problems. Research into a key catalytic component of telomerase – an enzyme at the heart of almost all human cancers – is also paving the way for a potential anti-ageing treatment. When telomerase malfunctions, it causes cells to divide beyond their normal limits and become cancerous. Cracking the structure of telomerase will mean work can begin on designing drugs that bind to specific sub-units, to either inhibit its activity for anti-cancer treatment or promote its activity as an anti-ageing therapy.

Anyone for scorpion?

A novel use for scorpion venom proves that cancer treatments don’t always originate from the lab. Among the powerful cocktail of neurotoxins packed into scorpion venom is a peptide that is not toxic to humans and binds to a receptor found only on some tumour cells. By attaching radioactive iodine isotopes to the venom, researchers have found that they can extend the lifespan of people suffering from inoperable brain cancer.



I SAY chaps, this jolly well isn't on, don't you know, what?

When Chris James contacted Google Docs help centre in order to post a comment, he got this message: "If you would like to contact us, you will need to do so in one of the languages below. We are unable to provide email support in your language at this time."

The "languages below" consisted of a list of precisely one: "English (US)".

Chris's language is English (UK) – which, apparently, Google cannot provide support in. Feedback is appalled, don't you know.

THE IT service at the University of Hull's Centre for Environment and Marine Science in Scarborough, UK, recently sent round a message headed: "Update - Failure of Uninterruptible Power Supply Unit."

Lisa Scott tells us that this interruption to the uninterruptible unit - which regulates the power to the main university data centre - was

so serious that all university networked computing services were at risk from power surges until the interruption was dealt with.

THE AlphaGalileo European science news organisation always signs off the headlines of its press releases with the words "from AlphaGalileo.org". Sometimes, Alan Burkitt-Gray notes, this can have unfortunate consequences, as in a recent headline that read: "Inadequacy of current guidelines for sexually transmitted infections from AlphaGalileo.org."

HERE is our nomination for daft product instruction of the week. When Tim Newberry ordered some light bulbs - or "lamps" - from BLT Direct, the company sent him an email notifying him that the goods had been dispatched and warning him: "Important Information - Please note goods cannot be refunded unless the original packaging is intact. Please ensure you have

the correct lamp before opening packaging."

The goods arrived in a totally opaque cardboard box, making it impossible to fulfil the second instruction without an X-ray scanner or the like. And of course, if Tim ignored this instruction and opened the package, thus rendering it no longer intact, he would not be eligible for a refund if it turned out the contents were a set of croquet hoops instead of the lamps he had ordered.

THE technical support web page of the ZoneAlarm website states: "Users who have no internet or email access at all and cannot uninstall or shutdown ZoneAlarm, please Click Here."

Although he did have internet access - as we suspect you will have figured out already - Roy Kettle clicked. He was given a phone number for use only by those with "no internet or email access at all".

"Presumably," Roy speculates, "someone at that number is wondering why no one ever calls."



SOUTH OXFORDSHIRE District Council in the UK is changing its waste collection system to encourage residents to recycle more. This will involve using three outdoor bins, two of which will be large wheeled affairs. The council is aware that this might pose difficulties for some residents, and has circulated a leaflet to all homes that states: "We realise that not all homes are suitable for wheeled bins, for

example flats and houses with no side, front or rear access."

Jim Watson wonders how people without these forms of access get into their homes. Do they lower themselves through a hole in the roof?

MEANWHILE, it is good to see that some organisations are beginning to take seriously the problem of ridding the planet of hazardous emails. The instruction at the bottom of an email that Joe Geesin received told him: "If you are not the intended recipient of this email, please return to sender to arrange safe disposal."

FINALLY, a competition for all the family, to celebrate the Wallace and Gromit exhibition at the Science Museum in London. Feedback has teamed up with Carlton Books to offer you the chance to win a copy of *Grand Adventures and Glorious Inventions: The scrapbook of an inventor and his dog* by Penny Worms, signed by the characters' creator, Nick Park. This fun hardback is packed with information about Wallace's cracking contraptions and his madcap adventures with Gromit - from *A Grand Day Out* to *A Matter of Loaf and Death*.

All you have to do is write to us describing in no more than 100 words your own Wallace-and-Gromit-style invention. The best entry will receive a copy of the book signed by Park, with four runners-up each receiving an unsigned copy.

