brain entertainment

ISSUE 34

VERY interesting

the quest for knowledge

Refresh your mind

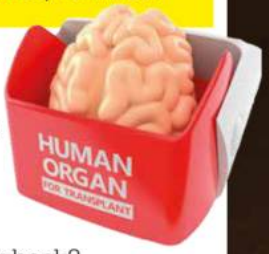
Does music affect our behaviour?

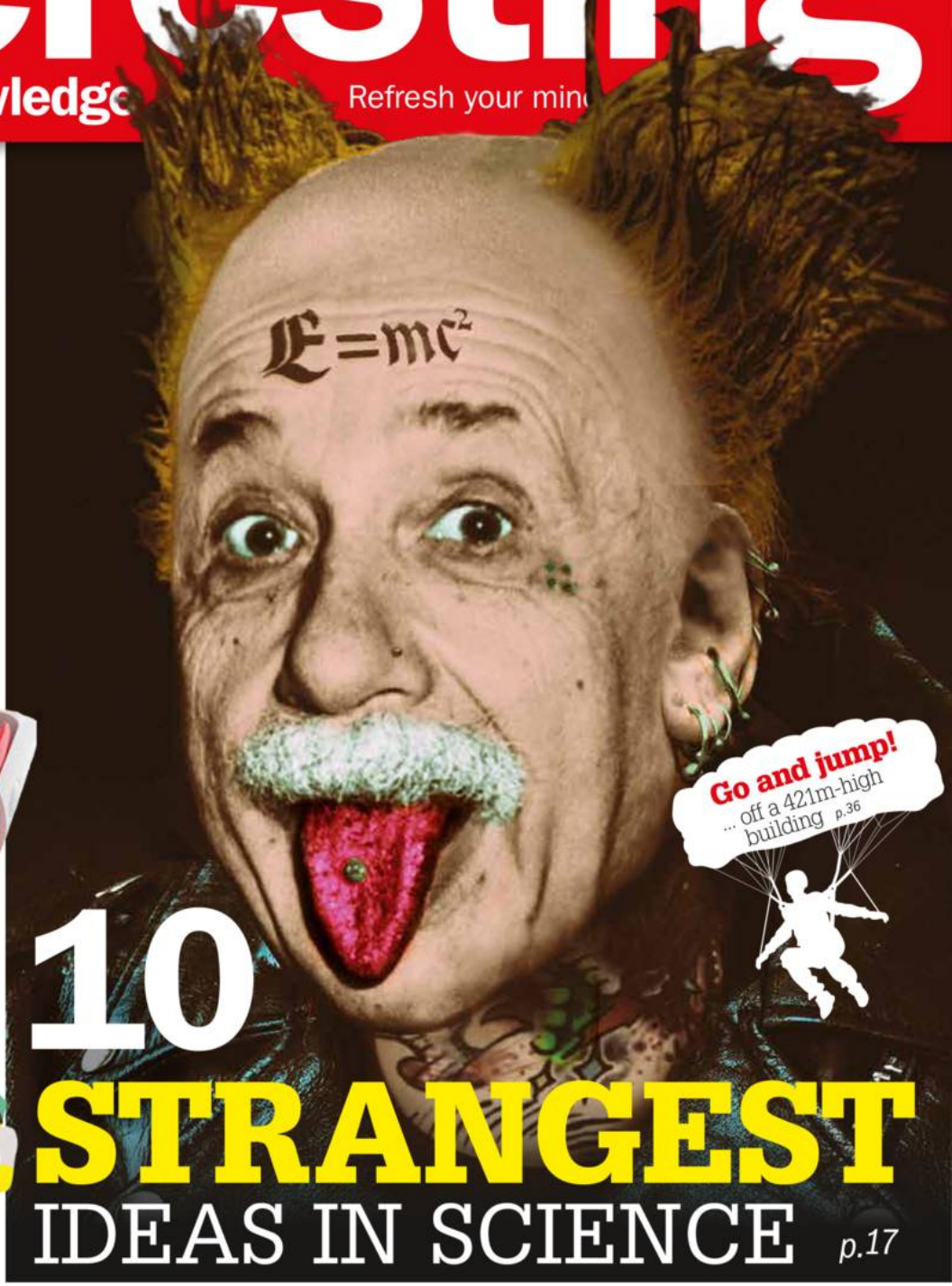
p.28

Are you tuning me, china?

Plus:

- **If I put my brain in another body, would I feel different?**
- Can your tonsils grow back?
- **Can computers keep getting faster?**
- If a lift is falling, what's my best chance of staying alive?
- **What are the longest-lasting landfill items?**





Go and jump! ... off a 421m-high building p.36

10 STRANGEST IDEAS IN SCIENCE

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CAN SPONGES HEAL US ALL?

Are there cures below the waves? p.60

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THE TRUTH ABOUT EXERCISE!

Does it actually help you lose weight?

p.49

ARE WE BECOMING MORE VIOLENT?

p.40 The stats are surprising!

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A mammoth bonus

It sounds like the plot of a movie made across town in Hollywood. In 2006, when the Los Angeles County Museum of Art (LACMA) began the excavation of an underground parking garage, engineers discovered 16 previously unknown fossil deposits. That fossils existed in the area was not entirely unexpected – the famous La Brea Tar Pits are adjacent to the LACMA property – but finding a nearly complete Columbian mammoth skeleton was a highlight for the team working on the discovery. The adjacent Page Museum has since been renamed the La Brea Tar Pits and Museum to highlight the tar pits and their value.

VERY interesting?

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Go with your gut

Sometimes the straight and narrow is the way to go. Be guided by your intellect, not your emotion. Tick all the boxes on the questionnaire. All of that will work a lot of the time – you won't, for instance, get 7,000 cars off a production line by the end of the week by juggling with pistons during lunch hour.

However, at other times, you may just get a feeling that something different is required, that the status quo should be as widely ignored as a brassiere at the Reed Dance. There have always been mavericks willing to go out on a limb, even when that meant that the Spanish Inquisition* might come knocking, and we celebrate a few of those apparently bonkers ideas in *The 10 strangest ideas in science* on page 17.

Music is something that makes people behave in strange ways – witness everything from the dad-dancers at weddings to the mass head-banging at a metal band's stadium gig – and its impact on our emotions is explored in *The power of music* on page 28.

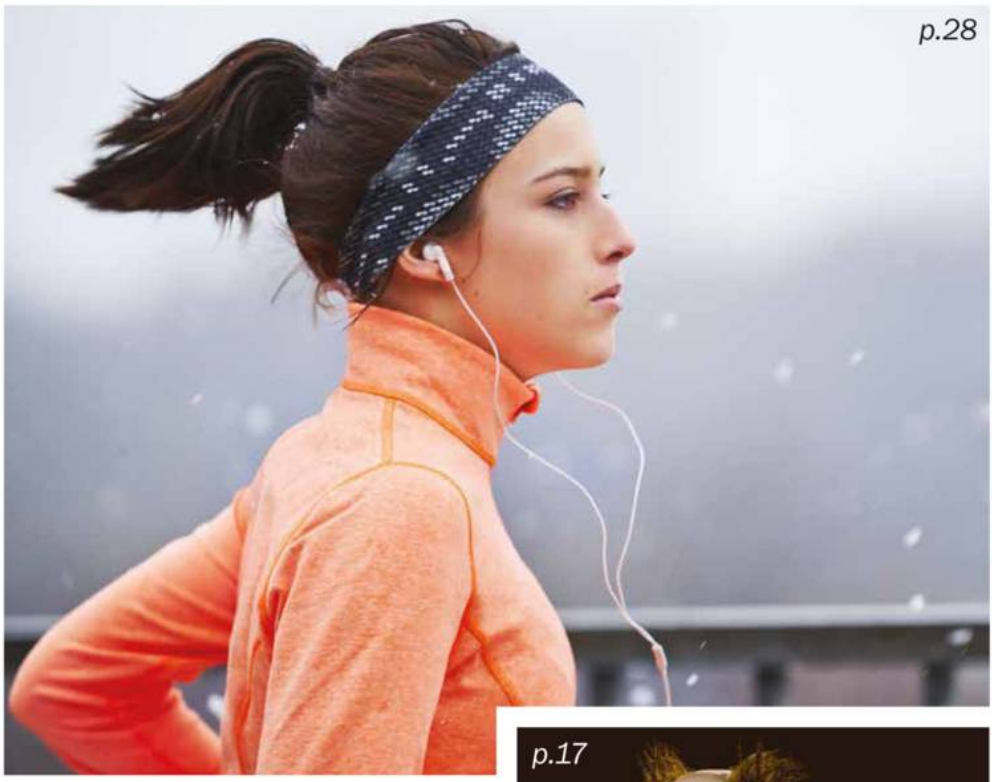
Go to page 36 for a picture essay about people who jump off skyscrapers for fun, and then consider whether the decision to do so can be all down to a carefully considered academic process. And note extreme swimmer Ryan Stramrood's sensible answers in our interview on page 56: he's decided to swim huge distances with icebergs bobbing around him, but he's not crazy.

Be inspired to think differently by these and other stories in this issue. And keep your questions coming to VI@panorama.co.za. Also, take advantage of our subscription deals at www.coolmags.co.za/product/vi/.

Bruce Dennill
Editor

***NO ONE expects the Spanish Inquisition!**

this issue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Should Venice still be on your travel bucket-list?


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Can a piece of cake make you friendlier?

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All you need to know about the foam on your beer.

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mavericks, groundbreakers,
and trailblazers.

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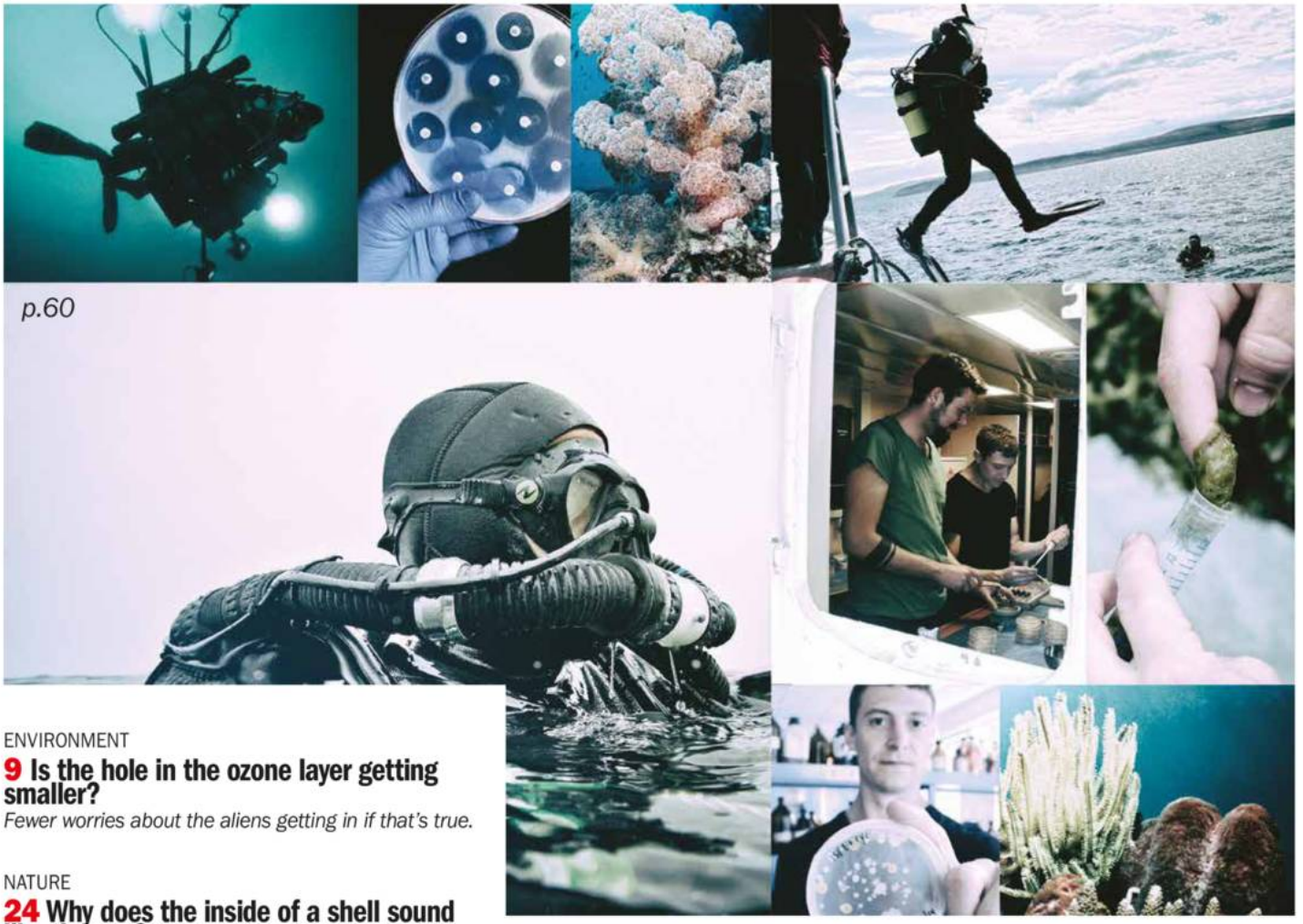
this**issue**



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ENVIRONMENT

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Fewer worries about the aliens getting in if that's true.

NATURE

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Hmm – does the Indian Ocean sound different from the Atlantic?

HISTORY

67 Were the Neanderthals the original hipsters?

Look, we know there were no skinny jeans at the time, but still ...

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The alternative medicine visionary on his ideas and challenges.

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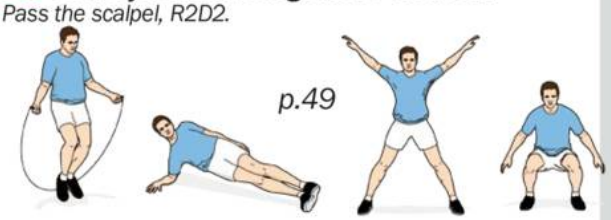
Pass the scalpel, R2D2.



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PLUS All the questions you didn't know you wanted the answer to including:

- *How do drought balls work?*
- *What is dark matter?*
- *If I put my brain in another body, would I feel different?*
- *Can computers keep getting faster?*
- *If a lift is falling, what's my best chance of staying alive?*
- *What are the longest-lasting landfill items?*
- *Why is nail-biting so addictive?*
- *How does snake venom kill so quickly?*
- *Could an asteroid knock Earth out of its orbit?*
- *What's the difference between Formula 1 and Formula E?*
- *How far can dandelion seeds travel?*
- *Can your tonsils grow back?*
- *What is the Interplanetary Superhighway?*
- *What connects X-Men and elephants?*
- *What happens to a person's online data after they die?*
- *Can you survive skydiving without a parachute?*

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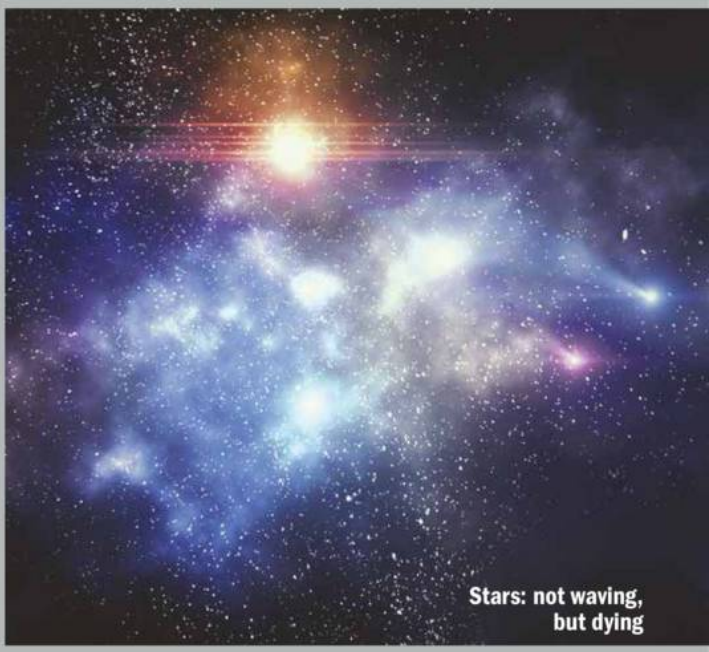
Stars: not waving, but dying

Big bang theory

■ Why does a star shine its brightest just before it dies?
Matt Anderson, Hillcrest

Stars' centres are nuclear reactors converting hydrogen to helium, a process that results in their brightness. A star's mass and the amount of matter it contains are what determine its longevity and brightness. Heavier stars are hotter, experiencing greater compression at their centres, resulting in younger – and much brighter – deaths. This death takes millions of years to occur, beginning when the central stores of hydrogen are exhausted, leaving a thin layer around the core still experiencing nuclear reactions and, ironically, producing more energy than before. The now continually expanding star shines a brighter red colour, resulting in the name 'red giant'. As the outer edges of a red giant disperse, the remaining gas forms a bubble around the dying star, like a glowing halo. This is called a 'planetary nebula'. Due to its brightness and size, this is easy for us to see.
In the last stage of a star's death, it is called a 'white dwarf'. Due to the star's reduced size, shining only because of the heat it held at birth, it cools over time, fading from yellow to orange and red before dying and fading from sight altogether.

Scratch that itch

■ What is the purpose of itching and why does tickling sometimes feel funny and at other times painful?
Jos Graindor, Pretoria

Professor Mark AW Andrews of Lake Erie's College of Osteopathic Medicine explains that itching (pruritus) is a sensation caused by irritation of skin or nerve cells. As with other bodily functions such as coughing, itching has a self-protective purpose, helping

Questions, suggestions or observations? Share them with us:
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- **Email: VI@panorama.co.za**

Please include your name and address. The editor reserves the right to shorten and edit letters.

Sound over speech

How and why is a person's accent indistinguishable when singing, whereas in normal conversation, their voice is thickly accented?
Vanessa Leong, via email

Singers are able to learn how to sing in a language different to their own by learning the words to a song phonetically. A tool such as the International Phonetic Alphabet helps singers of opera, classical and traditional music, which often requires them to perform in many different languages. It is based on how letters and words sound, rather than trying to learn the correct pronunciation and spelling as we would when studying a language.
Physically, the air pressure that we use to make sounds and speech increases when we sing, improving the pronunciation of words. The same is true of the tempo or rhythm of the song itself.
David Crystal, a Northern Irish linguist and author, believes that the melody of a song removes natural speech intonations while the music's beat eliminates a person's natural speaking rhythms.
Marly Mageau, who holds a master's degree in Cognitive Science, has researched this very question, adding to what David Crystal has published. She also believes that there are social or cultural pressures at play. It has become very fashionable to sing with an American 'neutral' accent, which many artists emulate without realising it – singers such as England's Adele, who sings with a markedly American accent. Mageau believes that this could be a conscious or unconscious decision based on the music's market appeal or genre being associated with American accents.

to let us know that we have encountered potentially harmful substances. Nerve endings that cause itching when stimulated are called pruriceptors and are most typically stimulated by inflammation – either chemically, mechanically or thermally induced:
- ***Chemically** – histamines (immune response), opioids (pain relief)*
- ***Neuropeptides** – such as endorphins*
- ***Neurotransmitters** – such as acetylcholine and serotonin*
- ***Prostaglandins** – lipids (fats) responsible for feeling pain in spinal nerve cells*

Specialised nerve cells called C-fibres, while identical to those that allow us to feel pain, specialise in creating our itchy feeling, causing us to rub or scratch, which has the knock-on effect of interfering with the pruriceptors of the C-cells by activating a multitude of pain and touch receptors in the same area, explaining why we sometimes feel heat, pain or tingles when we scratch an itch or are tickled.

Seed of discontent

Why does the flavour of aniseed permeate other products when touching them or when kept in the same container?
Armand Kaalsen, Centurion

*While aniseed is not liquorice, they do share a common flavour. Aniseed (*Pimpinella anisum*) is a flowering plant native to the eastern Mediterranean and Southwest Asia. Anethole, one of the aniseed plant's essential oils, is the most powerful component of the liquorice flavour that we experience when eating foods flavoured with aniseed.*
To understand the power of scents, we have to look at their volatility (vapour pressure). The higher the pressure, the stronger the taste or smell. While there is no specific research on the specific volatility of anethole, the permanence of its scent suggests that it is fairly volatile, allowing it to permeate plastic containers and other foodstuffs in a shared environment.
Aniseed is used medicinally, as food flavouring and in alcoholic beverages.

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Very Interesting is the only magazine I regularly buy and actually read from beginning to end.

Trish Engelbrecht
My family always has so much fun sharing facts from the magazine.

Dorothea Mackenzie
We recently discovered, to our delight, this magazine providing amazing facts and answers!

Nomthimba Chiliza
Your magazine is so entertaining to read. Thank you!

Like us on Facebook (*Very Interesting*), follow us on Twitter (@V_I_mag) and ask a question at VI@panorama.co.za.

Quickies

Locating survivors in a burning building just got easier, thanks to this new fireman's mask with built-in thermal imaging

TECHNOLOGY

How do firemen see in dark, smoky rooms?

American company Tyco, which makes fire and security products, has unveiled 'Scott Sight' – a firefighter's face mask with built-in thermal imaging.

These days, firefighters routinely use thermal imaging to locate people who are in need of rescue from smoke-filled rooms, but until now this has meant carrying bulky thermal imaging cameras into the emergency zone, which obviously leaves them with one less hand for fighting fire and rescuing people. Scott Sight solves that problem by placing a thermal imaging camera on the front of the mask, and a small heads-up display inside it. The camera and display will run for up to four hours on a single charge, and the system can be calibrated for different ambient temperatures, which is kind of useful when you're inside a burning building. We're actually quite surprised it's taken this long for such a device to arrive. But better late than never, eh?

CYBERNETICS

Fingertip control

This robotic hand was created by a team led by Zhe Hu of Yale University and Emanual Todorov of the University of Washington. It's already incredibly human-like in its abilities, and is able to pick up very small objects – but now the researchers want to go one step further and give it real human tendons and skin.

To create the hand, the team 3D-printed exact replicas of the bones from an actual human hand, then joined them together using a polyethylene fibre called Spectra which is both strong and flexible. To give the hand realistic contours, laser-cut sheets of rubber were used, but now the researchers hope to use the hand as a frame on which to grow real human tissue.

If it works, the obvious application would be as a prosthetic hand for people who've lost one. But since the hand can also be operated remotely using a sensor-equipped glove, it could also prove a valuable tool for anyone undertaking delicate engineering tasks in hostile environments, such as astronauts or nuclear power plant personnel.

Shorts

- **The first known case of a robot killing a person occurred in 1981, when a Kawasaki factory worker was crushed by a robotic arm in Japan.**
- **There are 4,000 robots (mostly used for recon-naissance) in the US military.**

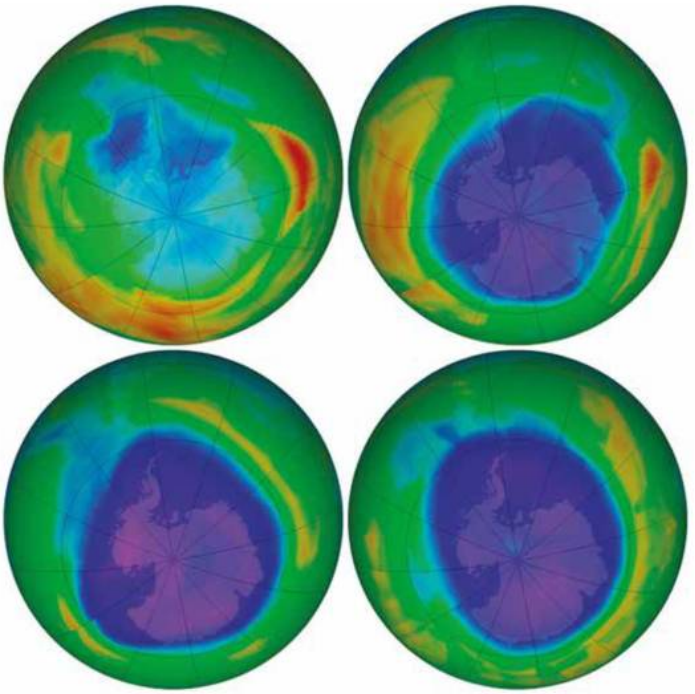
Bumblebees' hairs quiver when exposed to static electricity from flowers

ROBOTICS

Shelf-employed robots are coming

More and more jobs can be done by machines these days, and the latest occupation put on the endangered list by robotics engineers is that of the supermarket stocktaker. Developed by Canadian firm 4D Retail Technology Corp, the Space Genius is a Segway-based robot that can inventory an entire supermarket in less than an hour. It uses AI to navigate its way around, while digital cameras and object-recognition software help it determine what is on the shelves.

For consumers, this means there's much less chance of the items you want being unavailable – but the arrival of Space Genius is likely to be greeted with rather less enthusiasm by existing supermarket staff.



Visualisation of the changes in the hole in the ozone layer over Antarctica from 1979 to 2011, moving from purple (low ozone levels) through to blue, green, yellow and orange (high ozone levels)

NATURE

Bees sense flowers' electric signals with their hair

With their bold yellow and black markings and fuzzy bodies, bumblebees are some of the most charismatic insects around. Now, a team from the University of Bristol has found that they use their distinctive fuzz to detect electric signals from flowers.

The researchers found that bumblebees' fuzzy hairs quiver rapidly when exposed to the static electricity created by flowers. By investigating the insects' nervous system they were then able to confirm that they used the hairs to guide them to sources of pollen. The findings suggest that electroreception in insects may be widespread, they say.

"We were excited to discover that bees' tiny hairs dance in response to electric fields, like when humans hold a balloon to their hair," said research lead Dr Gregory Sutton.

"A lot of insects have similar body hairs, which leads to the possibility that many members of the insect world may be equally sensitive to small electric fields."

Electroreception may arise from the bees' hairs being stiff and lightweight, giving them properties similar to the spider hairs and mosquito antennae that are sensitive to sound, the researchers say.

Electroreception is common in aquatic mammals, such as sharks, but has been little studied in insects. Scientists hope that research into how flower signals are perceived, received and acted upon by bees will lead to a deeper understanding of the complex relationship between insects and pollinators that keep the planet green.

ENVIRONMENT

Hole in the ozone starts to heal

In 1987, virtually every nation in the world signed the Montreal Protocol. It was a concerted effort to ban the use of CFCs in order to repair the widening hole in Earth's ozone layer. Now, almost 30 years later, it appears to have paid off as scientists at MIT have found evidence that the hole in the ozone layer over the Antarctic is closing.

The team found that the ozone hole has shrunk by more than four million square kilometres, or about half the area of the United States, since 2000, when ozone depletion was at its peak.

"We can now be confident that the things we've done have put the planet on a path to heal," says lead researcher Susan Solomon. "Which is pretty good for us, isn't it? Aren't we amazing humans, that we did something that created a situation that we decided collectively, as a world, 'Let's get rid of these molecules'? We got rid of them, and now we're seeing the planet respond."

Shorts

- **Ozone was used to disinfect wounds and to treat gangrene and trench foot in World War 1.**
- **Ozone can also be used to sanitise water in swimming pools.**

The ozone hole was first discovered in the 1950s. But concerns began to grow in the mid-1980s when scientists from the British Antarctic Survey noticed it was widening. CFCs (chlorofluorocarbons), chemical compounds once emitted by dry-cleaning processes, refrigerators and aerosol sprays, were thought to be the main culprit because the chlorine they emit into the atmosphere eats away at ozone. According to Solomon, if levels of chlorine in the atmosphere continue to dissipate at the current rate, the ozone hole could be closed by the middle of the century.

Q&A
Questions & Answers

Is Jupiter growing?
Gugu Ngcolosi, Villiers

Jupiter's large gravitational field makes it prone to impacts from asteroids, comets and other solar system flotsam. This was spectacularly demonstrated in 1994 when the comet Shoemaker-Levy 9 plunged into the atmosphere of Jupiter, adding at least one trillion kilograms to the planet's mass in a single event. It is estimated that Jupiter's rate of mass increase from impacts or accretion is up to 8,000 times that of the Earth's. Events like Shoemaker-Levy 9 are rare but even adding up the smaller bombardments of Jupiter that continuously rain down on the planet, the increase in mass is still a tiny fraction of Jupiter's overall total. However, this does not mean that Jupiter's mass is increasing. Jupiter's atmosphere is warm; so warm that gas molecules are moving fast enough to escape the gravitational pull of the planet. Furthermore, the solar wind actually ionises many of the atoms in the Jovian atmosphere. Since these atoms become neutrally charged, they can easily escape Jupiter's magnetic field and float off into space. This slow but constant loss of mass from Jupiter's atmosphere is actually greater than the gain in mass from collisions so, overall, Jupiter is shrinking not growing in mass.

Q&A FLASH
- Jupiter is the fastest-spinning planet in the solar system, completing a full rotation on its axis in only 10 hours.
- The magnetic field on Jupiter is 14 times stronger than Earth's.

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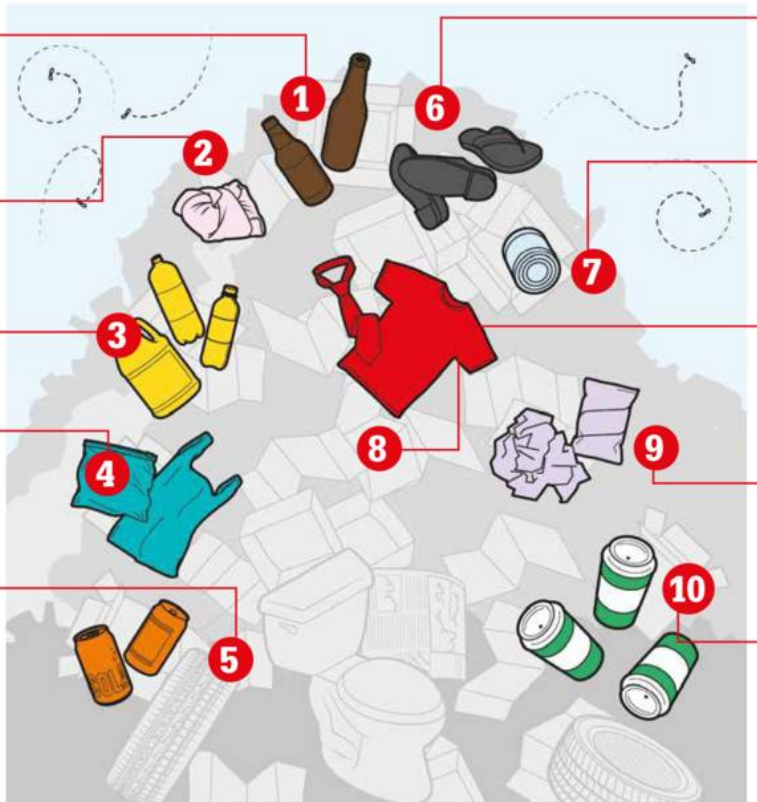
Longest-lasting landfill items



1. Glass bottles
Time to break down: one million years

2= Disposable nappies
Time to break down: 450 years

2= Plastic bottles
Time to break down: 450 years

4. Plastic bags
Time to break down: 200-500 years

5. Aluminium cans
Time to break down: 80-200 years

6. Rubber-soled shoes
Time to break down: 50-80 years

7. Tin cans
Time to break down: 50 years

8. Clothing
Time to break down: up to 40 years

9. Plastic film*
Time to break down: 20-30 years *clingfilm, magazine wrappers, crisp packets, etc

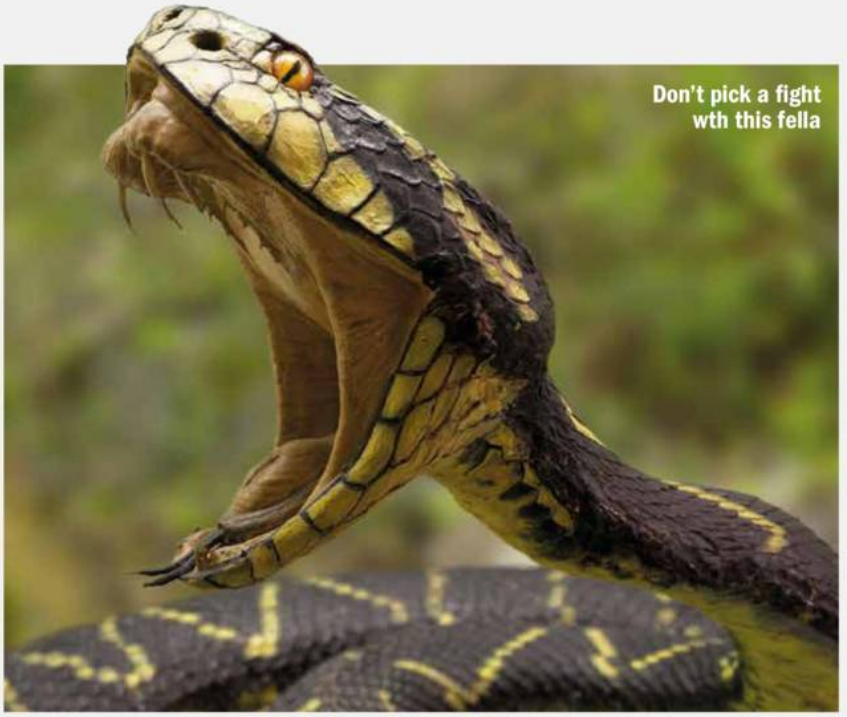
10. Paper coffee cups
Time to break down: 20 years

Got questions you've been carrying around for years? *Very Interesting* answers them! Mail your questions to VI@panorama.co.za

Why is nail-biting so addictive?

Jenny Venter, Westonaria

There are plenty of theories for why people start nail-biting (or what doctors call 'onychophagia'), including perfectionism and stress. And there's also the Freudian notion that it's to do with being stuck at the oral stage of psychological development! But as to why nail-biting is so addictive (20 to 30% of us do it), there's little research. We can speculate that it is to do with its cost-free ease, practicality and relative social acceptability, and there's the rewarding aspect of getting each nail just how you want it. On a positive note, childhood nail-biters are less prone to allergies, presumably because they're exposed to more germs.



Don't pick a fight wth this fella

How does snake venom kill so quickly?

Lukhona Khathini, Askham

Snakes don't have claws or powerful jaws to pin down their prey. If the venom doesn't kill quickly enough, the victim may escape into a burrow or up a tree and die out of reach of the snake – or, worse, injure the snake in its death throes.

Snakes are in an evolutionary arms race with their prey, which are evolving ever-greater resistance to snake venom. Snakes have adapted to this by evolving venoms that contain a cocktail of several hundred different enzymes and proteins. Some block nerve transmission, others interfere with the beating rhythm of the heart, some break down muscle tissue or cause blood vessels to suddenly become leaky.

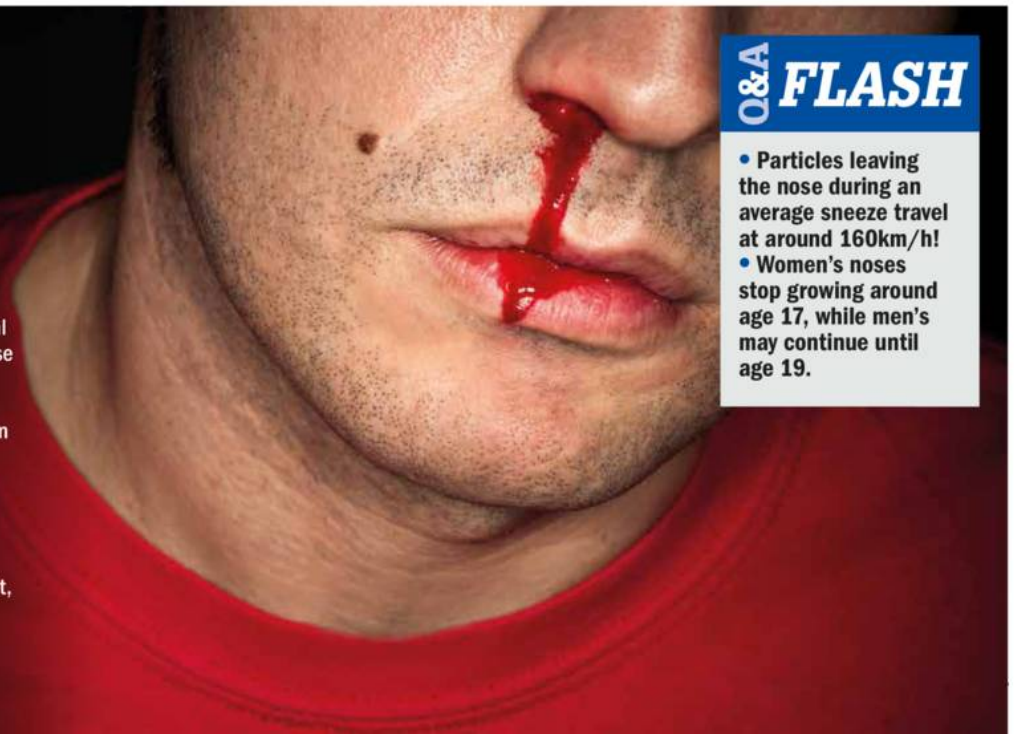
Snakes can control how much venom they inject with a single bite and generally use far more than the lethal dose. The black mamba, for example, injects up to 12 times the lethal dose for humans in each bite and may bite as many as 12 times in a single attack. This mamba has the fastest-acting venom of any snake, but humans are much larger than its usual prey so it still takes 20 minutes for you to die.

Can you die from a nosebleed?

Andre Nel, Carletonville

Most nosebleeds involve superficial bleeding from the capillaries close to the skin and can be stopped with pressure and an ice pack. But nosebleeds can also be caused by a torn internal carotid artery and in that case the bleeding can be fast enough to be life-threatening. It's also possible for a milder nosebleed to block your airway and asphyxiate you.

A 47-year-old man from Gravesend, Kent, died this way in 2011.



Q&A FLASH

- Particles leaving the nose during an average sneeze travel at around 160km/h!
- Women's noses stop growing around age 17, while men's may continue until age 19.

Q&A
Questions & Answers

Got questions you've been carrying around for years? *Very Interesting* answers them! Mail your questions to VI@panorama.co.za

What is dark matter?

Lionel Govender, Ballito

Over 80% of the matter in the universe is made up of this stuff, but despite its name it can't simply be made up of dead stars, gas and dust. Dark matter has to consist of something more exotic than standard atomic particles to ensure the Big Bang produces a universe chemically similar to the one we see.

Such observational constraints have forced theorists to focus on a handful of candidates for dark matter.

Leading the pack are so-called weakly interacting massive particles ('WIMPs') and gravitinos, whose existence is predicted by theories aimed at unifying all the fundamental forces and particles of nature.

The other main contenders are axions, predicted to exist by theories of how atomic nuclei hold together. Experiments now underway at the LHC could soon reveal the truth.

How did cavemen cut their toenails?

Tracey Botha, Hillcrest

They could theoretically have used a flint edge to trim them, or a rough stone to file them down. However, we don't have any firm evidence of 'cavemanicure' at all, since no fingernails or toenails survive from any Stone Age burial sites. If you spend your day walking barefoot and scraping up roots with your hands, your nails will wear down naturally, which is why they have evolved to keep growing throughout our lives.

Can your tonsils grow back?

Perpetua Mkhize, Moddel Bay

Yes. In about 10% of cases in one study, there was some regrowth of the tonsils after four years. This can happen if the surgeon accidentally leaves some of the tonsil tissue behind, but it's quite common to deliberately perform a partial tonsillectomy too. Regrowth is more common after the age of seven and in individuals with diets high in sugar.

Is sea level rise accelerating?

Tom Smith, Oudtshoorn

Wading through floodwater: still more pleasant than public transport

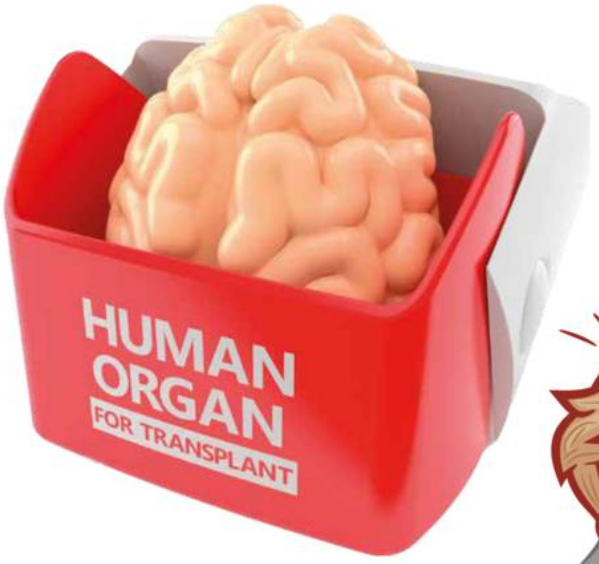
PHOTOS: GETTY X2, ISTOCK, SCIENCE PHOTO LIBRARY

Global sea levels rose by about 19cm from 1900 to 2010, creeping up by an average of 1.7mm a year.

Since 1993, satellite measurements have allowed us to make more precise measurements of sea level change, showing that between 1993 and 2010, sea levels increased by just over 3mm per year, almost double the average pace for the 20th century. As global temperatures continue to soar, scientists expect that sea levels will rise at even faster rates in coming decades, resulting in a further increase in global sea levels of up to 80cm by the end of the century.

Q&A FLASH

- **In the 1990s, weather-related disasters claimed around 600,000 lives.**
- **There were 150 glaciers in the Montana National Glacier Park in 1910 – today there are only 25.**
- **Some scientists believe that inducing global warming on Mars could help make it possible for humans to live there.**



If I put my brain in another body, would I feel different?

Armand Pretorius, Paarl

You'd feel paralysed! The only time this has been tried was in 1970 when Robert White transplanted the head of a monkey onto the body of another, decapitated monkey. This gruesome hybrid was conscious, but paralysed from the neck down because we can't yet reattach severed nerves. If we ever get past this obstacle, body transplants will still take a lot of getting used to. For one thing, your brain would be exposed to a different cocktail of hormones.

Can computers keep getting faster?

Almahle Bhengani, Sabie

The laws of physics stop computers getting faster forever. Computers calculate at the tick of an internal clock, so for many years manufacturers made transistors smaller and clocks faster to make them perform more computations per second. However, conventional electronics get too hot if you make them calculate too fast, which is why we no longer see clock speeds increasing much. Instead we now have more and more 'cores' – lots of processors all calculating in parallel – to let them do more work in the same time. Scientists have calculated fundamental limits on maximum speed and storage achievable by computers. In order to reach those theoretical limits, you may need to use black holes as quantum computers, and they would probably evaporate in a puff of Hawking radiation too quickly to allow them to calculate very much.

If a lift is falling, what's your best chance of staying alive?

Arthur Chambers, Eastleigh

1. Sit tight

Unless the building suffers catastrophic damage, such as during the World Trade Center attacks of 2001, lifts almost never fall. A lift has between six and 12 independent cables and each one is strong enough to support a fully loaded lift. If all the cables fail, brakes will automatically clamp onto rails lining the lift shaft.

2. Don't jump

Jumping up at the last moment, before the lift hits the bottom, only works in cartoons. Even if you were somehow strong enough to leap fast enough to negate your falling velocity, you would just smash your head against the lift ceiling at the same speed you had been falling!

3. Fall from the top floor

In 1945 a B-25 bomber crashed into the Empire State Building and damaged the lift cables. Betty Lou Oliver fell 75 storeys, breaking her neck, back and pelvis, but survived. The huge length of steel lift cables hanging beneath the lift car coiled into a springy mat at the bottom of the shaft and this partly cushioned her fall.

PHOTOS: ISTOCK X2 ILLUSTRATION: CHRIS PHILPOT

Q&A
Questions & Answers

Got questions you've been carrying around for years? *Very Interesting* answers them! Mail your questions to VI@panorama.co.za

Could an asteroid knock Earth out of its orbit?

Irvine Moodley, Despatch

No. The Earth has a lot of mass and moves extremely quickly in its orbit around the sun; in science speak, we say its 'momentum' is large. To significantly change the Earth's orbit, you would have to impart a very great change to the Earth's momentum. Not even the largest asteroids have sufficient mass and kinetic energy to make much of a difference to the Earth's momentum. Even more of an obstacle is the fact that our planet's binding energy is greater than its orbital kinetic energy. This means that any object large enough to change the Earth's orbit is also big enough to completely destroy it!

Q&A FLASH

- **Some asteroids have their own moons.**
- **The '1 Ceres' asteroid is 952km across, and has an icy core and a rocky outer crust.**

FORMULA 1		FORMULA E
728kg	**WEIGHT (INCL DRIVER)**	898kg
710kW	**MAX POWER**	200kW
2.1 secs	**0-100KM/H**	3 secs
378km/h	**MAX SPEED**	225km/h
134dB	**NOISE LEVELS**	80dB

Like Formula 1, Formula E is a racing championship with single-seater, open-cockpit cars, but the vehicles are entirely battery-powered. With a top speed of 225km/h and a power-to-weight ratio 35% higher than a Tesla Roadster, they are no slouch. But F1 cars still win – their 1.6-litre petrol/electric hybrid engine has more than three times the power.

How do drought balls work?

Anna Kendal, Tiverton

The warmer water gets, the faster its molecules move. This extra energy allows water to evaporate more quickly. By shielding the water from sunlight and keeping it cool, drought balls (also known as shade balls) can slow evaporation from water bodies. In 2014, the Los Angeles Department of Water and Power released 96 million of these plastic balls into the city's main reservoir. Their goal was not to save water but to reduce the growth of microorganisms and prevent the creation of bromate, a carcinogen that forms through a chemical reaction triggered by UV light. The balls did, however, reduce evaporation by up to 90%.

The drought balls in Los Angeles will last for 10 years, and will then be recycled

PHOTO: ZUMA PRESS/EYEVINE

Q&A FLASH

• The oldest viable seed, found in the fortress of Masada near the Dead Sea, was approximately 2,000 years old. The date palm grown from the seed is known as 'Methuselah'.

Poor dandelion seeds. They never get out of their parent's shadow

How far can dandelion seeds travel?

Phila Menziwa, Fochville

A 2003 study at the University of Regensburg in Germany found that 99.5% of dandelion seeds land within 10% of their parent. That's because the seed 'parachute' falls at about 30cm per second and dandelions only grow about 30cm high. So that gives each seed just one second of flight time to be blown sideways by the wind to its new home. Higher wind speeds don't really increase the distance the seeds fly, because strong winds tend to blow downwards as well as sideways, so the seeds just land even sooner. The best conditions for dandelion seeds are actually relatively calm, sunny days that generate thermal updraughts. Under these conditions, dandelion seeds can go much further and the study estimated that 0.014% – about one in 7,000 – would travel more than a kilometre.

PHOTOS: SCIENCE PHOTO LIBRARY, ISTOCK, GETTY ILLUSTRATION: CHRIS PHILPOT

Skydiving without a parachute

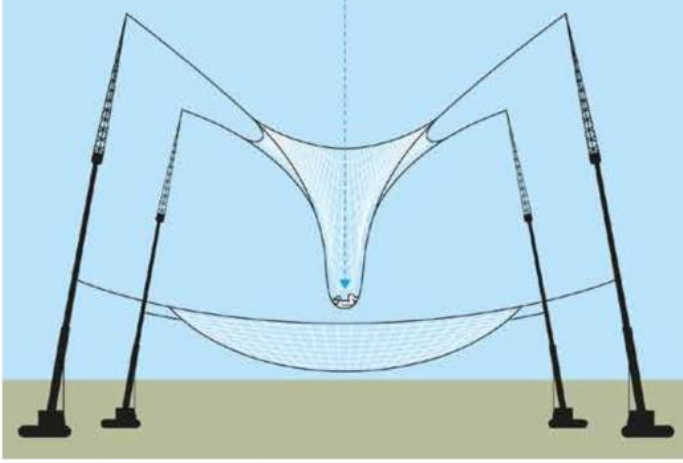
In July 2016, 42-year-old US skydiver Luke Aikins set a new record for the highest skydive without a parachute. But how did he do it?

THE JUMP
Aikins leapt out of the plane at a height of 7,620m without wearing a parachute or wingsuit.

THE FALL
Aikins reached speeds of 193km/h during the two-minute fall.

THE GUIDANCE SYSTEM
A GPS system on his helmet relayed his position to a guidance system on the ground, which was linked up to the net. The net featured a system of lights that shone red when he was off-target, and white when he was correctly oriented.

THE LANDING
A second before impact, Aikins flipped onto his back. He landed in a polyethylene net measuring 30 x 30m that was suspended above the ground by four cranes.



Non-genuine parts work. Technically.

Just because it sort of meets the requirements, doesn't mean it'll perform quite as it should. The difference between genuine and non-genuine parts comes down to a question of quality, safety, and keeping your warranty. Choose the parts that ensure all three. Ask for Volkswagen Genuine Parts.