You may enter the competition by email (address below; please put "Competition" in the subject field), fax, post or by visiting www.newscientist.com/article/dn16888. The competition closes on 4 May 2009 and no entries will be accepted after that date. The results will be published in the 16 May issue of *New Scientist*. The editor's decision is final.

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.

Travelling across Wales recently, David Lloyd passed a pub apparently called THE WHITE ION. He wondered if this reflected the scientific sophistication of the pub landlord, or the quality of Welsh beer

Surround sound

I live a kilometre north of a busy motorway. When the wind is coming from the south the noise of the motorway is noticeably greater than when the wind is coming from the north. Assuming a wind speed of a mere 30 kilometres per hour, how can the wind direction affect the level of traffic noise I hear when the speed of sound is more than 1235 kilometres per hour.

■ Wind is the single most influential meteorological factor within approximately 150 metres of a noise source such as a highway.

The wind's effects are mostly confined to noise paths close to the ground. The reason for this is what is known as the wind shear phenomenon: the wind speed is lower in the vicinity of the ground because of friction.

This velocity gradient tends to bend sound waves downward when they are travelling in the same direction as the wind and upward when in the opposite direction. This process, called refraction, creates a noise reduction upwind from the source of the sound and a noise increase downwind from the source.

Over distances greater than 150 metres, vertical air temperature gradients are more important. This is because under certain stable atmospheric conditions, temperature increases with height either from the ground up, or from some altitude

above the ground. Such an inversion occurs when a layer of warm air is trapped between layers of cold air. This inversion increases the speed of sound with increasing altitude, causing sound waves to be refracted back towards the ground. This would lead to an increase in ambient noise levels for far-away listeners.

*Victor Zeuzem
San Mateo, California, US*

■ The wind does not appreciably speed up the sound and, even if it did, this would not explain why the sound should be louder. What happens is that the sound is refracted, or "bent", in rather the same way as a ray of light is refracted as it passes from air into water.

This happens because wind speed is not constant with height. At 100 metres altitude, say, the air is moving at 30 kilometres an

"Sound moving horizontally through air will be bent upwards if it is moving against the wind"

hour. Closer to the ground, however, trees and buildings get in the way, so the wind speed is lower. At ground level, in between the blades of grass, the wind speed is close to zero.

Sound moving horizontally through air when there is a velocity gradient like this will be bent upwards if it is moving against the wind, and downwards if moving with the wind.

The best way to visualise this



is to imagine a row of joggers with their arms hooked together running in a straight line on a beach. If the sand is uniformly firm, they all run together at the same speed and the line of joggers moves straight ahead. Now imagine that the sand is moist but firm at the end of the line of joggers nearest the water (providing fast-going conditions), and dry and soft at the other end away from the water (providing very slow running conditions). In this case the line will curve around because the fast runners have to stay hooked to the slow runners.

So, by the same reasoning, if sound travels 30 kilometres an hour faster at 100 metres altitude than it does at ground level, the sound wave front, which can be thought of as a planar disturbance, bends downwards.

*Hugh Hunt
Department of Engineering
University of Cambridge, UK*

THIS WEEK'S QUESTIONS

GET YOUR SKATES ON

I recently saw this collection of pond skaters on our garden pond (see photo, left). Can anyone tell me what they were doing and why they adopted this strange formation?

*Dominic Cox
Enfield, Middlesex, UK*

HIGH BALL COCKTAIL

When I lived in Addis Ababa, Ethiopia, I played badminton and squash. The reduced air resistance at 2600 metres altitude makes a perceptible difference to the flight of a shuttlecock: it travels much further. Should there also be a noticeable difference to the flight of a squash ball? If there is an effect it is less noticeable, but my squash partners and I would like to think that it exists, rather than admit age and a lack of fitness are slowing us down.

*Mark Harvey
London, UK*

HORSING ABOUT

When I was younger, my mum used to drive us past a field with a horse in it. There was a sign that read: "This horse is not dead, he sleeps that way." Indeed, sometimes the horse was lying on its back with its legs locked straight up in the air. How unusual was this behaviour and why or how did the horse learn to sleep that way?

*Rosemary Bell
Bradford, West Yorkshire, UK*

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