Volkswagen

Visit your nearest Volkswagen Dealership to find out more.

THE 10 STRANGEST IDEAS IN SCIENCE

As Albert Einstein once said, "Imagination is more important than knowledge." So with that in mind, here are some of the most radical theories in science, from anti-ageing humans to the Earth's second sun

TEXT: DUNCAN GEERE

10 PSYCHEDELIC DRUGS MAY HELP TREAT MENTAL ILLNESSES

It's no secret that drug policy is confusing. At times, it can seem that there is little scientific rigour involved in the regulation of substances (for up-to-date, confidential advice and information on drugs, visit talktofrank.com). This state of affairs is changing slowly, however, as researchers discover previously unknown, positive effects in some of the most villainised drugs.

Of particular interest is the use of psychedelic drugs in treating mental illness. At Imperial College, scientists have been mapping the effects of LSD on the brain, showing that it can be used to develop therapeutic approaches for breaking patterns of negative thought and treating depression.

Elsewhere, psilocybin, the active ingredient in magic mushrooms, has been found to be effective in alleviating anxiety and depression among cancer patients for as long as six months after a single dose.

And in tests on mice, a chemical by-product created when the body breaks down ketamine has reversed depression-like behaviours without triggering any of the dissociative or addictive side effects normally connected with the drug.

All this adds up to a potential renaissance when it comes to understanding how these drugs affect the human body. Perhaps soon, a visit to the doctor may mean coming away clutching a prescription for something that would currently see you locked up.

9 MYSTERIOUS DISTANT STAR IS SURROUNDED BY AN ALIEN MEGASTRUCTURE

In the constellation of Cygnus, 1,480 light-years from Earth, sits a very weird star. KIC 8462852 (or 'Tabby's Star', named after its discoverer Tabetha S Boyajian) dims and brightens in an odd pattern, utterly unlike anything we've seen elsewhere in the night sky. A number of explanations have been proposed, like swarms of comets or planetary building blocks, but none can wholly explain the star's behaviour.

While ruling out various possibilities, however, other researchers noted that the signal was consistent with one pretty wild idea – that an enormous alien megastructure surrounds the star, perhaps harvesting its energies. The theory was originally suggested half-jokingly, but as time goes on, and the more likely explanations get ruled out, people are beginning to wonder if it could be plausible.

Astronomers hunting the skies for extraterrestrial life have failed to find any signals coming from the star, but intend to keep listening. The odds are astronomically tiny that we've found aliens. But hey, who knows?

8

WE ARE ALL VAMPIRES

The blood of the young can slow down the ageing process, accelerate healing and even treat degenerative brain disorders. That's not the plot of a sci-fi novel, it's the result of new research by degeneration expert Dr Tony Wyss-Coray at Stanford University. Though to be clear, he's only experimented on mice so far. "We discovered that circulatory factors in the blood of young mice are sufficient to slow or reverse behavioural deficits and other signs of brain ageing in old mice," he says.

In other words, old mice that share a blood supply with young mice are rejuvenated: their brains, muscles, pancreases, livers and hearts start behaving like those of a younger mouse.

The discovery originally came about when Wyss-Coray was trying to find a protein biomarker for Alzheimer's disease. "We noticed that the biggest changes in dozens of measured proteins occurred with ageing rather than with disease," he says.

His colleague Dr Tom Rando had previously shown that young blood can rejuvenate old muscle stem cells, so Wyss-Coray decided to see if the brain would benefit from the same process. It did. In maze testing, older mice that had been injected with plasma from young mice performed as if they were half their age. When their brain tissue was examined, the team discovered that the exposure to young blood had strengthened connections between neurons that normally weaken with age.

But can the results be recreated in humans? "We are planning to treat 18 patients with mild to moderate Alzheimer's disease and hope to finish recruitment this year," says Wyss-Coray. "Once the trial concludes we will analyse the data. There are no results before then."

Elsewhere, a worrying market has begun to emerge in blood plasma. "I strongly believe in clinical trials and think there should be no treatments done without a positive phase three clinical trial result," he adds. "Until then, I feel nobody should really pay for plasma infusions."

But even if it does work, there are probably limits to the effect. "Biological systems are too complex to be maintained and regenerated indefinitely," says Wyss-Coray. "Even if our findings can be translated to humans, I think we will only have limited effect on some, but not all, aspects of ageing."

Five of the most bizarre science experiments in history

John Paul Stapp and flight testing

When jets were developed after WWII, questions were raised over what kind of acceleration the human body could safely handle. Colonel John Paul Stapp from the US Air Force volunteered for a series of tests that subjected him to g-forces of up to 45g. He survived the experiments with no lasting injuries and died at the grand old age of 89 in 1999.

José Delgado and his bull brain control

In 1963, Yale researcher Dr José Delgado stepped into a bullring in Cordoba, Spain. A huge, angry bull charged straight at him. But Delgado calmly pressed a button on a remote control, which sent a signal to an electrode he'd implanted in the bull's brain the previous day. The animal huffed a few times and walked away calmly, leaving Delgado unharmed.

Stanley Milgram experiments

In the wake of the war crimes trials of Nazi leaders, a public debate emerged over whether 'just following orders' was a valid legal defence. Yale psychologist Dr Stanley Milgram performed an experiment to find out, using electric shocks to prove that people will obey even the most awful orders when they are delivered by figures in authority.

Stubbins Ffirth and yellow fever

In 1804, a trainee doctor named Stubbins Ffirth went to extraordinary lengths to prove that yellow fever wasn't contagious. He smeared vomit from infected patients into cuts on his arms, poured it into his eyes, fried it and inhaled the fumes and drank it. He didn't contract the disease, but it was later found that the samples came from patients who were no longer contagious.

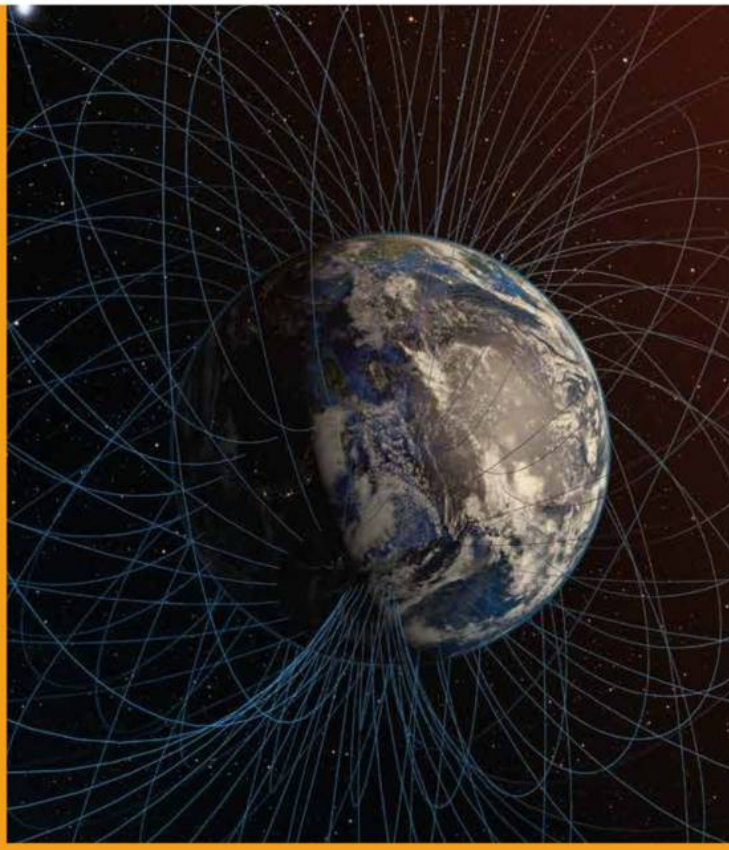
Margaret Howe and peter the dolphin

In the 1960s, NASA funded research into communicating with dolphins, hoping that the principles would allow us to talk to aliens. For 10 weeks, Margaret Howe lived with a dolphin named Peter in a lab flooded with water. Over time, Peter became disruptive, showing sexual attraction to Howe. She relieved his urges manually so the experiments could continue.

PHOTOS: GETTY, ALAMY, DAFYDD OWENS , CHRIS PHILPOTT

7 LIVING AND THINKING BEINGS CAN SPRING INTO EXISTENCE FROM NOWHERE

According to quantum mechanics, space is anything but empty. It is full of particles constantly flitting in and out of existence thanks to quantum fluctuations in energy. In principle, these fluctuations could give rise to collections of particles such as a hydrogen atom, a microwave oven, or even a living, thinking brain. The catch? The universe would have to be infinitely big and exist for an infinite period of time for this to happen.
Dubbed 'Boltzmann brains' after the 19th-century Austrian physicist Ludwig Boltzmann, the idea goes like this: though the chance of such an event occurring is minute, it isn't zero. Therefore, it is theoretically possible that, in an infinitely big universe, over an infinite period of time, such a thing could occur. There could be Boltzmann brains on planets, they could be floating in space. They could be anywhere.
According to some calculations, it is more likely that there are Boltzmann brains existing in the universe than beings that evolved gradually though natural selection. The trouble is nobody has seen one. For some, the theory is something of an embarrassment, and debate still rages among cosmologists of how exactly to rid physics of this so-called 'Boltzmann brain problem' once and for all.



6 HUMANS HAVE A LOST SIXTH SENSE

It sounds like something from *X-Men*, but geophysicist Prof Joe Kirschvink believes we may have a sixth sense that allows us to sense Earth's magnetic field in the same way that some birds can – we've just forgotten how to use it. And he's been performing a series of experiments to try to figure out if that's the case.
Deep underground at Caltech in the US, Kirschvink had 24 volunteers hooked up to brainwave monitors and sat, in complete darkness, inside a Faraday cage. This structure blocks out electromagnetic background noise. He then applied a rotating magnetic field similar in strength to Earth's around them. When the field was rotated in an anticlockwise direction, Kirschvink recorded a drop in the alpha waves in the volunteers' brains. This kind of drop is normally associated with brain processing, which suggests that the volunteers' neurons were firing in response to the moving magnetic field and so were able to subconsciously sense it.
The results have not yet been peer-reviewed, but two other labs are working on replicating the experiments.

Some experts think that abilities can be embedded in our genes

5 MEMORIES CAN BE PASSED DOWN IN YOUR GENES

It's pretty clear that organisms pass some form of knowledge down in their genes. Newly hatched sea turtles will automatically move towards the sea, while baby kangaroos climb into their mother's pouch when born.

The term we use for such behaviours is 'instinct', but some researchers believe it may be possible to transfer more than just instinct through genetics. They propose that knowledge, including learnt abilities and the rules that govern them, can also be embedded in our genetic code.

"There is ample room on DNA to store phenomenal amounts of information," says Dr Darold Treffert, a psychiatrist who specialises in the study of savants. "The entire Library of Congress, for example, could be recorded on a speck of DNA."

Savants are people with developmental disorders such as autism, who also demonstrate remarkable capabilities in certain areas. They may be a musical genius, an exceptional artist, have a photographic memory or be able to perform complex maths calculations in their head. Treffert says that the ability of savants to display prodigious skills without learning them is proof of 'genetic memory', the ability to pass memories down in the genes. "We do not start with a blank disk," he says. "Beginning life with much inherited software applies to us all."

The idea isn't new. Eminent Swiss psychiatrist Carl Jung proposed the idea of a 'cosmic consciousness' that some people could tap into. The concept of reincarnation deals with similar principles.

These ideas tend to be rejected outright by modern mainstream thought, in favour of a 'nurture' approach to how we acquire knowledge. But there is some experimental evidence to the contrary. Scientists at Emory University trained mice to fear the scent of cherry blossom by giving them a small electric shock every time they smelt it. After several repetitions, the mice began to cower whenever they smelt the scent, regardless of whether they were shocked or not. This may be exactly what you would expect, but the team also found that two subsequent generations of rodents whose parents had been trained to fear a smell similar to cherry blossom would avoid the scent, despite never having experienced the associated electric shock.

Treffert believes that his research is key to understanding how this process works. "I think savants, both congenital and acquired, are irrefutable evidence for the 'nature' side of the argument," he says. "I am just reporting what I have observed in so many savants now, and I'm searching for an explanation. Genetic memory makes the most sense to me."

PHOTOS: GETTY X3, NIKLAS JANSSON/WIKIPEDIA

4 THE FIRST HUMAN TO LIVE TO 1,000 IS ALIVE NOW

Medical technology is extending our lifespans at two years a decade

Around the globe, about two-thirds of all deaths are from age-related causes. In industrialised countries, that figure rises to 90%. Forget terrorism, malnutrition, war and malaria – when you look at the stats, the world's biggest killer is old age.

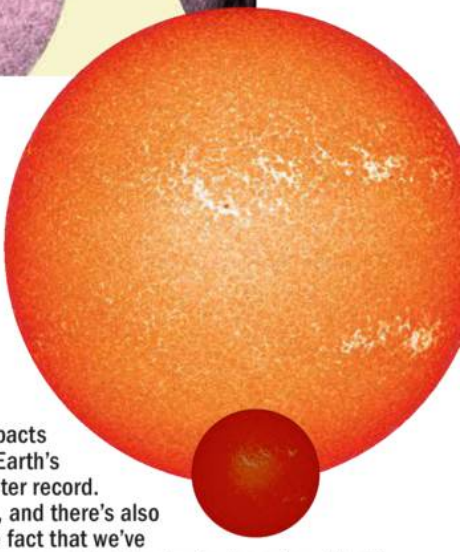
Over the millennia we've figured out a lot of ways to live longer, from tool-making and control of fire through to writing, agriculture, trade, the scientific method, democracy and so on. Today, new medical technology is extending our lifespans at a rate of about two years a decade. But what if we could increase that rate beyond the rate at which we age?

That's the question that SENS Research Foundation, founded in 2009 by expert in ageing Aubrey de Grey, is trying to answer. SENS says there are seven major types of 'damage' that occur in the human body and result in ageing: cell loss; mutations in mitochondria (a cell's 'energy factory'); junk proteins accumulating inside cells; junk proteins accumulating outside of cells; cancer-causing mutations in nuclear DNA; useless or harmful cells that don't die; and excess cross-linking proteins weakening bonds between cells within a tissue. For each of these areas, SENS has developed at least one proposed therapy and is now working towards starting human trials.

About a decade ago, de Grey made the grand prediction that many people alive today are going to live to 1,000 or more. He says he's still confident in that. "The science has proceeded very much along the path I had expected – not as rapidly as I'd hoped, but that's only because it's been harder than I'd hoped to attract the necessary funding," he says.

However, he admits that there aren't any low-hanging fruits in terms of achieving substantial life expectancy increases. "Multiple different types of damage can kill us by accumulating to levels that the body can't tolerate, and they require multiple different interventions to repair," de Grey explains. In the context of ever-more-sophisticated medicine, de Grey believes that there's no upper limit to how long a human can live. "It's like vintage cars," he says. "Cars that only receive the level of maintenance that the law requires have a very predictable upper limit to lifespan. But throw in a dollop of additional maintenance effort, and lo and behold, indefinite longevity. I don't think anyone is saying that cars that are currently 100 years old will definitely not make it to 200."

3 THE SUN HAS A HIDDEN TWIN



The universe is filled with binary star systems in which planets rotate around more than one star at the same time. But the solar system just has one star, the sun, right? Well, perhaps not if the 'Nemesis theory' is correct.

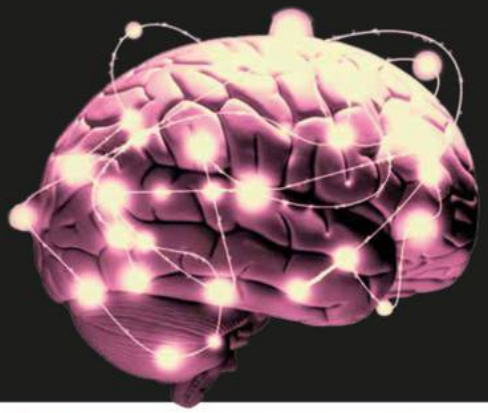
The theory goes something like this: over the last 250 million years, Earth has seen mass extinctions every 26 million years or so. The idea is that these extinctions were caused by the catastrophic impact of comets sent hurtling into the inner solar system by a small second star called Nemesis – the sun's twin star. We've never spotted Nemesis because it's very dim and small compared to the sun, and it's moving very slowly from our perspective.

Large parts of the theory are open to dispute. The scientific consensus is that Earth's mass extinctions don't in fact occur on a predictable cycle, and there's no evidence for periodic impacts in Earth's crater record.

Oh, and there's also the fact that we've been searching the sky for decades with all manner of instruments and have never seen even a whiff of such a star.

But the theory lives on, most recently in observations of Sedna, a dwarf planet that's locked into an extremely distant orbit of the sun. According to our understanding of the solar system, Sedna shouldn't be where it is. We've got something wrong, we just don't know what.

2 HUMAN INTELLIGENCE EMERGED AS A FREAK GENETIC MUTATION



PHOTOS: GETTY X3

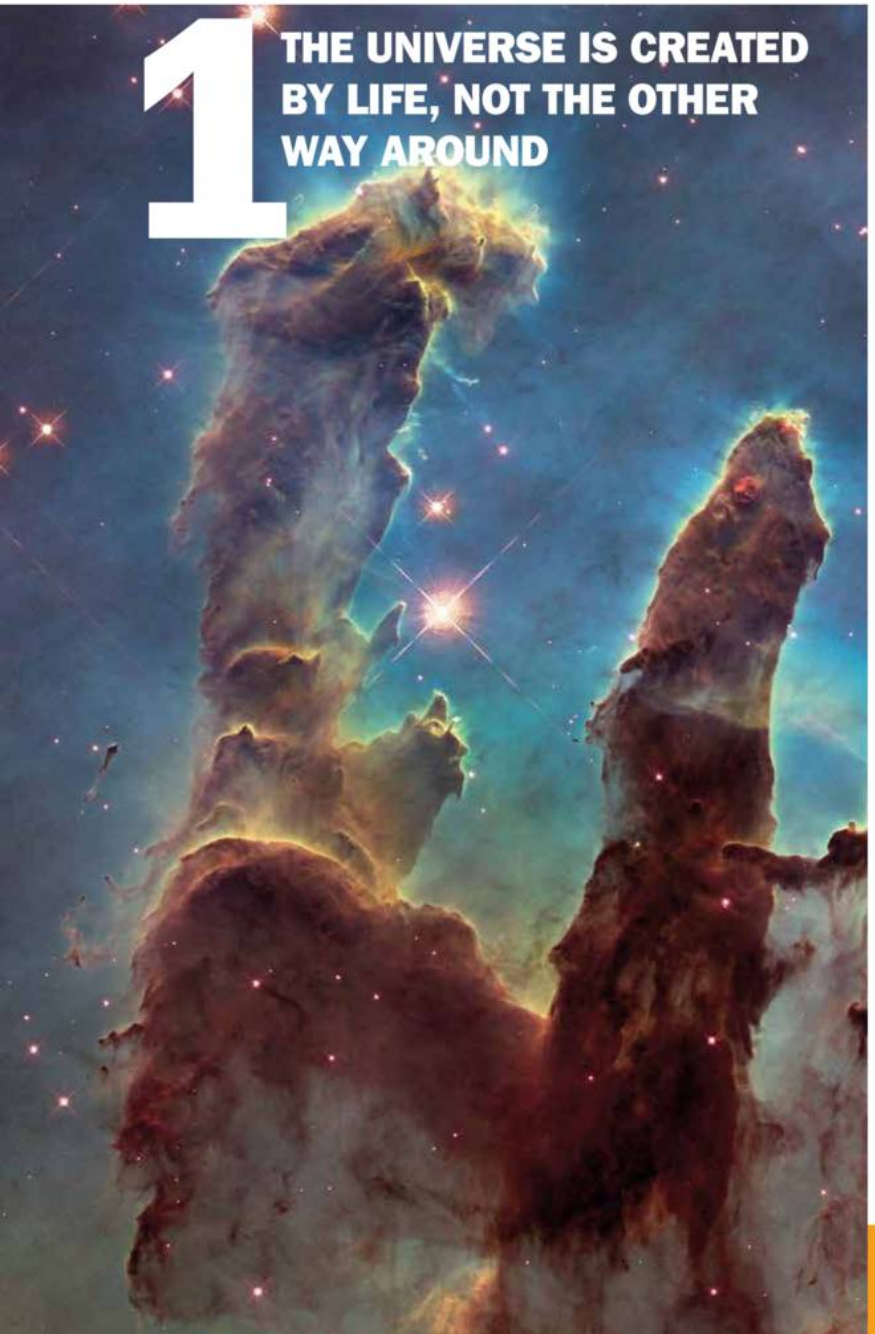
Two hundred thousand years ago, human brains were substantially smaller than they are today. They'd been growing slowly for about three million years or so, but then abruptly there was a dramatic increase of about 30% or so.

So what happened? Prof Colin Blakemore, a neurobiologist from Oxford University, believes that it's all down to an individual named 'Mitochondrial Eve' who lived about 200,000 years ago.

His theory is that a dramatic and spontaneous mutation in the brain of Mitochondrial Eve, or one of her relatives, substantially boosted our brainpower. It brought us to a level that allowed us to come up with solutions to crises like droughts and climatic changes that would otherwise have killed us off. From there, natural selection did its work.

The upshot of this theory is that *Homo sapiens* is something of a genetic accident. It's probably no surprise to learn that not everyone is on board with this idea, with most researchers believing that our intellectual abilities were gained through gradual evolution. But if Blakemore is correct, then perhaps we've only seen the start of what the human brain is capable of.

1 THE UNIVERSE IS CREATED BY LIFE, NOT THE OTHER WAY AROUND



Physicists argue that their field is the most fundamental science. After all, every other science – biology, engineering, chemistry and so on – depends on the substances, energies and interactions of physics.

But Robert Lanza, a US doctor and eminent scientist, believes this is upside-down, and that biology is the central driving science in the universe. He calls his theory 'biocentrism'.

Lanza first set out his ideas in a 2007 article that appeared in *The American Scholar*, and later expanded them in a 2009 book titled *Biocentrism: How Life And Consciousness Are The Keys To Understanding The True Nature Of The Universe*. In both works, he argues that consciousness creates the universe, not the other way around. "Biocentrism is a new theory of everything," he says. "In this view, life and consciousness are central to any true understanding of the universe."

Take the classic double-slit experiment, one of the mysteries in quantum mechanics. If you fire a beam of electrons at two parallel slits onto a screen, the electrons travelling through one slit interact with those travelling through the other to produce an interference pattern. However, the pattern is still produced even if the electrons are fired through one at a time. They seemingly interact with themselves. But that's not all. If we observe which slit each particle travels through, then the pattern isn't formed. The particles no longer appear to interact with one another. It's like they 'know' they're being watched. Physicists are yet to solve this problem, but Lanza thinks he has the answer.

"How can a particle change its behaviour depending on whether you watch it or not? The answer is simple – reality is a process that involves our consciousness," he says.

The same logic holds for entangled particles: the phenomenon that the specific quantum states of particles are seen to remain connected regardless of the distance between them.

"How can a pair of particles possibly be instantaneously connected on opposite sides of the galaxy? Because they're not – space and time are simply tools of our mind," Lanza says.

Reception to these ideas has been mixed. Some have questioned whether biocentrism can ever generate testable predictions, while others have argued that it is more of a philosophical than a scientific theory.

Lanza disagrees."They are incorrect," he says. "Even the entanglement of living beings might soon be scientifically testable." ■

VI@panorama.co.za

Q&A
Questions & Answers

Got questions you've been carrying around for years? *Very Interesting* answers them! Mail your questions to VI@panorama.co.za

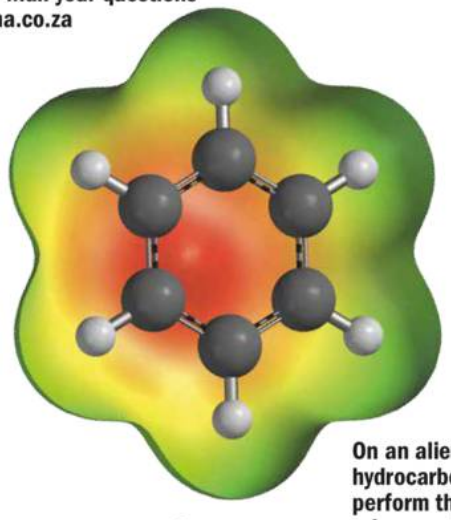
Who reached the North Pole first?

Claire Rogers, Benoni

For many years that accolade went to the US explorer Robert Peary, who claimed to have reached the North Pole on 6 April 1909. Yet even at the time his claim was disputed. Dr Frederick Cook, a rival American explorer, insisted he had reached the pole almost a year earlier. But neither of them could provide definitive proof of their supposed triumph. Cook's own evidence was rejected by an independent commission, while Peary refused to hand over any details at all.

In 1989, the US National Geographic Society announced that an analysis of photographs taken by Peary, together with his records of ocean depths and other data, were consistent with his expedition getting within 8km of the true pole. Cook's claim, meanwhile, has always been dogged by suspicions of fraud.

In the years that followed, the North Pole was reached many times by airborne and submarine expeditions. Surprisingly, the first undisputed expedition to reach the North Pole over the surface did not achieve its goal until 1968, when the American Ralph Plaisted and three companions arrived on snowmobiles. On 6 April the following year, the British explorer Wally – later Sir Walter – Herbert became the first to reach the North Pole the traditional way, on foot.



On an alien planet, hydrocarbons could perform the same role as water

Is water always necessary for life?

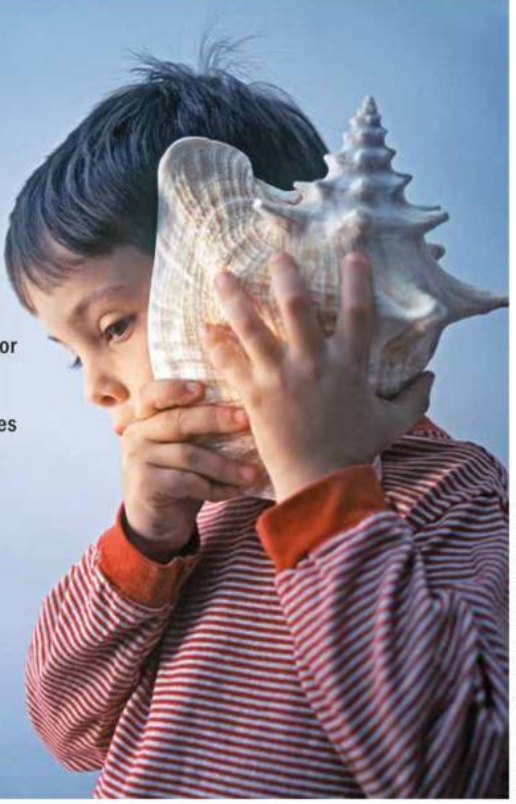
Simon Jacobss, Mafikeng

All known life needs liquid water to function properly. It's essential in part because water is such a good solvent, readily dissolving and transporting nutrients across a wide range of temperatures. Its molecules also play a key role in ensuring proteins behave properly. But some scientists suspect alien life may have evolved to exploit alternative chemicals like hydrocarbons capable of performing the same roles.

Why does the inside of a shell sound like the sea?

Charlotte Kruger, Inanda

The sound has nothing to do with the sea, nor the shell's oceanic origins. It's simply the result of the effect of the shell's shape on air trapped inside. Unable to escape, the air vibrates at frequencies dictated by the size of the shell, creating a mix that sounds a bit like waves on shingle. You can create a similar effect just cupping your hand over your ear.



PHOTOS: GETTY X2, SCIENCE PHOTO LIBRARY

IN NUMBERS

5,407

The number of threatened species on the IUCN Red List that are imperiled by agriculture alone. These species include the cheetah and the African wild dog.

1,700

The height in metres of an underwater mountain, Anton Dohrn, off Scotland's west coast. In comparison, Ben Nevis is 1,344m high.

10%

The proportion of UK adults who don't read any books at all.

Can moons have moons?

Zondwa Shenge, Nigel

There is no reason why a moon could not have a moon. But for such a 'sub-moon' to survive for any length of time, it would require a stable orbit around its parent moon. This generally means that the sub-moon would have to be quite small and orbit quite close to the parent moon. The bigger the sub-moon is and the further it is from the parent moon, the more likely it will be influenced by the gravitational attraction of the parent planet. Tidal forces can also easily prevent a stable orbit being possible. So, moons of moons are possible but probably extremely rare.

Q&A FLASH

- It was NASA scientist Eugene Shoemaker's final wish that his ashes be scattered on the moon, and the Lunar Prospector probe delivered his remains to its surface on 31 July 1999.

Why do we get 'the meat sweats'?

Jan Smit, Pinetown

There isn't much hard research specifically into whether meat makes you sweat, but one possibility is the 'thermic effect' of protein. We digest protein less efficiently, and for every 100 calories of meat we eat, 20 to 35 calories are wasted as heat, compared with 5 to 15 calories for fat or carbohydrate. The sweating may be necessary to flush away that waste heat.

Why do people get hangry (angry when hungry)?

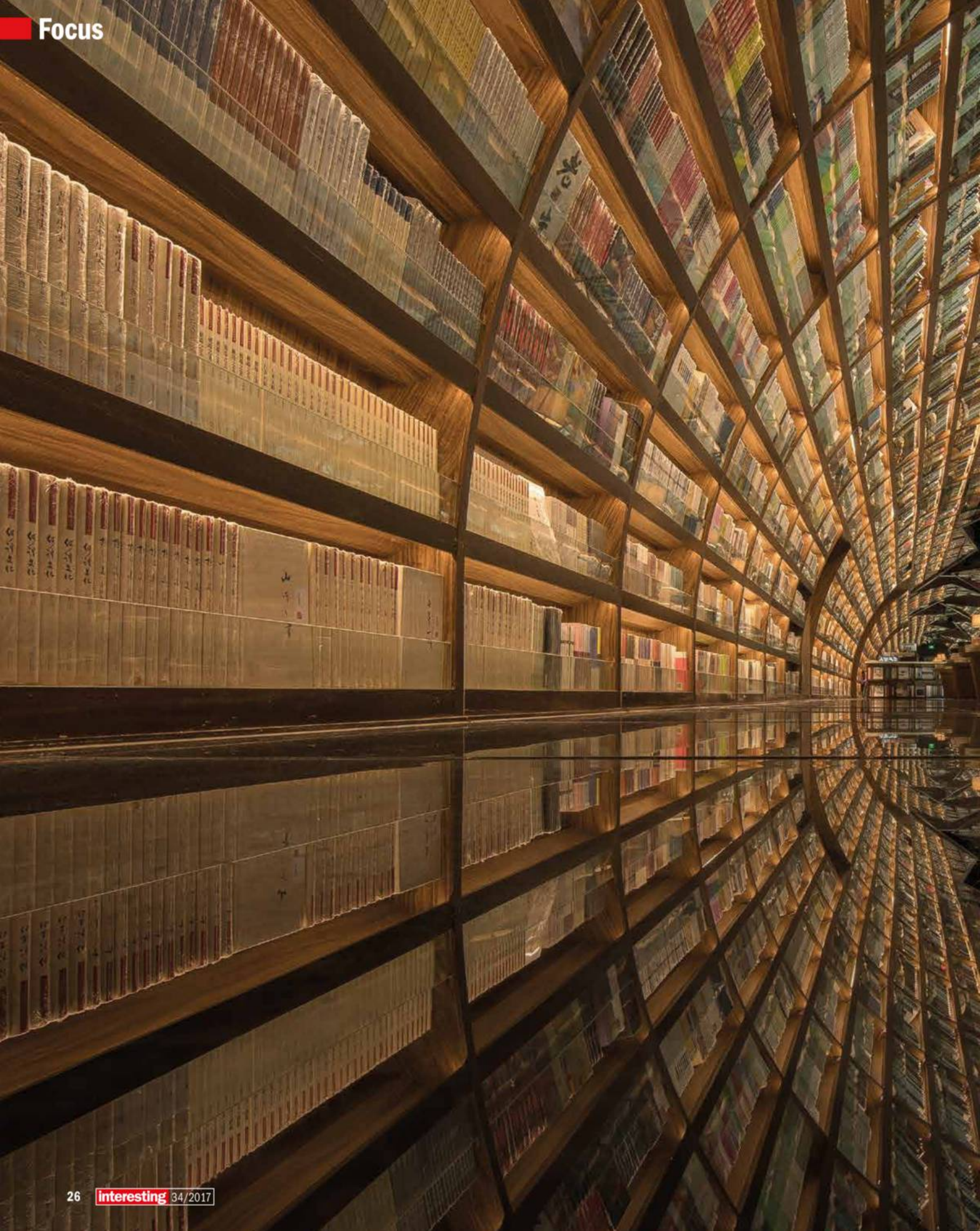
Jasper Singh, Rustenburg

Maintaining composure in the face of provocation takes self-control and there's a long-running theory in psychology that states self-control depends on blood glucose levels. When you haven't eaten you have less glucose, meaning that your tolerance is likely to run out sooner. In one study, psychologists gave married participants a voodoo doll to represent their spouse. Each night for 21 nights, the researchers measured the participants' blood glucose levels, and told them to stick as many pins in the doll as they wanted based on how angry they were feeling. The participants with the lowest glucose levels stuck in the most pins.

Q&A FLASH

- Heat, exhaustion and dehydration also tend to increase the likelihood of someone getting angry.

PHOTOS: ISTOCK X2



Tunnel vision

This seemingly infinite corridor of books leads to the entrance of the Yangzhou Zhongshuge bookshop in Zhen Yuan, southern China. The avant-garde architecture is the creation of designer Li Xiang of Shanghai-based architects XL-MUSE, and takes inspiration from the nearby Qiantang river.

Black tiles made from polished stone line the floor, which is intended to represent the reflective surface of the water. Meanwhile, the specially designed curved floor-to-ceiling bookshelves represent the many bridges that span the river.

"Yangzhou Zhongshuge is located in Zhen Yuan, which is next to the waterside and in front of the trees," says a spokesperson for XL-MUSE. "We added the arched bridge, an indispensable element of this historical and cultural ancient city, in our design concept as it used to be the guiding factor of culture and commerce. It represents that the bookstore is the bond between humans and books."

PHOTO: GETTY

DOES THE MUSIC WE LISTEN TO AFFECT OUR BEHAVIOUR?

What we choose to listen to can have a profound effect on our emotions and behaviour

TEXT: DR JOHN POWELL

Music is an integral part of our lives. We carry it in our pockets and blast it from the rooftops. It's the stuff that memories are made of, soundtracking our weddings, funerals and first kisses. But it has an even greater effect than you might imagine, from alleviating stress and depression to helping us bond with others and boosting IQ scores. Over the following pages, we delve into the surprising psychology of music.

Does music really have the power to affect our well-being?

Your body contains its own 'pharmacy' for dispensing an array of chemicals to help you respond to different situations: calming you down when you need to sleep, or putting you on alert if you're in danger.

If your pharmaceutical system is working properly, the correct chemicals will be dispensed at the appropriate times. If a dog starts chasing you, for example, your internal pharmacist will hand out a shot of adrenaline and a dose of cortisol. The adrenaline will get you ready to run or fight by increasing the oxygen supply to your muscles, directing more blood to your heart and lungs, and releasing extra glucose into your system. The cortisol reaction will further amplify the adrenaline's effects, increasing your blood sugar levels and concentrating energy supplies to your arms and legs. These effects are useful during short-lived 'fight-or-flight' events, but are not good for you over an extended period of time.

If you lead a busy, stressed life, you might become depressed or physically run-down because your inner pharmacist is constantly doling out adrenaline and cortisol – even in non-threatening situations. This is where music can help. Listening to calming music has been shown to diminish the adrenaline and cortisol levels in the bloodstream

Crystals of adrenaline, as seen through a light microscope

PHOTO: SCIENCE PHOTO LIBRARY

and therefore reduce stress. Researchers at the University of Toronto have even shown that this is true of distressed babies. On top of this, the fact that music is pleasurable tells the internal pharmacist to start handing out chemicals like dopamine and serotonin, which will improve your mood and help to banish the stress and depression.

How else can music help?

Music has also been shown to cure insomnia. In a study involving young adult insomniacs in Budapest in 2007, over 80% of the participants became better sleepers after three weeks of listening to classical music at bedtime. In a similar investigation involving Taiwanese insomniacs aged over 60, half of the participants were transformed into good sleepers within a few weeks. It normally takes an adult between 10 and 35 minutes to drop off to sleep. If you're having trouble drifting off, you could make your own playlist. Choose about 45 minutes of slow, calming music, and make sure the final track fades out gradually, otherwise the abrupt silence at the end will wake you up (one of our survival instincts is to wake up if things suddenly go quiet).

How does music manipulate our emotions?

The world of film offers obvious examples of music manipulating our emotions.

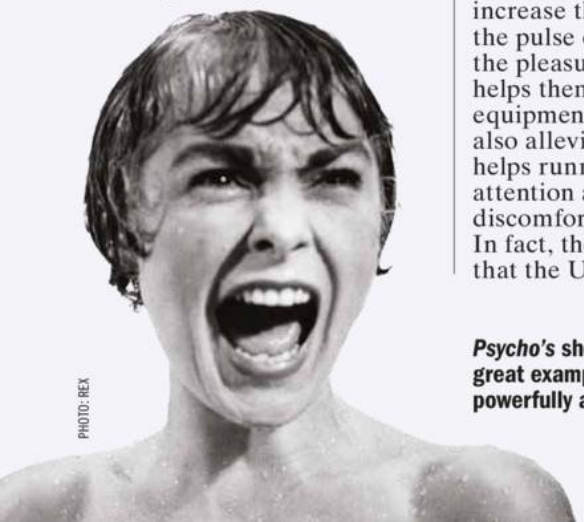


PHOTO: REX

***Psycho's* shower scene is a great example of how music can powerfully affect our emotions**

If the action on the screen is emotionally neutral (a woman walking down a street) the music can tip us off that something frightening or happy is about to happen. If the director wants to make you jump with fright, a sudden loud noise (or musical sound) is very effective in triggering your fight-or-flight response, which will flood your system with adrenaline and cortisol. Your brain subconsciously assumes that you're in danger because we have evolved to associate any unexpected noise (even music) with a possible threat. This is why the 'eee! eee! eee!' shower scene music in *Psycho* is so terrifying.

The job of a film's music composer is to manipulate your emotions without making the music too obtrusive. One effective way of amplifying the emotional impact of a visual event is to precede the climax of the scene with inappropriate music. If a father is searching for his daughter, we feel much more relief when she's found safe and sound if the searching scene was accompanied by creepy, menacing music. Similarly, we are a lot more horrified if, after a search accompanied by cheerful music, we are presented with a bloodstained body and a loud, anguished chord.

Does it help to listen to music while exercising?

Yes – gym-based studies have shown that music encourages people to increase their pace to match the pulse of the music, and the pleasure of listening helps them to stay on the equipment for longer. Music also alleviates boredom and helps runners to focus their attention away from pain or discomfort.

In fact, the effect is so great that the USA Track and Field's competition rules ban runners from using portable listening devices if awards or prizes are involved. And, of course, it's never a good idea to be wearing headphones if you're running close to busy roads.

How about listening to music while working?

The possible link between music and concentration has been the subject of much research – it's of interest to everyone from call centre managers to students trying to finish an essay.

These investigations have shown that music can help if the alternative sound is a distracting noise. If you're trying to finish that report in a busy cafe, then music through headphones will help keep you focused. If, on the other hand, you're working in a quiet environment, the music itself will be a distraction. Part of your brainpower will be taken up processing the music, leaving less capacity for the work you're trying to do. Music with lyrics is particularly distracting. The situation is a little different if you're performing a simple task

CHEMICAL BREAKDOWN

ADRENALINE

This chemical triggers the body's fight-or-flight response. It causes your air passages to dilate so you can get more oxygen into your system, and directs blood to the major muscle groups.

CORTISOL

This is another fight-or-flight chemical and backs up the adrenaline response. It also damps down your body's response to injuries (so you can keep running or fighting even when hurt).

DOPAMINE

This neurotransmitter is responsible for your ability to focus and get things done. It also acts as a 'good mood' chemical.

NEUROTRANSMITTER

These chemicals communicate information throughout your brain and body. They tell your heart to beat, they control muscles and senses, but also influence your mood.

SEROTONIN

A neurotransmitter that's involved in regulating appetite, sleep, memory and mood.

THE MOZART EFFECT

This is a controversial idea that suggests that listening to classical music can boost your intelligence or a child's mental development.

WHAT YOUR MUSIC SAYS ABOUT YOU

Would you rather relax to Rachmaninoff or rock out to the Ramones? According to psychologists at the University of Cambridge, your musical preferences can reveal a surprising amount about your personality

Take the test for yourself at musicaluniverse.org

EMPATHISERS (TYPE E)

Have a strong interest in people's thoughts and emotions

Likely to listen to mellow music with low energy and sad emotions such as R&B and soft rock. Prefer unpretentious music like folk and country, and contemporary music such as electronica.

Example song:
All Of Me
Billie Holiday

SYSTEMISERS (TYPE S)

Have a strong interest in analysing rules and patterns

Likely to listen to more intense music, including hard rock, punk and metal. Also prefer music with depth and complexity such as avant-garde classical music and experimental jazz.

Example song:
God Save The Queen
Sex Pistols

BALANCED (TYPE B)

Score relatively equally on empathy and systemising

Likely to listen to a broader range of different musical styles and genres than those people who are pure empathisers or systemisers.

Example song:
Come To Daddy
Aphex Twin

WHAT WE STILL DON'T KNOW

1 WHAT CAUSES THE 'TINGLE FACTOR'

Many of us have a particular song or piece of music that gives us goosebumps or sends shivers down our spine, whether that's a Bach cantata, a pop anthem, or a piece of experimental electronica. But we haven't yet worked out how or why this happens. What's going on in the body to produce this physiological response? Is it the same mechanism in everyone? Brain scanning should reveal the answer to this musical mystery.

Even today, these people probably still insist that '90s rave music is the best genre. It's not because it was, it's because of psychology and sociology

2 WHAT GIVES US MUSICAL NOSTALGIA

Anyone over the age of 30 will tell you that their youth was the best time for music, pointing out that "all modern stuff is rubbish!" But why do we retain such a strong affinity for the music we loved in our late teens and early twenties? The reasons are probably rooted in sociology and psychology, and have very little to do with the actual music itself.

3 WHY OUR MUSICAL MEMORY IS SO GOOD

Most of us can remember the finer details of musical pieces we haven't heard for years. People who have suffered serious memory loss due to accidents or disease often retain their musical recollections, and these can even be effective in restoring speech in stroke patients who have lost the ability to speak. We know that music is processed in lots of different areas of the brain, so could this be why musical memories are able to survive local brain damage?

PHOTOS: GETTY X7

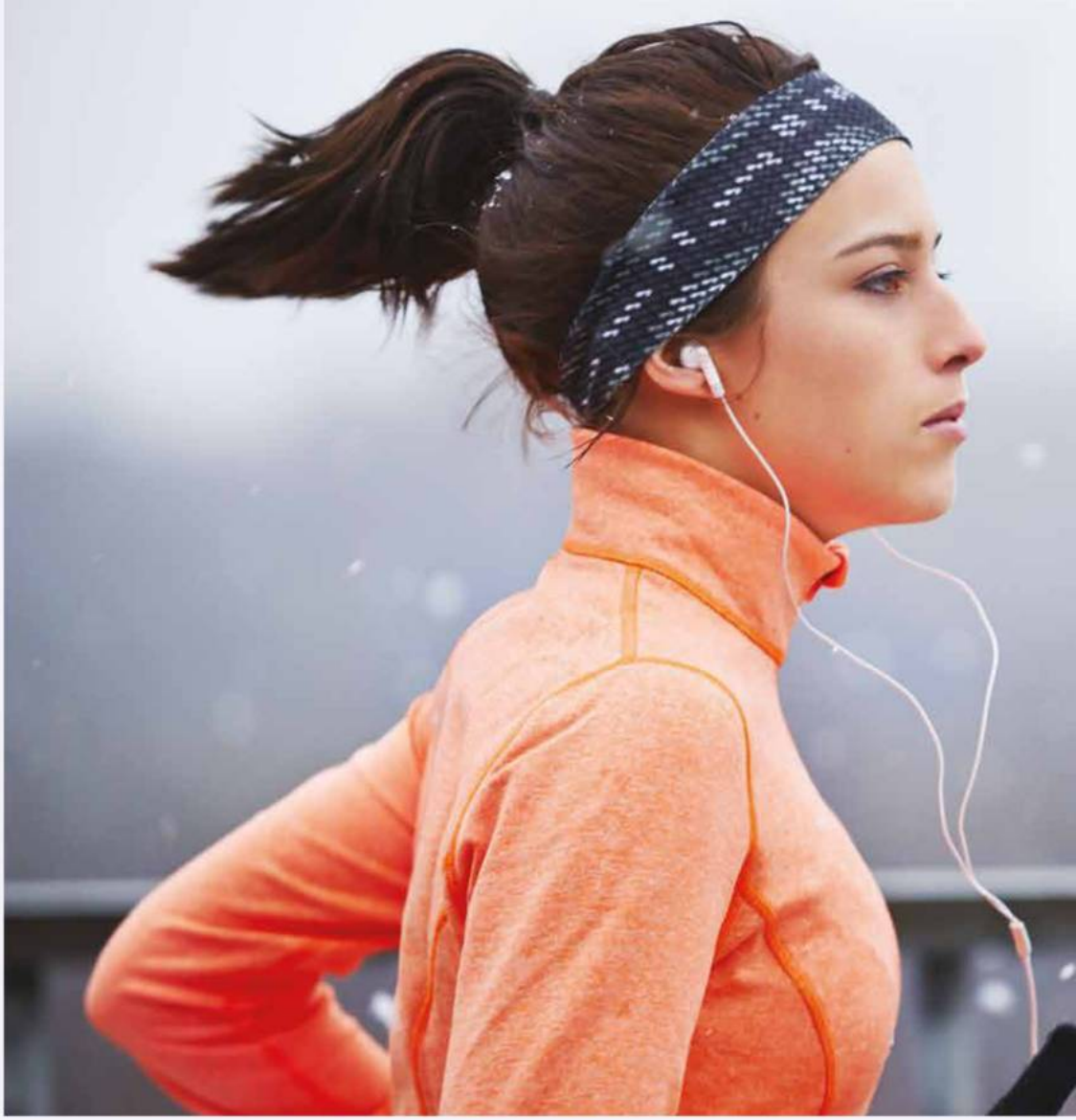
such as ironing or washing up. In this case, you'll have plenty of spare mental capacity available, and the music will help keep you in a good mood and prevent you from getting bored, probably improving your performance for the task at hand.

Can music really affect our behaviour?

Yes. Take, for instance, the background music that's often played in shops and restaurants. This can have a surprisingly powerful influence on how we behave. Working in the 1980s, US marketing professor Ronald Milliman discovered that slow, relaxing music in a restaurant actually makes you eat more slowly and increases the amount you spend on drinks during the meal. The tempo of the music also has an effect on how quickly you walk around a shop or supermarket – you tend to browse and buy more if the music is calming and relaxed. Surprisingly, the choice of background music can even influence which items you buy. One test, carried out by psychologists at the University of Leicester in 1999, involved changing the background music near a display of German and French wines in a supermarket. The German wine sold twice as fast if stereotypically German music was playing, but when French accordion music was being piped out, the French wine was five times more popular than the German.

Other research in this area has shown that the correct choice of background music can increase the income of a shop or restaurant by 10% – a surprisingly large effect for something that many of us barely notice.

Another indication of the power of background music is something known as the 'Manilow method'. In 2006, Sydney's city council was trying to work out how to disperse the groups of teenagers who were hanging out in the shopping malls. Simply asking them to 'move on' had no effect – but eventually someone had the idea of playing music that the teenagers would find embarrassingly uncool. Barry Manilow to the rescue! By the time a few tracks of his greatest hits had filtered through the public address system, the teenagers had wandered off to find somewhere cooler to hang out.



'Uncool' music, such as Barry Manilow's, can successfully deter teenagers

Why did music evolve in the first place?

Music is ancient and extends throughout all societies around the world, so it probably has links to the survival of our species. As any football fan will tell you, communal singing can help form a more cohesive social group. This bonding effect is a strong contender for why music exists – in prehistoric times, groups who sang together would protect each other more tenaciously from predators or enemies.

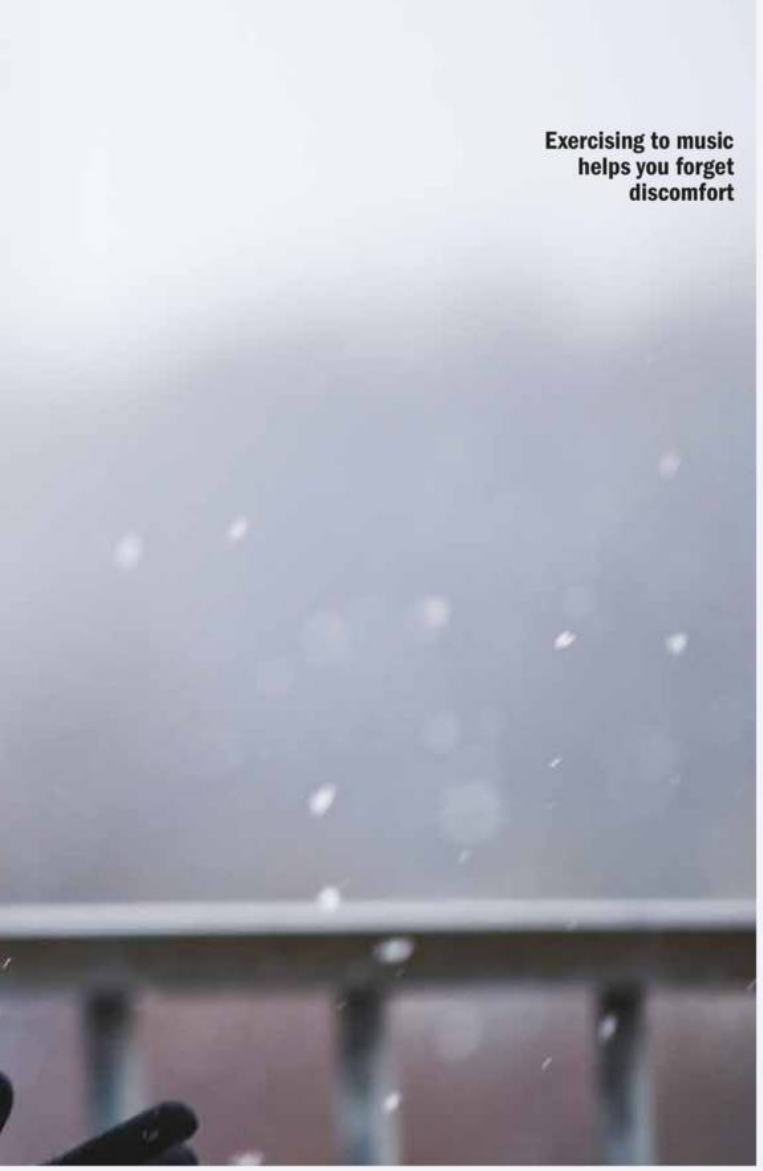
What's more, music has been found to aid the release of the hormone oxytocin. This hormone is also released during breastfeeding and sexual intercourse, and may have a powerful bonding effect.

Where's the most unlikely place that music is used?

Forget popping a paracetamol – music has also found an unlikely use as a form of pain relief.

One of the experiments that researchers use to test people's responses to pain involves asking subjects to keep their hands in freezing cold water for as long as possible. Psychologists Laura Mitchell and Raymond MacDonald have found that listening to music helps people to stand the pain for longer – and is particularly effective if the subjects

PHOTOS: GETTY X2, GETTY, UNIVERSITY OF EDINBURGH



Exercising to music helps you forget discomfort

choose the music themselves. This choice gave the participants a feeling of empowerment, which helped them to cope with discomfort for longer.

The concept of pain reduction through empowerment has also been shown to reduce discomfort during dental treatment. The patients felt less pain if they chose the music – especially if they were given a handheld volume controller.

Intriguingly, the best results happened when the patient was specifically told that their control over the music would reduce the pain.

● Does music really have the power to make us more intelligent?

Back in 1993, US psychologist Dr Frances Rauscher and her colleagues published a paper which gave birth to the so-called 'Mozart effect'. In this study, students were given a spatial reasoning IQ test, before which they had either sat in silence for 10 minutes, listened to relaxation instructions, or heard a Mozart piano piece. The researchers found that those who tuned in to the piano piece had noticeably higher scores than the other two groups.

The implication that listening to Mozart's music makes you more intelligent was widely covered in the press, and soon the music industry was generating Mozart CDs aimed at improving the IQs of everyone from babies to pensioners.

Psychologists set to work investigating whether the Mozart effect really exists, and by 2010 it was concluded that it did – but it had nothing to do with Mozart. Various psychologists, including Prof E Glenn Schellenberg and his team at the University of Toronto, have proved that your score in an IQ test can be improved simply by listening to any stimulating music you enjoy (Schubert and Blur worked just as well as Mozart). A similar result could even be achieved by listening to a Stephen King short story.

The effect works by raising the level of a neurotransmitter in your brain called norepinephrine, which increases alertness. On top of this, enjoyable music boosts dopamine, helping put you in a buoyant and confident mood.

So, the next time you're about to take an exam, try listening to 10 minutes of your favourite upbeat music before you go in – but wear your lucky socks, too, just in case. ■

VI@panorama.co.za

EXPLAIN IT TO A FRIEND

1 IT'S A NATURAL DRUG

Music can help to control the release of certain chemicals in your brain and blood supply. Stressed people often have too much adrenaline and cortisol in their system, so they are perpetually in a fight-or-flight mode. Music inhibits the release of these substances and encourages the release of pleasure-related chemicals such as dopamine and serotonin.

2 IT ALTERS OUR BEHAVIOUR

Background music can have a surprisingly large effect on your behaviour. Slow music makes you walk more slowly in shops, eat more slowly in restaurants and drink more with your meal. Supermarket music can even persuade you to buy particular products by suggesting a certain country or mood.

3 IT HELPS US BOND

Music is ancient and exists across all of the world's cultures, so it's probably linked to the survival of the human race. One Darwinian reason for the existence of music is that it helps groups of people (from families to rugby crowds) bond with each other. Bonded groups collaborate more closely and therefore have a higher chance of survival.

Q&A
Questions & Answers

Got questions you've been carrying around for years? *Very Interesting* answers them! Mail your questions to VI@panorama.co.za

What is the Interplanetary Superhighway?

Elna Coetzee, Hazyview

Space agencies like NASA often make use of the gravitational fields of planets to give probes a boost to their final destination. In the late 1970s, mission designers began plotting out the paths between the planets and their satellites that could exploit this fuel-saving effect. The resulting ribbon-like network of celestial routes is known as the Interplanetary Superhighway, and it's now regularly exploited on missions to deep space.

What happens to a person's online data after they die?

Ulwazi Bophela, Katlehong

Q&A FLASH

- **Around 300 hours of video footage is uploaded to YouTube every minute.**
- **In 2015, a trillion photographs were taken and stored or shared online.**

Each company that stores the data may have a different policy. If the person was paying a subscription to a website to store their data, then once the subscription expires, the data will probably be deleted. For free sites, anything can happen. For example, Yahoo! refused to hand over emails of a deceased son to his parents, despite being ordered to do so by a court. However, Facebook has a policy to change the deceased person's profile into a memorial page, if a family member notifies the company. Friends and family can then visit the page to share their experiences, express their sadness, and celebrate the life of the person.

What connects X-men and elephants?

1.

In the Marvel Universe, one of the founding members of the X-Men is the superhero Cyclops, who can shoot powerful beams of energy from his eyes.

2.

Although Cyclops has two eyes, he is named after a race of giants in Greek mythology that had a single large eye in the middle of their forehead.

3.

Cyclops means 'circle-eyed' and the monster may have been inspired by large fossil skulls found on Crete, Cyprus, Malta and Sicily, which do have a large central hole in the forehead.

4.

These are actually skulls of the dwarf elephant, which became extinct around 8,000 years ago. The central 'eye socket' is really the nasal cavity, where the trunk connects to the skull! This feature is also present in modern elephant skulls.

PHOTOS: NASA, ISTOCK, SCIENCE PHOTO LIBRARY, SHUTTERSTOCK

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The KL Tower Base Jump 2016 took place from 30 September to 3 October, with an incredible 3,074 jumps over four days and – yes, they're nutters – two nights. The 116 jumpers taking part represented 24 countries (including South Africa) and one man, Maurice Mahieu, completed a record 108 jumps during that period.

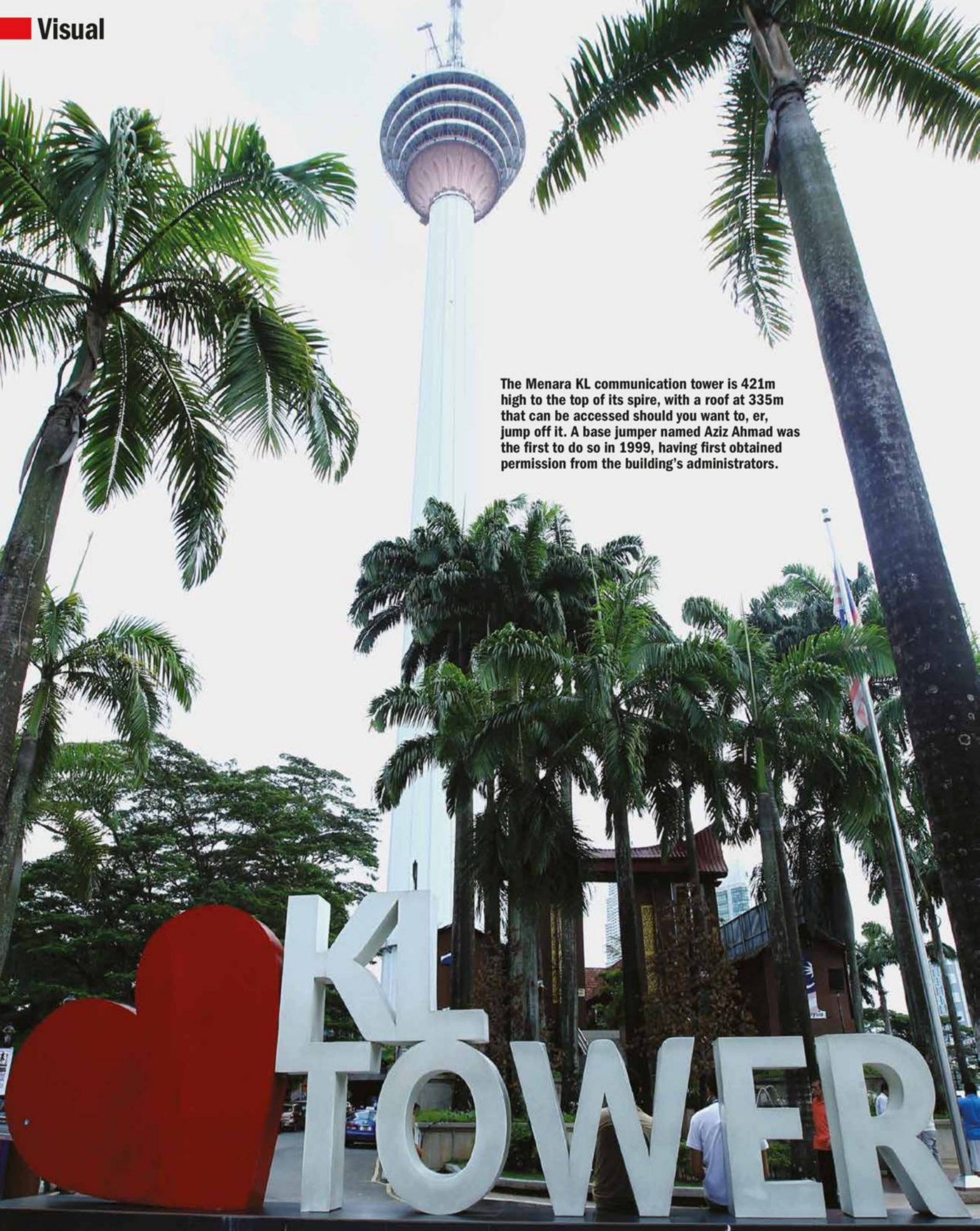
Go and jump!

Kuala Lumpur, capital of Malaysia and home to an event where visitors are encouraged to leap off a building

TEXT: BRUCE DENNILL PHOTOGRAPHY: SHUTTERSTOCK

Just because this is an activity that may end in a messy disaster is no reason not to dress up for the occasion. And the added bonus with the ensemble these gentlemen have chosen is that they'll be easy to spot if they're blown off course on the way down.

The 'base' in 'base jumping' stands for 'building', 'antenna', 'span' and 'earth', with the first three facets being things you step off with a parachute strapped to your back and the latter being the substrate you hopefully connect with at the speed you were planning to – after braking and whirling delicately around in the air for a while.



The Menara KL communication tower is 421m high to the top of its spire, with a roof at 335m that can be accessed should you want to, er, jump off it. A base jumper named Aziz Ahmad was the first to do so in 1999, having first obtained permission from the building's administrators.

Base jumping is not necessarily a solo activity, with 16-man 'canopy train' jumps being at the upper end of the collective craziness spectrum and tandem jumps like this one being relatively common. One of the obvious risks is the extra airspace taken up by everyone's parachutes, with it being necessary to ensure that nobody gets in anyone else's way.

One would expect that jumping off something 350m up would cause a touch of stress, but many of the KL Tower jumpers are relaxed veterans. That probably has to do with the criteria that must be met to attend the event: they must have been actively base jumping for two years, including having made at least 20 jumps in the year leading up to the event.

ARE WE BECOMING MORE VIOLENT?

With the conflict in Syria, terrorist attacks in France and racial tensions in the USA, it's easy to think we're becoming more violent. But do the stats paint a different picture?

TEXT: DR DAVID HAMMOND

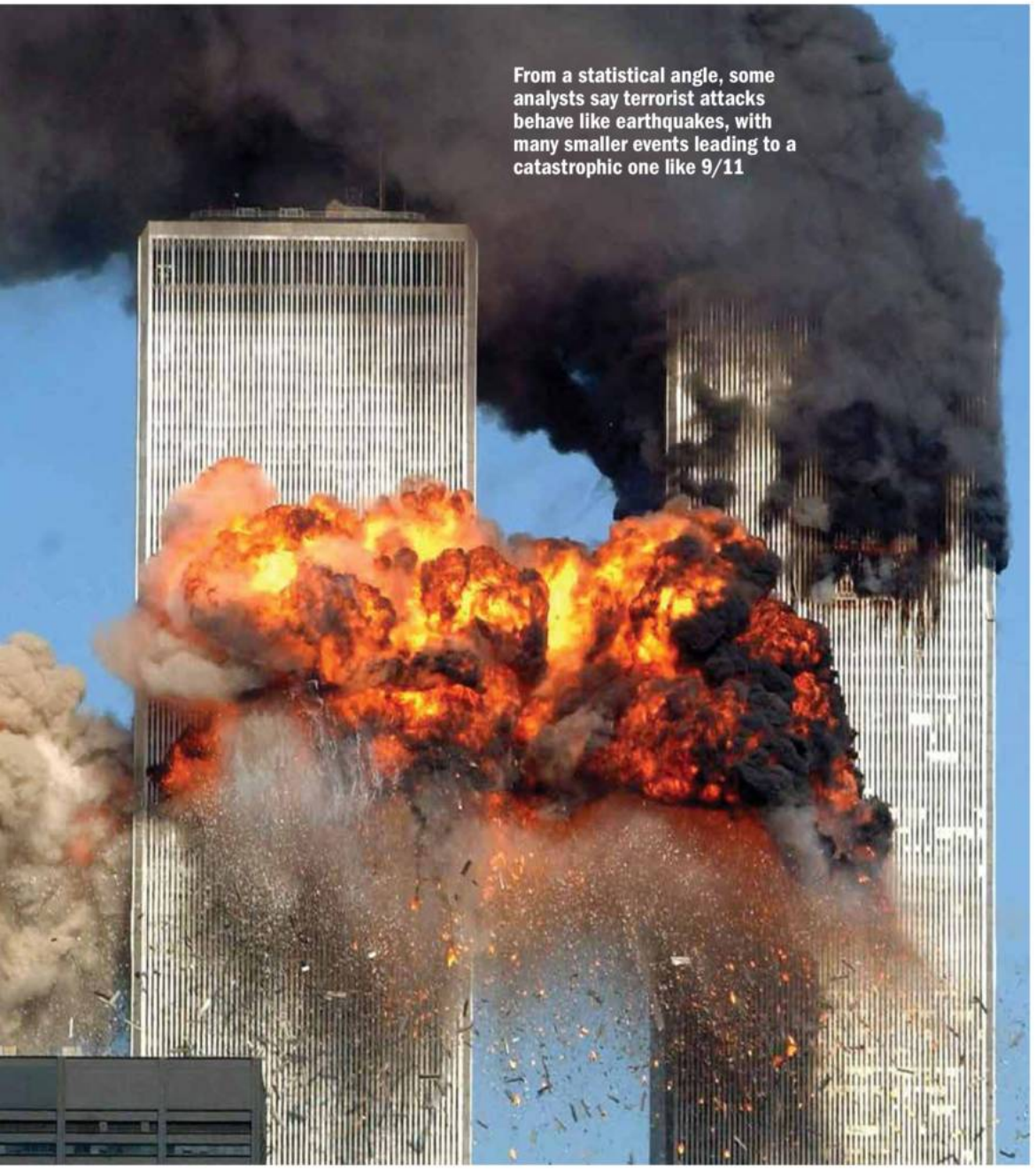
Conflict analyst Lewis Fry Richardson estimated that 1.6% of people have died at the hands of another

We are living in the most peaceful time in human history, at least according to the acclaimed book *The Better Angels Of Our Nature*, written by eminent psychologist Steven Pinker. Through analysis of historical estimates, Pinker details how common violence was in our past. Back then there were clans, witch trials and crusades to contend with. Today, evidence suggests that the developed world has never had to worry less about violence.

To account for this, Pinker describes the process of civilisation. The evolution of national governments allowed the emergence of fair and consistent trade.

But 9/11, the War on Terror and ongoing conflicts in Syria and Iraq demonstrate that violence is far from a bygone problem. The United Nations High Commissioner for Refugees (UNHCR) estimates that 65 million people are now forcibly displaced because of violence, which is the highest number since WWII. The Global Terrorism Index 2015 showed that deaths from terrorism have increased ninefold since the year 2000.

So this is the most peaceful time in history, yet there are also recent trends in violence. And it is this juxtaposition that leads to a surprisingly statistical debate.



From a statistical angle, some analysts say terrorist attacks behave like earthquakes, with many smaller events leading to a catastrophic one like 9/11

Myths and trends

First, some good news: violence is rare. Lewis Fry Richardson, a Durham meteorologist turned conflict analyst, estimated that only 1.6% of people died at the hands of another between 1820 and 1945. Sociologist Randall Collins suggests that, contrary to popular belief, humans generally do not find violence easy. Most bar fights end once one person makes contact with another and rarely escalate into the all-out brawls of Hollywood. In WWII it is estimated that as few as 15 to 25% of soldiers actually fired upon the enemy when being fired upon themselves. Fear, it seems, became incapacitating. Many troops reported simply 'firing in the air' lest being branded a coward. In general, Collins suggests that people require intense social pressure to resort to violence at all.

Furthermore, in an age where individualism is stronger than patriotism, armed forces are finding recruitment a challenge, and finding popular support for war is increasingly difficult.

Pinker's work demonstrates violence has declined in recent decades. Homicide rates, estimates of rape, domestic violence and even wars all appear to be falling. But a lot has happened since

Following the attack on French satirical paper *Charlie Hebdo* in early 2015, terrorism in Europe has increased

Modern conflicts tend to be domestic in nature, but are no less violent for citizens such as these pro-government fighters in Iraq

the publication of Pinker's book in 2011. The Global Peace Index, a measure of 23 indicators ranging from interpersonal violence to terrorism to international conflict, shows that the world is less peaceful than it was 10 years ago. Civil wars continue in Syria and Iraq. Terrorist attacks in Europe have increased since January 2015 when two brothers forced themselves into the offices of the French satirical paper *Charlie Hebdo*, killing 11 people with assault rifles. While homicide rates in the US have halved since 1995, mass shootings in 2015 killed 205 people, around five times as many than 2014. In the UK, violent crime has been on the increase since 2013 with reported hate crime increasing by 42% after Brexit on 13 June 2016.

On an international level there are also ominous signs. The Doomsday Clock, which is compiled by the Bulletin Of The Atomic Scientists, estimates how close we are to global disaster from threats posed by climate change, deteriorating international relations and nuclear weapons. In 2015 the clock was set at three minutes to disaster, the worst assessment since 1984 when US and Russian relations were at their worst. And the list of instabilities that could be the prelude to an escalation of violence is long. The 2014 Russian annexation of Crimea and ongoing conflict in Ukraine has tested post-Cold War relations, exacerbated by the shooting down of a Russian plane by Turkey in 2015. Last year, over 52,000 people had been detained or arrested in the aftermath of the failed military coup that took place in Turkey on 15 July.

Elsewhere, on the 12th of July, tensions heightened between China and the rest of the world after Beijing refused to accept the international tribunal in The Hague that ruled in favour of the Philippines in territorial disputes over the South China Sea.

The statistics of violence

To understand the arguments regarding whether we are becoming less violent, it is useful to consider a simple yet seemingly unrelated analogy: a sandpile. As sand falls it naturally forms a conical structure. Pour some more sand into the middle and it piles up higher and higher. Now imagine you add sand grains in a slow and controlled manner to a fully formed sandpile. Each grain falls and then comes to rest somewhere along the slope where friction balances gravity. This happens for many grains of sand, but eventually a single grain falls that causes one side of the pile to collapse, displacing a lot of sand in its wake. While simple, the forces and interactions taking place

As of January 2017, the Doomsday Clock has sat at two-and-a-hald-minutes to midnight.

between the sand grains in the pile are difficult to model accurately and the effect of any single grain has to be treated as random. First described in 1987 by the fathers of complexity theory, Per Bak, Chao Tang and Kurt Wiesenfeld, the randomness of the sandpile is strikingly similar to other phenomena. There are many grains of sand that have little effect but there is an occasional grain that has a major impact. In mathematical terms, this randomness can follow something called a 'power law'. Here, there are many small, low impact events and the occasional highly consequential event. In 2005, Aaron Clauset and Maxwell Young, computer scientists from the Santa Fe Institute, showed that terrorism followed the same statistical patterns of earthquakes, with many small attacks and infrequent but devastating events such as 9/11.

To illustrate, scale is useful. The United Nations Office of Drugs and Crime estimated that in 2012, almost 500,000 people were killed by homicide. The Global Terrorism Index shows that almost 33,000 people were killed by terrorism in 2014. According to the Uppsala Conflict Database, deaths from violent conflict in 2015 totalled 118,435. The World Health Organization estimates 800,000 deaths by suicide every year. So, given the current global population of 7.4 billion, the mortality rate from all of these disparate forms of violence is around 20 people per 100,000. By contrast, WWII killed 60 million people in a worldwide population of 2.3 billion, an annual mean rate of over 435 people per 100,000. In absolute average terms, WWII killed as many individuals every seven weeks

Modern drones can perform strikes remotely; could this make pulling the trigger easier?

On average, WWII killed as many individuals every seven weeks as we would expect today in one year of violence

During WWII, it is estimated that as few as 15% of soldiers actually fired upon the enemy

as we would expect today in one year of violence. When violence follows power laws, extremes need to be prioritised.

While patterns of violence provide interesting analogues with other phenomena, it is also disconcerting: in power laws it is not as unlikely to see an event bigger than the biggest on record. This is true for earthquakes, and may be true for violence.

But is violence really like earthquakes just because the numbers look alike? Philosopher John Gray is sceptical of the ability of statistics to capture the true nature of violence, as it's a topic that requires understanding of history, politics, economics, sociology and even psychology. While care certainly needs to be taken when interpreting statistics on violence, it is also true that the world is a complex system, and complex systems occasionally produce unpredictable results. Like the one grain of sand that causes an avalanche in the sandpile, no one could have predicted that Gavrilo Princip's opportunistic assassination of Archduke Franz Ferdinand would spark WWI.

But randomness doesn't mean that the odds can't change over time. So when it comes to violence, is there any evidence that the world is changing the odds toward peace?

The Long Peace

The absence of large-scale conflicts between superpowers in the post-WWII period has been described by eminent war historian John Gaddis as the 'Long Peace'. The frequency of wars between countries has plummeted since 1945: the battles fought today are largely domestic in nature. Even today, nuclear weapons have only been used twice in warfare, despite tensions surrounding the Cold War. In a world in which military technology is capable of total annihilation of our species, humanity has so far managed to avoid Armageddon.

In light of this, in 2011 Pinker asked the obvious


TRUMP

When Donald Trump was running a campaign of border protection he suggested that NATO is obsolete

question: has something changed? There are clear developments in the post-WWII period that could account for the decline in violence. Democracy has continued to spread across the world. The emergence of the United Nations has offered new avenues of diplomacy and has enshrined the principle of sovereignty of state and borders. The use of chemical, biological and nuclear weapons have become an international taboo. The European Coal and Steel Community opened up markets for trade and eventually led to the European Union, offering an example of the benefits that come with regional integration. Meanwhile, across the Atlantic, civil rights movement represented a turning point in race relations in the US.

While recognising that the Long Peace may not be a perpetual peace, Pinker offers the theory that the post-WWII period has shifted from a game where countries conquer or be conquered, to a more co-operative system where war will only occur when the benefits outweigh the costs.

Just luck?

However, as many experts have pointed out, there may be alternate explanations for the data. For example, Tanisha Fazal, associate professor of political science and peace studies at Indiana's University of Notre Dame, highlights that the reason that fewer people are dying in wars may be because there have been advancements in medical treatments over the years. The Long Peace could also just be a run of luck in the power law nature of violence. In books such as *The Black Swan*, statistician and risk analyst Nassim Taleb has famously written extensively on the follies of projecting future trends from past data. In his work with probability expert Pasquale Cirillo, Taleb shows that the expected time between wars with at least five million casualties is 93 years. Taleb and Cirillo's work suggest that, when violence is dominated by extremes, it is too early to say with statistical confidence that the world has shifted towards peace only 71 years after WWII.

Current climate

So is the fact that the world is less peaceful than it was 10 years ago a statistical fluctuation or something more serious? Well, almost 50 years after the civil rights movement in the US, the current Black Lives Matter protests show that tensions surrounding race issues remain. The EU project was dealt an unexpected blow with the Brexit referendum. In the recent US presidential election, Donald Trump, running on a campaign of border protection, suggested that NATO is obsolete and that the UN was ineffective. The factors that Pinker ascribes as central to the Long Peace seem to be under attack.

But there are good reasons not to get despondent. In a 2013 interview, US politician Donald Rumsfeld explained a simple truth: "Belief in the inevitability of conflict can become one of its main causes."

It is easy to focus on negatives, but the Global Peace Index shows that there is good news in the world. While wars continue, the most peaceful countries continue to become more and more peaceful. So it is fitting to finish this article with the insightful observation of Steven Pinker: "Instead of asking 'why is there war?' we might ask 'why is there peace?' We can obsess not just over what we have been doing wrong but also what we have been doing right."

There are undoubtedly challenges to face, but the post-WWII period has more than enough 'rights' to enable us to face them. ■

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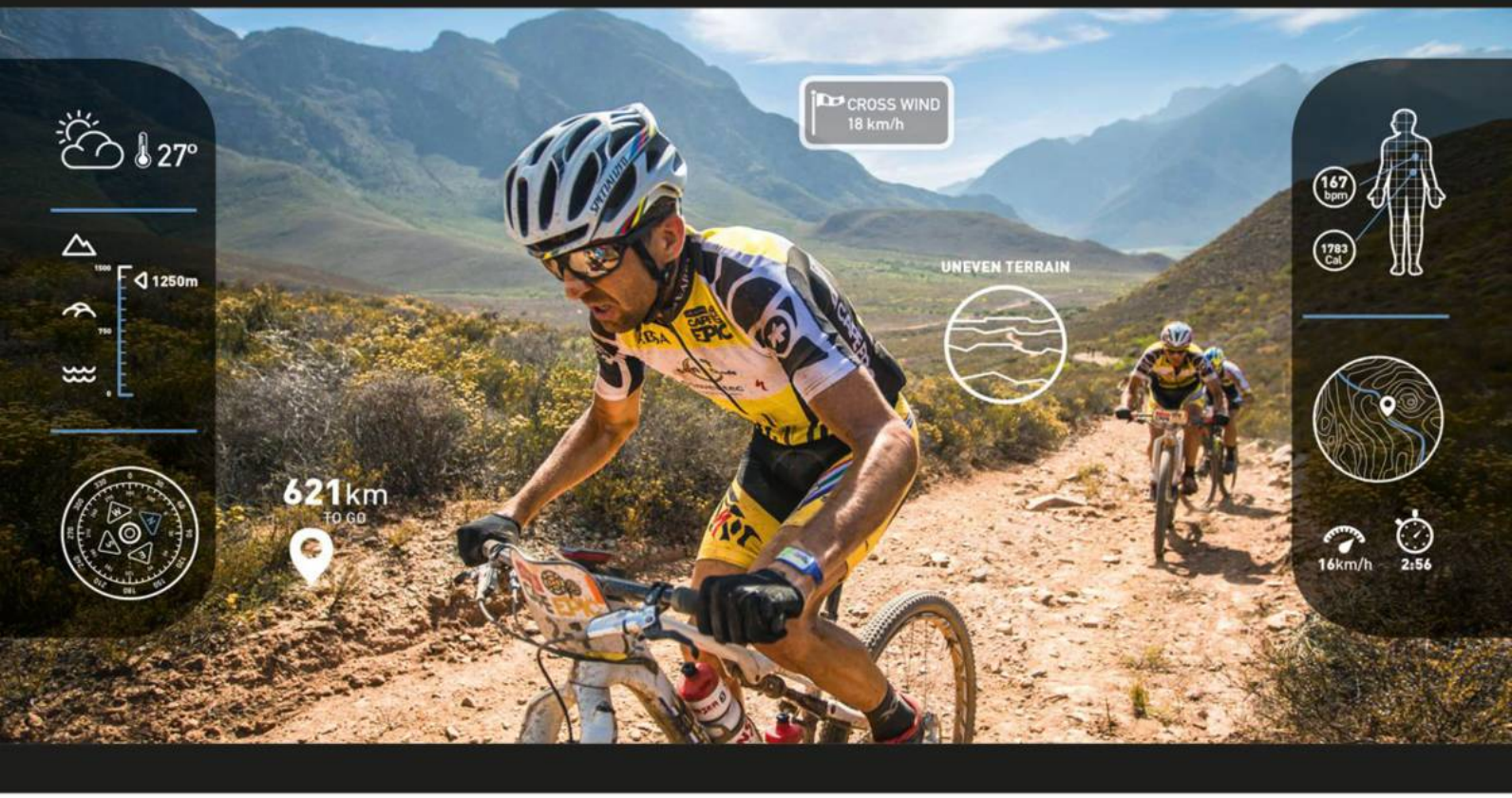

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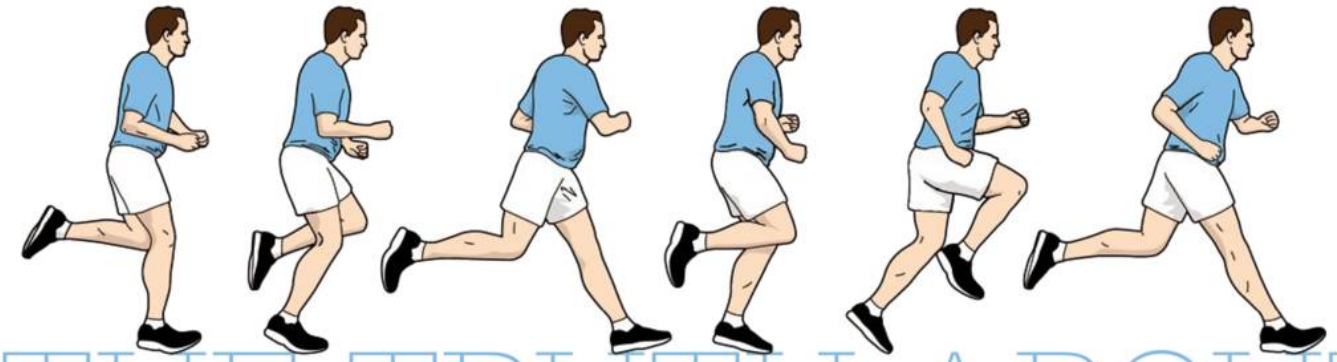
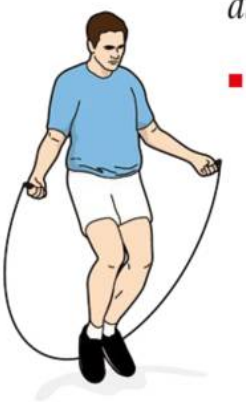
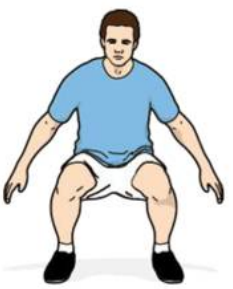


THE TRUTH ABOUT EXERCISE

Losing weight is a common New Year's resolution. But as Michael Mosley discovered, exercise may not be the best way to do it

TEXT: MICHAEL MOSLEY PHOTOS: SHUTTERSTOCK





You might imagine shedding kilograms to be straightforward: do more exercise, burn calories, lose weight. Unfortunately it's not that simple, as I discovered when filming *Horizon: The Truth About Exercise* for BBC Two. Results from the latest studies seem counterintuitive, but scientists are at least getting closer to understanding why. One study at the University of Pittsburgh put nearly 200 overweight women on an intensive weight-loss programme for two years. The women were asked to reduce their calorie intake – they had to consume less than 1,500 calories a day – and to up their exercise levels. To make sure they kept to the programme they were given lots of support. This included treadmills to take home and regular meetings and phone calls urging them to keep going. Initially all went well. Six months after starting the programme, over half the women had lost at least 10% of their body weight and most were still doing regular exercise. Then, as often happens, it all began to fall apart. Most of the women relapsed and started to regain the weight they had so painfully lost. Some did manage to keep going for two years but, to keep the weight off, they were having to do really significant amounts of exercise – nearly 70 minutes a day, five days a week.

Studies suggest that we compensate for exercise sessions by doing less

But why is it so difficult to shed fat? Part of the problem is that fat is an incredibly energy-dense substance. A pound of fat contains more energy than a pound of dynamite, though it is rather less explosive. So you have to do an awful lot of exercise to burn it off. To find out just how much I went to Loughborough University where I was put through my paces by Dr Keith Tolfrey. Dr Tolfrey, a senior lecturer in Loughborough's School of Sport, Exercise and Health Sciences, asked me to wear a face mask attached to mobile monitoring equipment. The equipment, he told me, would measure the amount of oxygen I inhaled and the amount of carbon dioxide I exhaled. From that he could calculate the number of calories I burnt doing exercise.

When it was all set up, Keith got me to run at a brisk pace around the track, while he cycled alongside shouting encouragement. I wasn't exactly going at Olympic pace, but I was going fast enough to feel relieved when, after 10 minutes, Keith told me I could stop.

The data-gathering machine showed I had burnt a grand total of 80 calories. This was not encouraging. As Keith pointed out, a small bar of chocolate contains about 240 calories, while a chocolate muffin comes in at an impressive 520 calories. "If you translate that into minutes of exercise," Keith announced, "you would need to run for half an hour to burn off the chocolate and for nearly an hour to undo the effects of eating a single muffin."

The trouble is that the bad news doesn't end there. Studies show that humans don't stick to their normal food intake when they begin to exercise. Instead they compensate by eating more. In fact, even the thought of exercise may encourage you to start eating.

Changing your appetite

In a study carried out at the University of Illinois in the US, students were asked to evaluate the effectiveness of some leaflets. The students were split into two groups. Some looked at leaflets encouraging them to do more exercise and others looked at leaflets urging them to make friends. Afterwards they were asked to eat raisins, to rate their flavour. The students who had been shown the exercise leaflets ate a third more raisins than the other group. This was hardly a real-world experiment, but there is plenty of evidence from the real world of calorie-eating compensatory behaviour.

"The initial effect of exercise is often to decrease appetite," Dr Jason Gill at the University of Glasgow's Institute of Cardiovascular and Medical Sciences told me. "The trouble is we may later decide to reward ourselves after a heavy session in the gym with a bar of chocolate or a full-fat cappuccino. There's also evidence that we unconsciously eat to fill the energy gap, or compensate for increased activity by doing less when we aren't exercising."

Studies that suggest your body will try to sabotage your attempts to lose weight

Finding out just how much exercise is required to burn off part of a muffin

are supported by something called Set Point Theory. This theory was originally developed in the early 1980s and has a lot of experimental backing. It's an attempt to explain why so many people who try to lose weight through exercise, dieting or some combination of the two, fail. The answer seems to be that your body will do everything in its power to keep your weight steady. We're familiar with the idea that balance, or homeostasis as it's known, is crucial to how our bodies function. The reason we're able to walk around in all sorts of weather is because our

GET FIT WITH SCIENCE

What the latest research tells us about maximising the benefit of exercise

EXERCISE AT THE RIGHT TIME

Exercising at night or in the evening may lead to larger increases in thyrotropin and cortisol than morning and afternoon workouts. Thyrotropin boosts metabolism, so exercising late may help to boost weight loss. Cortisol tends to increase the energy available for muscular activity – perhaps allowing more prolonged and intense activity, helping to boost fitness.

DO THE RIGHT EXERCISE

It's hard to lose much weight through standard exercise regimes, but it is possible. The best way to shed weight by exercising is not to maintain a steady pace, but to do high-intensity intermittent training combined with a general increase in your overall level of activity. Occasional sprints, whether on a bike or on foot, are better than going steady.

DRINK BEETROOT JUICE

This won't actually make you fitter but it will make you feel fitter. Research done at Exeter University has shown that drinking beetroot juice allows people to exercise for up to 16% longer by dilating blood vessels and increasing blood flow to muscles. You have to drink at least a glass of concentrated juice a day to get a measurable result, though.

KEEP PUSHING YOURSELF

Research at the University of Sussex has shown that your brain normally steps in when you first start to exercise to protect you from pushing yourself too far. The less fit you are, the more susceptible you are to the messages coming from your brain saying: "It's time to stop and have a nice rest." If you persist, over time these messages will reduce in intensity.

MEASURE YOUR FITNESS

How do you know if what you're doing is actually making any difference? The most widely accepted way of measuring aerobic fitness is VO2max – the maximum amount of oxygen your body can use during a period of intense exercise. To measure it you would normally need to go to a lab, but a quick online search will provide some simple ways to calculate yours.

CAN YOU OVER-TRAIN?

How doing too much exercise can be harmful

Some injuries seem to be an inevitable part of sport. Arthritis of the lower joints, for example, is more common in footballers and endurance athletes than in the normal population, and a study of former PE teachers in Sweden turned up some pretty disturbing findings. In the study, published some years ago in the *Journal Of Occupational And Environmental Health*, the researchers tracked down more than 500 teachers who had qualified between 1957 and 1965. They found that the teachers now had higher rates of arthritis of the knee and hip, which needed replacement surgery in some cases.

And it's not just joints. A study in the June 2011 edition of the *Journal Of Applied Physiology* found that half of serious marathon runners and rowers showed early signs of myocardial fibrosis, or scarring of the heart. It can lead to irregular heartbeats that, in turn, can lead to more serious problems. It's worth mentioning, though, that the men who were studied had undergone immense amounts of training, far more than the average distance runner. The good news is that this damage seems to be reversible – at least it is in rats.

10 to 20

times more calories were eaten by children than they had just burned in exercise sessions in a study carried out by scientists in Boston, USA.

500

calories are typically burned off in a two-hour bike ride.

45 million

people in the US belong to a health club and spend R262 billion a year on gym memberships.

6

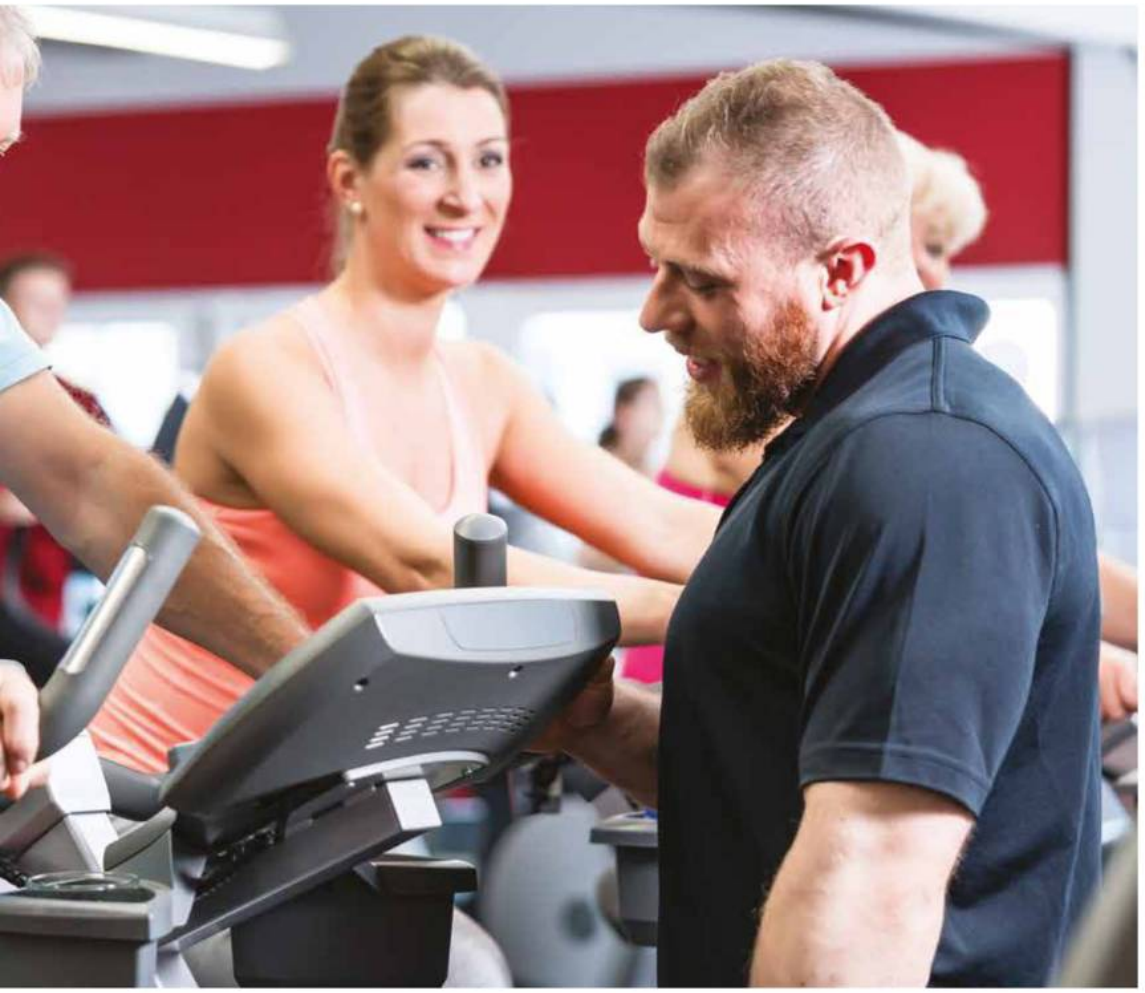
calories per day are burned by a pound of muscle in a resting body according to calculations by a Columbia University team.

bodies regulate our internal temperature with a high degree of accuracy. Whether it's 40°C or -10°C outside, your body will keep your core temperature at 37°C.

Set Point Theory suggests that just as we have an internal thermostat, we also have an internal weight sensor. Once you reach a certain weight, your body will do all it can to make sure you don't lose any of it. There seems to be a number of different ways your body works to ensure that it clings onto that unwanted fat (unwanted, that is, by you). Imagine you are overweight and decide to lose a few kilos. You go on a diet and increase the amount of exercise you do. Initially the results are spectacular. The weight drops off with relatively little effort. Great. But then it stops dropping off. You've cut your calories, increased your activity but nothing is changing and you are constantly hungry. What's going on?

Well, as you lose weight your metabolic rate slows down, simply because you're carrying around less weight than you were before. But the amount your metabolic rate slows can't be explained simply by weight loss. It seems that your body also becomes more efficient at storing and using calories. At the same time hunger hormones, like ghrelin, kick in, telling you to eat more. The reason for all this activity is that once upon a time, it was an essential survival adaptation. When our distant ancestors found themselves in a famine

Energy-rich food is abundant in the developed world today, unlike in the past



situation, it was essential that their bodies responded by conserving energy in whatever ways they could until the good times returned.

These days, living in an energy-rich food environment, this tendency to hold onto fat is incredibly frustrating. So what can you do about it?

The short answer is don't get fat in the first place. The flip side of the body's attempts to stop you losing weight is that it'll also stop you trying to put on too much weight. Assuming, however, that you are already overweight, then your best bet is to set a realistic target to reduce your body weight by a maximum of 10%, and take plenty of time doing it.

Nobody knows how long it takes for your body to grudgingly accept that the new, lighter version of you is 'normal' – it's probably years. It may be never.

Pointless exercise?

But exercise isn't just about losing weight. Anything that raises your pulse a bit appears to lower your risk of all sorts of diseases, including heart disease, type 2 diabetes, stroke and some cancers. Although even here it's not simple. One measure of how fit and healthy we are is our VO2max – the maximum volume of oxygen our bodies can use during exercise. It's determined by the amount of blood our hearts can pump and the ability of our muscles to take up oxygen. Scientists believe our VO2max is one of the best predictors of health and longevity.

Although aerobic exercise, such as a brisk walk or run, tends to increase VO2max over time, not everyone responds to the same extent. In fact, some people's VO2max doesn't improve with exercise – so a bike ride or swim may not ward off heart disease and some other conditions.

A team of researchers led by scientists at the Royal Veterinary College, University of London and the University of Copenhagen pooled the results of three studies to identify about 30 genes that appear to have an influence on how someone's VO2max will respond to exercise. It suggests that in future, a genetic test may tell you how much you stand to gain from a workout, making it a good investment before you buy a gym membership or go for yet another jog around the park. ■

VI@panorama.co.za

THE FUTURE OF WEIGHT LOSS

An injection that could help fight the flab

One of the hottest areas of research, when it comes to weight loss, is into the hormones produced by the gut that control appetite. The two main hormones of particular interest are leptin and peptide YY (also known as PYY), both of which suppress appetite.

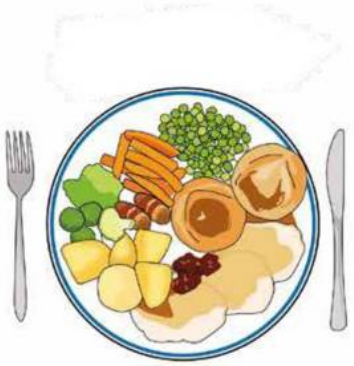
Leptin normally acts on the hypothalamus in the brain, suppressing hunger signals. There was, in the 1990s, a widespread belief that a simple injection of leptin would reduce the appetite of obese patients. Unfortunately it's not anything like that easy. Researchers soon discovered that most overweight people are not deficient in leptin. Far from it – they often have extremely high circulating levels. It seems that they have become insensitive to leptin and research is now focused on why this happens.

PYY seems to offer more immediate hope. It's secreted in response to eating and reduces the rate at which the stomach empties and reduces appetite. In a study carried out at the Hammersmith Hospital in London, researchers injected volunteers with PYY and noticed that on average they ate a third less than they previously had when offered a buffet lunch. Clinical trials are currently underway.

Got questions you've been carrying around for years? *Very Interesting* answers them! Mail your questions to VI@panorama.co.za

What happens to your body after eating a huge dinner?

As you prepare to start feasting, it's probably best not to think about the discomfort that may follow. Here, we remind you of what lies in store in the 24 hours following your day of overindulgence. Recent South African research suggests one large meal could fuel a 1.7-day hike in the Himalayas. But don't focus on the calories – this is a day of celebration!



FIRST 5 MINUTES
Alcohol absorbs rapidly into the bloodstream and will hit you five to 10 minutes after your first sip. The small intestine absorbs most of the alcohol, while 20% enters through the stomach. Alcohol dilates blood vessels, particularly the capillaries under your skin, making you feel warm.

20 MINUTES
The average stomach capacity is around one litre, but it takes 20 minutes for 'full' signals to reach the brain from the gastrointestinal tract, after you first starting eating. By then, you may already have overeaten. Eating and drinking too fast makes you belch as you swallow excess air.

30 MINUTES
As you eat, the food hikes up your blood sugar levels. In response, your pancreas will start producing the hormone insulin, which will convert the glucose into a storable form called glycogen. The resulting drop in your blood sugar levels makes you feel overwhelmingly tired.

ONE HOUR
After eating, more blood flows to the digestive tract. To aid digestion, your heart and metabolic rate go up, accompanied by a slight increase in body temperature, making you sweat and feel more tired. To make matters worse, rich foods are harder to process, and alcohol slows digestion.

TWO HOURS
A heavy meal rich in protein and fat can sit in your stomach for two to three hours, making you feel bloated. Flatulence is partly triggered when the body's enzymes can't deal with certain substances such as raffinose, a complex sugar found in Brussels sprouts and other brassicas.

THREE HOURS
It takes about three hours for the body to break down a 250ml glass of wine, but you've probably drunk more than that. Is it time for the cheeseboard? Combined with the carbs in crackers, the amino acid tryptophan in cheese could make you crash out.

SIX HOURS
It takes six to eight hours for food to pass through the stomach and the small intestine, before reaching the large intestine. The body digests meat into amino acids, which are absorbed through the small intestine and into the blood.

24 HOURS
With any luck, your hangover, caused largely by dehydration from alcohol's diuretic nature, will have eased by now. The body may finally start eliminating undigested food, having absorbed water and minerals, and stored excess fat.

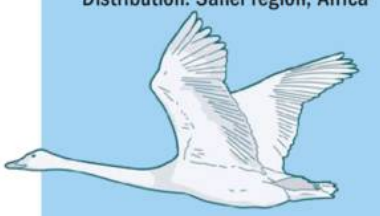
ILLUSTRATIONS: ACUTE GRAPHICS

What are the highest-flying birds?

Linda Schultz, Cape Town

1. RÜPPELL'S GRIFFON VULTURE
Altitude: 11,300m
Distribution: Sahel region, Africa

2. COMMON CRANE
Altitude: 10,000m
Distribution: Northern Europe and Asia



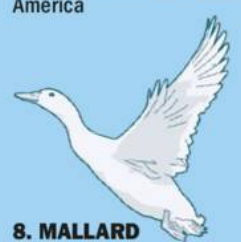
3. WHOOPER SWAN
Altitude: 8,200m
Distribution: Europe and Asia

4. ALPINE CHOUGH
Altitude: 8,000m
Distribution: Mountains from Spain to China

5. LAMMERGEIER
Altitude: 7,300m
Distribution: Mountains in Europe, Asia and Africa

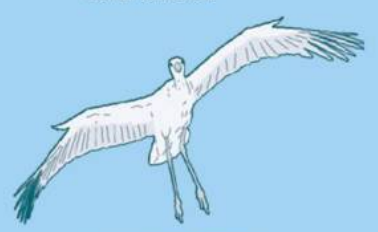
6. ANDEAN CONDOR
Altitude: 6,500m
Distribution: Andes, South America

7. BAR-HEADED GOOSE
Altitude: 6,437m
Distribution: Central and South Asia



8. MALLARD
Altitude: 6,400m
Distribution: Europe, Asia and North America

9. BAR-TAILED GODWIT
Altitude: 6,000m
Distribution: Northern Europe, northern Asia and Alaska



10. WHITE STORK
Altitude: 4,800m
Distribution: Europe, North Africa and western Asia

Why do hard-boiled eggs sometimes get a grey ring round the yolk?

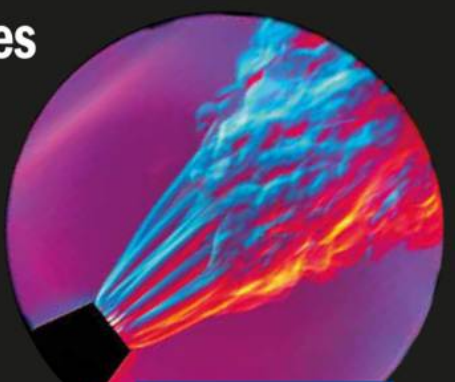
Christine Ellis, Norwood

Egg white is 92% water, with a mixture of around 148 different proteins, mainly ovalbumin, ovotransferrin and ovomucoid. At room temperature, these proteins are held in a complex 3D globular structure by sulphur bonds between the amino acids in the protein chain. When the egg cooks, the heat causes the sulphur bonds to come undone so each protein molecule unravels and gets tangled up with its neighbours in a solid mass. This process happens at 77°C for ovalbumin. But above 70°C, the sulphur also forms hydrogen sulphide that reacts with iron in the egg yolk to form iron sulphide, and this gives it a greenish grey colour. You can prevent this by running the eggs under the cold tap to lower their temperature as soon as they are cooked.

Why are gases invisible?

Thomas Mclaughlin, Springs

Actually, gases aren't invisible: many are quite brightly coloured. For example, nitrogen dioxide is brown-y orange, chlorine has a yellowish green hue and iodine vapour is a vivid purple. Other gases in the atmosphere (particularly oxygen, carbon dioxide and water vapour) also absorb light, but at ultraviolet and infrared wavelengths that we can't see. There's a sweet spot between the absorption spectra of oxygen and water where not much light gets absorbed. Lo and behold, that's exactly the range of light that we've evolved to see! So it's not that gases are invisible, as such, it's just that we can't see atmospheric gases as they don't have a colour in the visible range.



Q&A FLASH

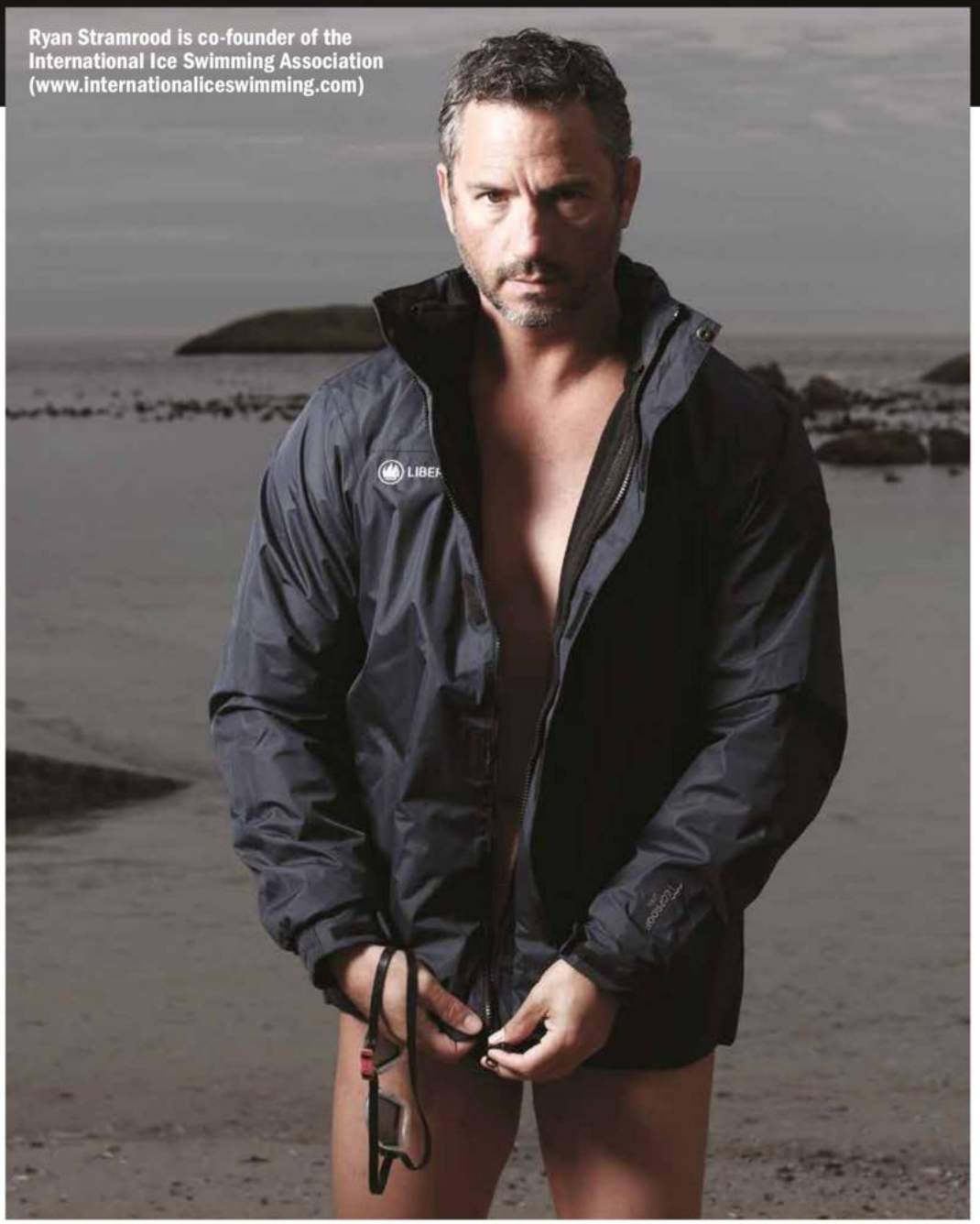
- Gas pipelines were built in China – using bamboo – as early as 500BC.
- In front of the MGM Mirage Hotel in Las Vegas, there's a fake volcano that has hourly eruptions, powered by scented natural gas.

PHOTOS: GETTY X9, ISTOCK, SCIENCE PHOTO LIBRARY

Extreme swimmer Ryan Stramrood uses his own experiences to encourage others to excel

TEXT: BRUCE DENNILL

PUTTING FEAR ON ICE



Ryan Stramrood is co-founder of the International Ice Swimming Association (www.internationaliceswimming.com)

Setting records is great for publicity, but how do you ensure that what you do does some good; that others get some benefit from it?
When I started swimming and then got into the extreme stuff, it was all for personal reasons; to see how far I could push myself. The publicity angle wasn't even a consideration. Now that I've built a bit of a platform, I'm able to make some sort of a difference, including in raising awareness of the issues our oceans are facing. I loathe the celebrity for its own sake thing, but I know that if I want to share a corporate space with guys like Lewis Pugh and Braam Malherbe, I need to have a bit of a profile. There's nothing particularly dramatic about it, though. I used to laze around on the couch with the remote like a lot of people, until I started trying something different. It's that simplicity that makes people go "Holy cow – he did that, so maybe I could. He's put himself in a position a human shouldn't be in and found a way out."

With so many incredible swims already under your belt, what do you need to do to ensure that the next project stands out and results in a story worth telling?
It's a developing journey – there's no five-year plan. I have a bunch of mates and we keep trying to push ourselves to find something that hasn't been done before. That was the thinking behind swimming around Cape Horn, at the southernmost tip of South America, known for centuries as a sailors' graveyard. Sometimes it's just special to be able to get to these places.
The next one will be closer to home. I'm developing something around Cape Town that will push me way beyond my limits. It's something I'm not sure I can do, though it may be humanly possible. It will involve extreme distance, extreme stamina and extreme psychological strength. All of these facets interest me.

It's necessary to push harder nowadays if you want to extend the idea of what's possible. Adventurers in the Victorian period had huge blank spaces on the map to aim at, but today, so much more has already been done.
I have a fascination with being the first person to do something, so that adds to the attraction for me. I'm not dedicated to it, though – I have a family and run a business, so it's really tap in and tap out adventures for me. I do explore the human mind, though. It's set up to keep us from failure and harm, and I like to try and discover where its limits are.

Scaling things down for the average man or woman: what would you suggest for someone wanting to push themselves in a new direction?
Stop worrying so much about success and failure. If you can, things will change as the fear of failure stops overriding the potential for success. A comfort zone is steady, but you'll always underachieve there. Figure out a journey to test your new understanding of being 'comfortable'. The responses to us trying such strategies are often the reason we don't do it, but whatever happens, you will learn something from the experience that will help you with the next challenge. ■

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PHOTO: SUPPLIED

Q&A
Questions & Answers

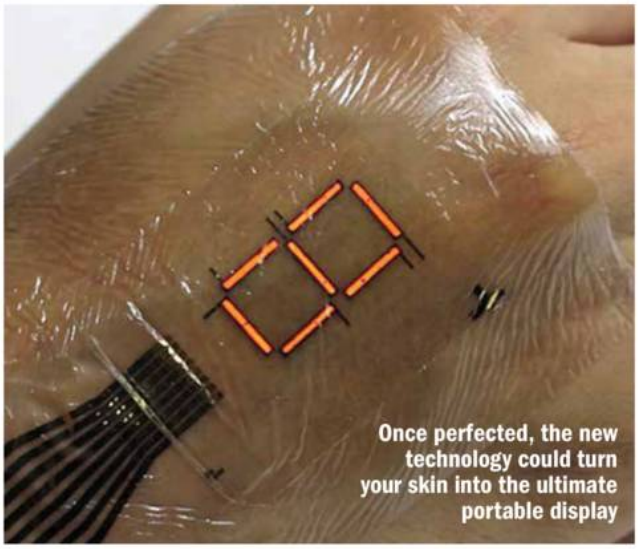
Got questions you've been carrying around for years? *Very Interesting* answers them! Mail your questions to VI@panorama.co.za

Could we have a screen on our skin?

Sandra Kotze, Sandhurst

Scientists in Japan have built an early prototype of a system that could one day turn your skin into a computer display. The device consists of polymer LEDs that are just three micrometres thick and equipped with organic photodetectors. In the proof-of-concept trial shown here, the University of Tokyo researchers mounted the LEDs on a flexible rubber substrate and connected them to a sensor that measures blood oxygen levels, and then attached them to a human hand using, essentially, clingfilm. The effect, if you can ignore the clingfilm at least, is somewhat akin to having an LED tattoo.

It's hoped that, going forward, the technology will be used to make wearable devices much less bulky and intrusive. Before long, you could be ditching your smartwatch and getting email notifications right on your wrist, while the technology could also be used to replace the heads-up displays currently used by military and emergency services personnel.



Once perfected, the new technology could turn your skin into the ultimate portable display

"Do I know you from somewhere?"

Can fish recognise human faces?

Craig Kruger, Houghton

Call it 'plaice recognition' (get it?). A team at the University of Oxford has found that archerfish are able to recognise and remember human faces.

The researchers showed archerfish, a species of tropical fish known for shooting jets of water at its prey, two images of human faces and trained them to choose one by squirting it. The fish were then shown the familiar face alongside a series of 44 new, unknown faces and were coaxed into squirting one.

After two experiments, the fish proved to be more than 80% accurate in their choices, even when more obvious details of the faces, such as colour and overall shape, were removed.

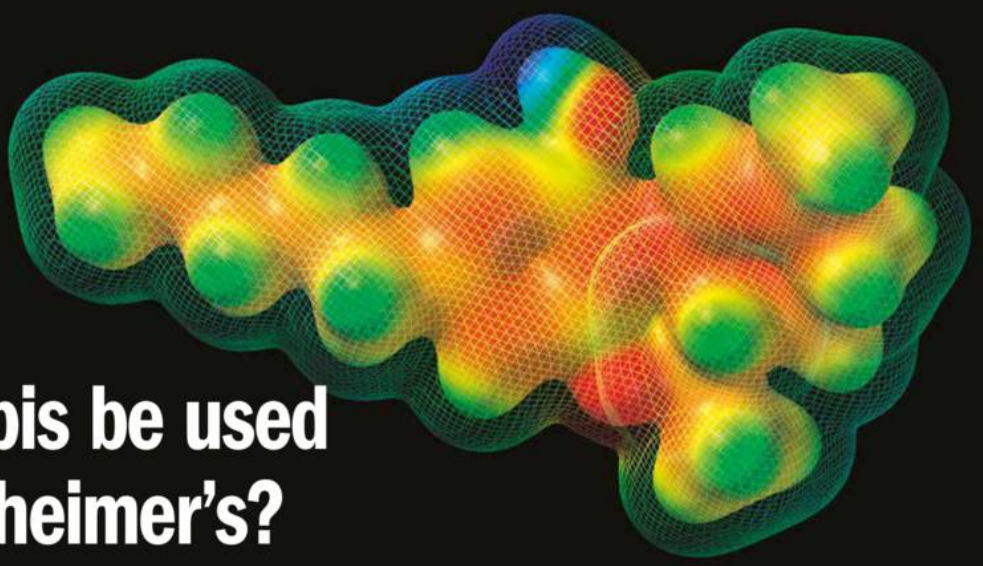
The result is surprising as fish lack the sophisticated visual cortex that allows humans to quickly distinguish different faces.

"Fish have a simpler brain than humans and entirely lack the section of the brain that humans use for recognising faces," explained lead researcher Dr Cait Newport. "The fact that archerfish can learn this task suggests that complicated brains are not necessarily needed to recognise human faces. Humans may have special facial recognition brain structures so that they can process a large number of faces very quickly or under a wide range of viewing conditions."

Q&A FLASH

- Light from street lamps causes trees to start producing leaves up to a week earlier in cities than in rural areas, biologists from the University of Exeter have found.
- Images recorded using the Herschel space telescope have shown more and more cosmic dust is being mopped up thanks to the formation of stars.
- A review of nine studies involving more than 600,000 people has found that butter is not linked to cardiovascular disease. Its bad reputation may be due to people spreading it on unhealthy foods such as white bread.

PHOTOS: CAIT NEWPORT, SCIENCE PHOTO LIBRARY



Computer model of THC, the psychoactive molecule present in cannabis. Cannabis is a class B drug in the UK, with a maximum sentence of 14 years for supply

Can cannabis be used to treat Alzheimer's?

Sarah Viljoen, Kensington

Chemical compounds found in cannabis may help to fight the toxic proteins that build up in the brain in Alzheimer's disease, researchers at the Salk Institute in California have found.

The team found that tetrahydrocannabinol (THC), the psychoactive part of cannabis, can remove amyloid beta, a toxic protein that accumulates in the ageing brain and is considered to be a hallmark of Alzheimer's disease.

Exposing nerve cells to THC also shuts down the inflammatory response triggered by the presence of amyloid beta, a major component of the damage associated with Alzheimer's disease.

So far, the trials have only been conducted on neurons grown in the lab, but the finding could provide clues to developing novel therapeutics for the disorder, the researchers said.

"Although other studies have offered evidence that cannabinoids might be neuroprotective against the symptoms of Alzheimer's, we believe our study is the first to demonstrate that cannabinoids affect both inflammation and amyloid beta accumulation in nerve cells," said lead researcher David Schubert.

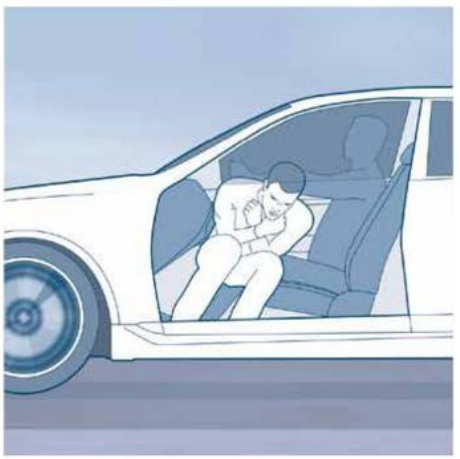
However, clinical trials on human subjects are required before any therapies using THC-like compounds can be developed.

How can I jump safely from a moving car?

Dexter van Royen, Parys

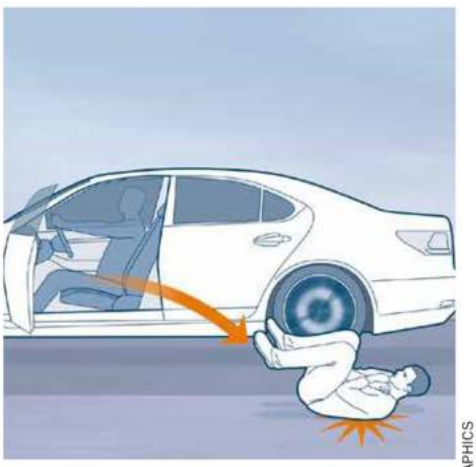
1. Timing

'Safe' is unrealistic. However, you can make it survivable with a little bit of planning. If you are sitting in the left seat, wait until the car is travelling around a bend to the right, so you will be thrown clear of the car. Make sure there are no oncoming signposts.



2. Angle

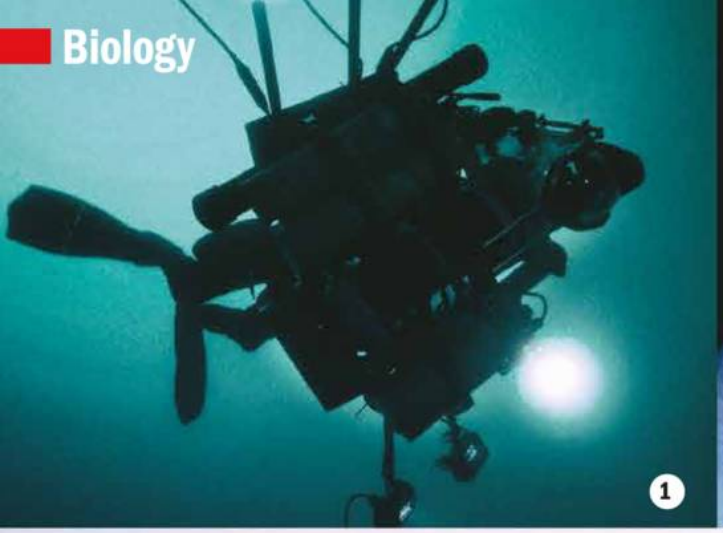
To protect your elbows, stuff your sleeves with paper or anything you can find. Crouch in the footwell, facing the door. Push the door open and jump out at a 45° angle. Pull your elbows in and put your fists under your chin. Keep your legs together and don't try to land on your feet.

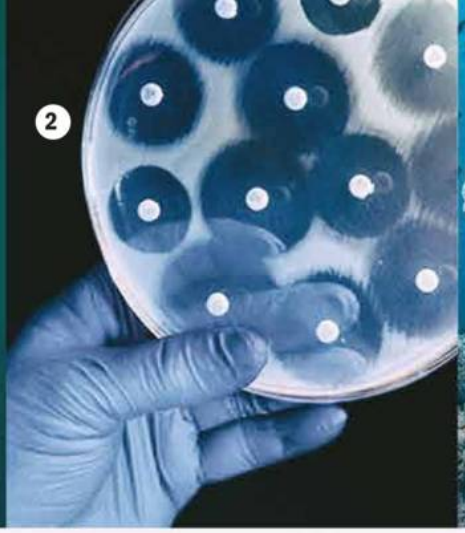


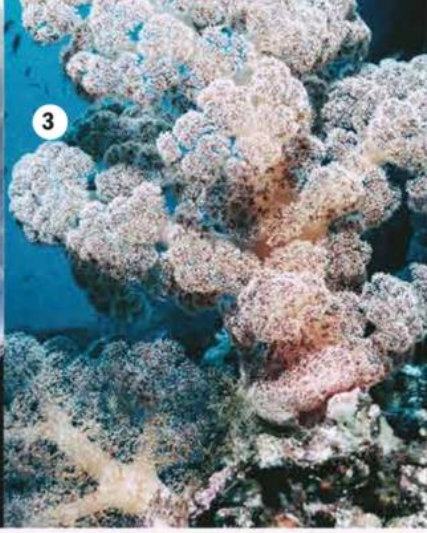
3. IMPACT

Aim to land on your back. This is the widest part of the body and will spread the impact force most evenly. Keep your limbs and neck tensed to prevent them flailing, and allow your body to roll. Resist the urge to put your hands out, otherwise you will break your wrists.

ILLUSTRATIONS: ACUTE GRAPHICS





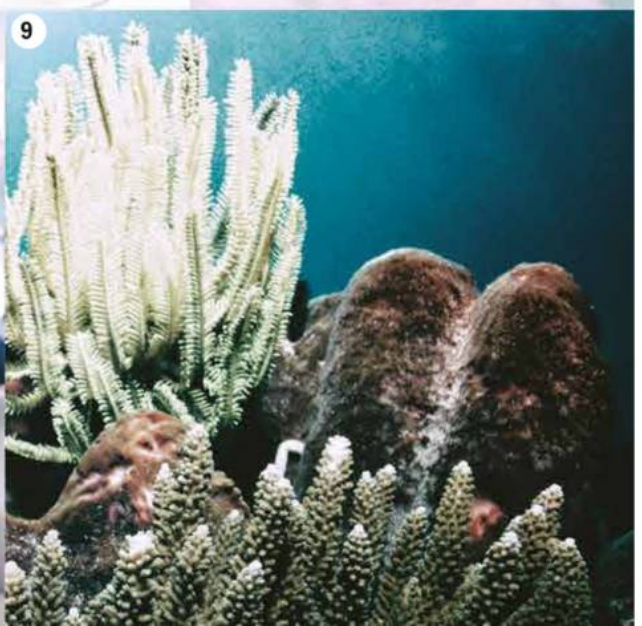


RAIDING THE OCEAN'S MEDICINE CABINET

Antibiotics are losing their effectiveness against disease. But the world's waters could be full of new drugs, just waiting to be discovered

TEXT: HELEN SCALES

PHOTOS: GETTY X7, FLPA X2



1 Diving the Great Lakes

2 Testing antibiotics in the lab

3 Animals on coral reefs have evolved interesting chemical defences

4 One of Brian Murphy's students leaps into the water to hunt for new drugs

5 The Great Lakes in the US are a popular dive spot as they contain hundreds of well-preserved shipwrecks

6 Michael Mullowney (left) and Brian Murphy processing deep-sea sediments

7 Gathering Icelandic algae for research

8 Brian Murphy with bacteria he's collected – some of these colonies contain a specific group of bacteria that's widely used in antibiotics

9 Bioprospectors first looked to coral reefs in the 1950s

Mud and sponges probably don't feature highly on most scuba divers' bucket lists. But scientist and explorer Brian Murphy, based at the University of Illinois at Chicago, has his sights set on the sediments lurking at the bottom of lakes and the gooey animals clinging to submerged shipwrecks. And for good reason. He recently brought back a blob of mud from Lake Michigan and found it contained bacteria that make two previously unknown molecules. Lab tests showed that this class of compounds is lethal to the bacterium that causes tuberculosis, a disease that existing drugs are struggling with. "For millions of years bacteria have fought one another," says Murphy. "We're just harnessing that power."Around the world, superbugs are on the rise. Earlier this year, two patients in the US were discovered with strains of E. coli that are resistant to many antibiotics, including drugs that doctors only use as a last resort. It's an alarming trend in

The hope is that nature has plenty more in its medicine cabinet for us to dip into

which bacteria are gaining the upper hand in their battle against the antibiotics we use to kill them, hastened by the world's overuse of these drugs.

"The way to combat drug resistance is to find new chemistry," says Murphy. He's one of many modern-day prospectors who are searching for that new chemistry underwater.

Plumbing the depths

From icy polar seas to scorching hydrothermal vents, and from coral reefs to inland lakes, the vast, aquatic realms covering seven-tenths of our planet are home to an immense diversity of life. They include many animals that evolved complex chemical defences, along with a profusion of microbes; it is thought that around 90% of oceanic life is microscopic. From among these creatures, researchers are uncovering molecules that could form the basis for new medicines.

Tapping the natural world for pharmaceuticals is nothing new – pop an aspirin and your headache will be soothed by a substance that was discovered in willow tree bark. With the rising tide of drug resistance, the hope is that nature has plenty more in its medicine cabinet for us to dip into. The trick is sifting through all those potent chemicals to find the ones that could fight disease.

"It's no secret that there's an incredibly high failure rate in developing drugs," says Murphy. "It's really difficult to find a set of molecules that can target a specific disease and do it within the incredibly complex environment of the human body."

To help with this, Murphy is working to smarten up the sample collection process, as it's one of the few steps in drug development that hasn't seen a major revolution in recent decades. According to Murphy, looking for molecules in original places is an important part of drug development, so he decided to use a new resource altogether: the general public. Chatting with recreational scuba divers gave Murphy the idea of searching shipwrecks for sponges. These unprepossessing animals spend most of their lives stuck in place, sifting the water for food and taking on hordes of bacteria. "Bacteria can constitute up to 30 or 40% of sponge biomass," Murphy explains. Freshwater sponges are a common sight across the USA's Great Lakes but almost nothing is known about them. Rather than go out himself and gather sponges – a time-consuming and expensive business – Murphy piloted a citizen science project asking divers to collect tiny samples for him while they're out and about. Last summer he sent out collecting kits and got a great response, receiving more than 40 nubbins of sponge in the mail. This year he's rolling the project out across the Great

The Great Barrier Reef spans 344,400km² – that's a lot of area to search for potential drugs

Shipwrecks act as artifical reefs and become colonised with many species

PHOTOS: GETTY, FLPA

Lakes and hopes to sample as many sites as possible. Ultimately, Murphy wants to map the distribution of sponges and bacteria across the lakes so that future efforts can be more effective and will zero in on fruitful spots, both in the Great Lakes and beyond.

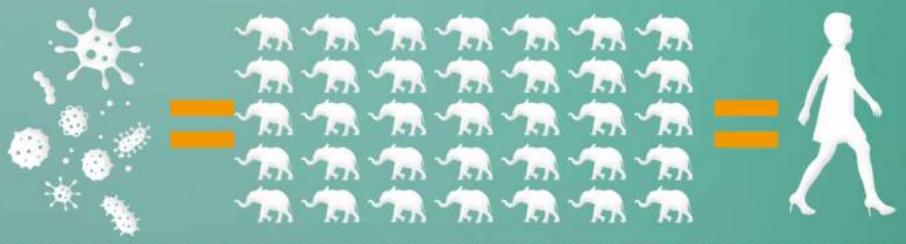
Diverse oceans

When bioprospectors first turned to the oceans in the 1950s, their initial targets were coral reefs. These bustling ecosystems, packed with species, are a logical place to look and they've yielded many natural products, including some that made it to the end of the drug

MARVELLOUS MICROBES

Bacteria can help us beat disease, but they can cause problems too

Microbes living in the ocean collectively weigh the equivalent of 35 African elephants for every person alive today.



In the last 30 years, around half of all new medicines released have been based on molecules found in the natural world.

R1,160

R1,160tn is the estimated annual cost of global inaction against antibiotic resistance by 2050.

By 2050, 10 million people could die per year (or roughly one every three seconds) if no action is taken to combat antibiotic resistance. That's more than the death toll from cancer and diabetes combined.

63,000 tonnes

Roughly half of all antibiotics used worldwide are given to food-industry animals to prevent infection and speed up growth rates.

In a survey of 139 academic studies, 72% showed a link between antibiotic use in farm animals and drug resistance in humans.

In 2011, the global market in drugs initially discovered in the sea was worth around $4.8bn.

In the US, between 1997 and 2010, 60% of cases of sore throats were treated with antibiotics, even though only 10% were caused by bacterial infection, at a cost of R6,85 billion.

Vancomycin was introduced in 1972 against drug-resistant strains of 'superbugs'. After seven years, bacteria began evolving resistance to the drug.

Brian Murphy's researchers hunt for new antibiotics in unusual locations, such as this waterfall in Iceland

Some sea squirts contain cancer-fighting agents

development pipeline. Early on was chemotherapy agent cytarabine, approved in the US in 1969 and originally found in a sponge on a Florida Keys reef. Another cancer-fighting agent called trabectedin, from a Caribbean sea squirt, has been used in Europe since 2007 and in the US since 2015.

Elsewhere, other researchers are hunting for novel chemistry even further beneath the waves. An international team called PharmaSea, led by Prof Marcel Jaspars, is searching for new antibiotics in the deep sea, including at the bottom of trenches – the deepest parts of the oceans. Jaspars describes these as 'negative islands' sticking down into the seabed, instead of pointing up. "It's possible there have been millions of years of separate evolution in each trench," he says. Jaspars and his collaborators send unmanned probes miles down into the depths to bring back mud loaded with unique bacteria. Techniques for keeping these extreme creatures alive in the lab have advanced in recent years, so experiments can be carried out. According to Jaspars, they've done around 100,000 tests, with targets including the so-called ESKAPE pathogens. This group of six bacterial strains are showing growing resistance to multiple existing antibiotics.

Ultimately, the PharmaSea team aims to narrow down two compounds that can be produced at a larger scale and put forward for pre-clinical trials. So far, their most promising finds are compounds that could be effective against diseases of the nervous system, in particular epilepsy and Alzheimer's disease.

Benefits for all?

But who owns these

PHOTOS: BRIAN T MURPHY, PHARMASEA, SEAN NASH

UNDERWATER PHARMACY

These creatures contain chemicals that could beat cancer, MRSA, and more

HORSESHOE CRABS
The blood of these arthropods is packed with amoebocyte cells that react to tiny traces of bacteria. Their blood has been used for the last 50 years to test equipment and vaccines for contamination.

CONE SNAILS
The stings of these molluscs contain conotoxins. There is already a conotoxin-based painkiller that's more potent than morphine. There are also cancer and diabetes treatments on the horizon.

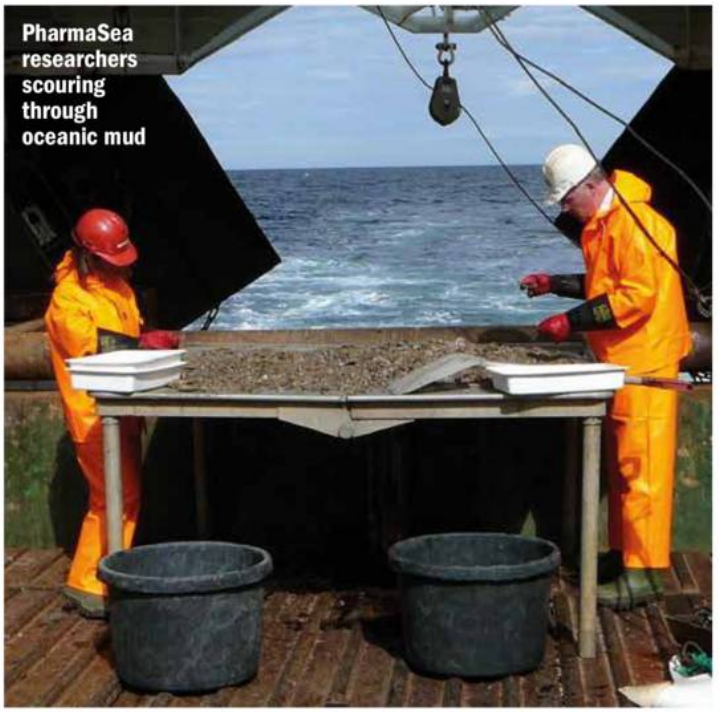
SPINY STARFISH
This starfish's body is covered in slime consisting of 14% carbohydrate and 86% protein. The substance is being investigated as a treatment for arthritis and asthma.

PUFFERFISH
These fish contain tetrodotoxin (or TTX). This is what makes fugu (a delicacy made from pufferfish) a risky dinner. TTX is being developed as a treatment for the pain suffered during chemotherapy.

MICROCOCCUS LUTEUS
This bacterium produces a pigment called sarcinaxanthin that can block long-wavelength UV radiation. This could be used in the development of more effective sunscreens.

DENDRILLA MEMBRANOSA
This sea sponge contains a molecule called darwinolide. This substance has been found to be effective against the drug-resistant MRSA 'superbug', which can often cause problems in hospitals.

ELYSIA RUFESCENS
This species of sea slug has a wide distribution. It contains a substance called kahalalide F, which is currently under investigation as a potential tumour-fighting agent.



PharmaSea researchers scouring through oceanic mud

PHOTOS: BILL BAKER, CENTERS FOR DISEASE CONTROL AND PREVENTION, HOWARD LASKER, WESLEY OOSTHUIZEN, GETTY X3

discoveries from the deep? The word 'bioprospecting' usually has a negative connotation. At worst, it brings to mind indigenous people giving away their knowledge of traditional medicines and receiving little reimbursement. Thankfully, things have moved on, and protocols for sharing benefits are now commonplace. Prior to collecting anything, researchers will generally enter written agreements with the country of origin. In 2010, the international Nagoya Protocol came into effect, making such agreements a legal requirement. But not everyone is signed up to Nagoya – the US is notably absent.

The high seas begin 200 nautical miles from shore and don't technically belong to anyone, making them difficult to police. Currently, the UN Convention on the Law of the Sea (UNCLOS) covers certain activities including deep-sea mining and laying cables, but it says nothing about biodiversity. Formal discussions got underway in March this year to amend UNCLOS to encompass bioprospecting. Various views are on the negotiating table. "The G77 and China believe that it should be the Common Heritage of Mankind, which would mean everybody could benefit," explains Jaspars. The idea is that one single nation or company shouldn't be allowed to solely benefit. On the other hand is the concept of Freedom of the High Seas, backed by the US and Norway, which would give any nation freedom to bioprospect in the high seas, just as anyone can fish there. They could research anywhere and hold on to the profits. Other groups, including the EU, are keen to find a solution. It's likely to be several years until bioprospecting in the high seas becomes regulated.

New ways ahead

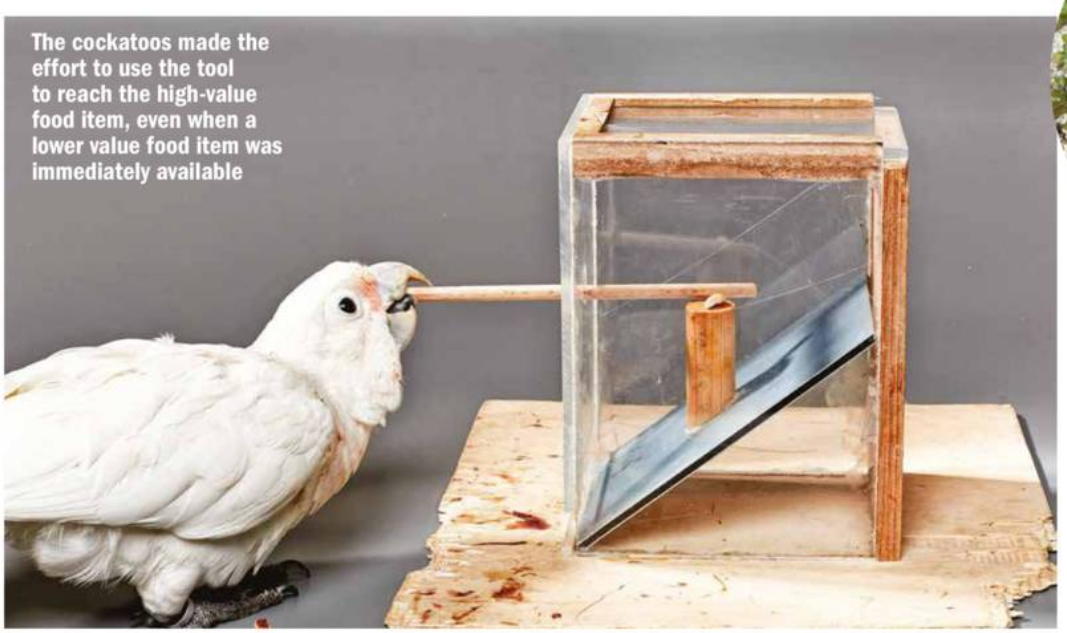
Back in the lab, Murphy's tuberculosis-busting molecules are entering the next round of tests to see if they could lead to new medicines. Even if they don't, Murphy is confident they will still be useful. "They showed very selective antibacterial activity towards tuberculosis," he says. Other bacteria were left untouched. Finding out exactly how these molecules selectively kill the tuberculosis bacterium could reveal vital information about the disease itself and perhaps point the way towards effective medicines.

But bioprospectors will have to hurry. This summer has seen the ailing Great Barrier Reef make headline news around the world, and human activities continue to threaten the health and biodiversity of Earth's oceans, rivers and lakes. Let's hope we can find the drugs and cures we need before our planet's waters become irrevocably sickened. ■

VI@panorama.co.za

Q&A
Questions & Answers

Got questions you've been carrying around for years? *Very Interesting* answers them! Mail your questions to VI@panorama.co.za



The cockatoos made the effort to use the tool to reach the high-value food item, even when a lower value food item was immediately available

Can cockatoos use tools?

Charl van Zyl, Elspark

Who's a clever boy, then? Researchers at the University of Vienna have devised a test to show that conscious reasoning is involved in tool use by Goffin's cockatoos, a species native to Indonesia.

The cockatoos prefer cashew nuts to pecans: if the former are available they will disregard the latter. They have also been seen to demonstrate two forms of tool use: using a stick to rake food into reach, and dropping balls into a tube to knock out a reward. In the University of Vienna experiment, cockatoos were presented with a piece of equipment that required a tool to reach the food inside (whether a high-value cashew or a lower value pecan), a food item and a tool.

"If a lower value food or a high-value food was out of reach inside the apparatus and the choice was between a high-value food item and a tool, they chose the food over the tool," said research leader Isabelle Laumer. Yet when the cockatoos had a choice between a low-value food or a tool, they picked the tool but only if it worked for the apparatus. If the wrong tool was provided, they picked the low-value food.

Yet it also seemed as if the cockatoos contemplated the variations in quality between the two rewards. "When the stick apparatus with the high-value food inside was available, they chose the stick tool over the immediate lower value food," she added.

Goodbye, little friend

What is it?

Fiona Atkins, George

The Bramble Cay melomys is a small rodent that lived on the island of Bramble Cay, off the coast of Queensland, Australia.

It's thought to be the first known species of mammal to be wiped out by man-made climate change. The animals have not been seen since 2009 and have recently been declared extinct. It was considered the Great Barrier Reef's only endemic mammal.

Bramble Cay measures just 150m by 340m and sits 3m above sea level. Experts say that rising sea levels due to climate change are to blame.

A recent study at the University of Connecticut has estimated that up to one in six species of animals and plants could go extinct if global temperatures rise by 4°C by the end of the century.

What is the youngest exoplanet?

Perpetua Choongoo, Zambia

Ahh ... it's only a baby. The Kepler space telescope has found the youngest exoplanet yet discovered. K2-33b is a gas giant around six times the size of Earth that orbits star K2-33 in the Upper Scorpius region, some 500 light-years away, and is no more than 10 million years old.

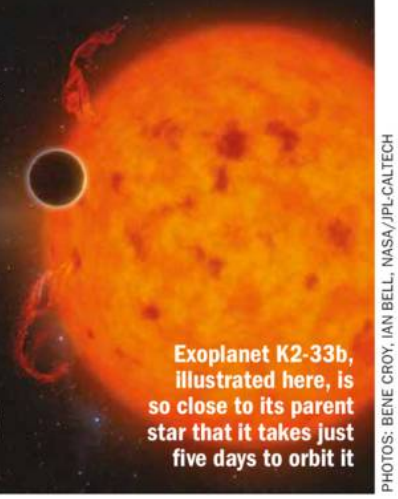
That may not sound very 'young', but bear in mind that Earth is 4.5 billion years old, and that the overwhelming majority of the 3,000-plus exoplanets discovered today are at least a billion years old. "Earth is a middle-aged planet – about 45 in human years," said lead author Trevor David. "By comparison, K2-33b would be an infant of only a few weeks old."

It is hoped that the new discovery will enable scientists to get a more accurate picture of how planets are formed. Already, its proximity to its parent star – K2-33b is nearly 10 times closer to K2-33 than Mercury is to the sun – has called into question our understanding of gas giants.

While such planets, which in our solar system lie a long way from the sun, have been found closely orbiting their parent stars before now, it was always assumed that they were formed further out then migrated inwards.

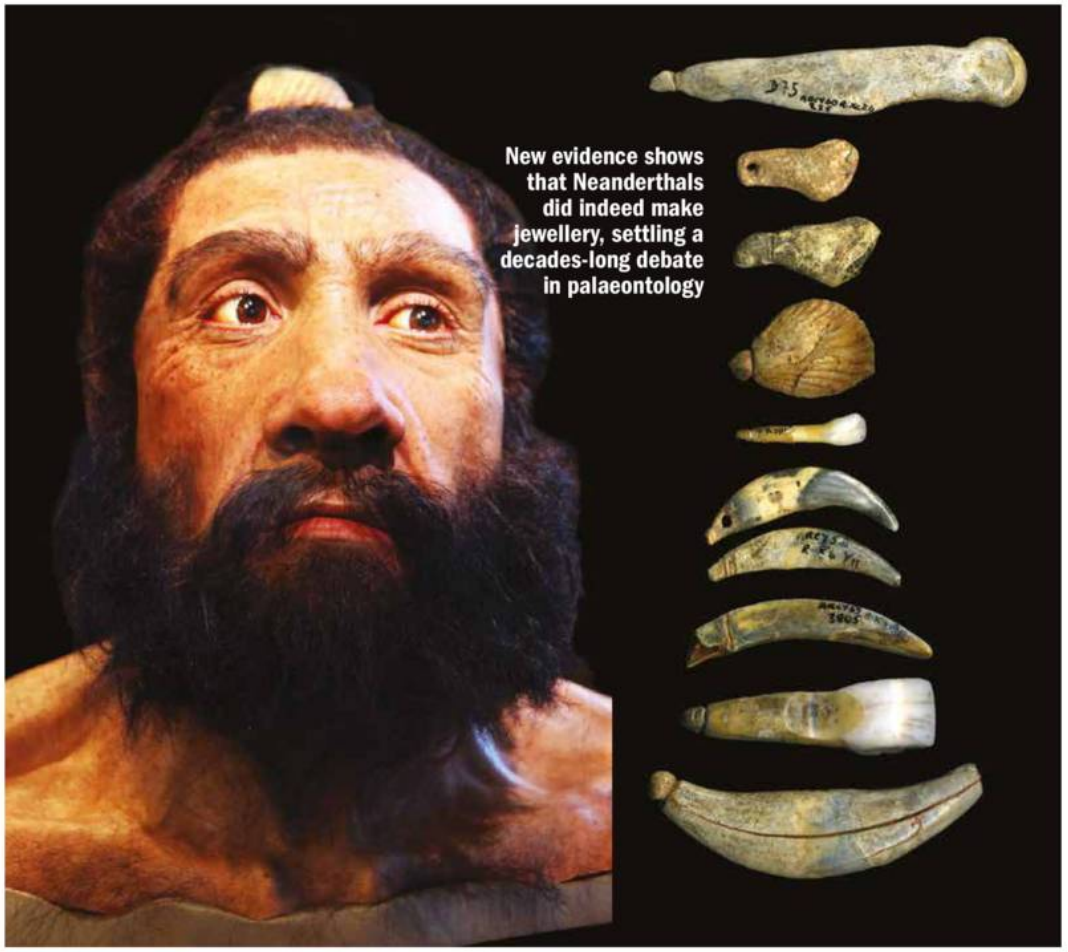
K2-33b's relative youth, however, suggests it must have formed more or less where it is now.

K2-33b was first detected when Kepler's K2 mission picked up a slight, regular dimming of the light from its parent star, an observation that was later confirmed by the WM Keck Observatory in Hawaii.



Exoplanet K2-33b, illustrated here, is so close to its parent star that it takes just five days to orbit it

PHOTOS: BENE CROY, IAN BELL, NASA/JPL-CALTECH



New evidence shows that Neanderthals did indeed make jewellery, settling a decades-long debate in palaeontology

PHOTOS: DR MARIAN VANHEREN, TIM EVANSON/WIKIPEDIA

Were Neanderthals the original hipsters?

Laura-Lee Williamson, Roodepoort

We've already had the paleo diet, but could paleo jewellery be the next big hipster trend? A team from the University of York has found that Neanderthals crafted necklaces and other items of jewellery using animal teeth, shells and ivory. Such behaviour was previously thought to be exclusive to humans.

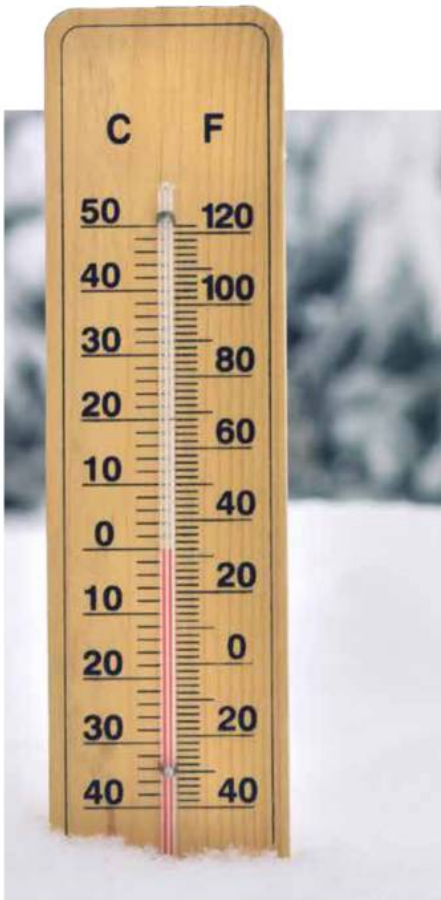
In the late 1940s a large collection of hominin remains were found surrounded by intricate body ornaments and jewellery in the Grotte du Renne in Arcy-sur-Cure, central France. Over the intervening decades, debate has raged among palaeontologists as to whether Neanderthals would have been capable of the complex, symbolic thought processes required to produce such decorative items.

Now, by analysing the proteins of some of the previously unidentified hominin specimens, the researchers from York were able to determine the remains most likely belonged to a Neanderthal infant. And radio carbon dating shows that the sample is around 42,000 years old. This puts it near the end of the Pleistocene epoch, which ranged from 1.8 million to around 11,000 years ago – a perfect match for the date of the artifacts which can now be assumed to have indeed been the work of Neanderthal jewellery-makers.

As interesting as that is, it's perhaps the protein analysis technique involved that's the real story here. "For the first time, this research demonstrates the effectiveness of recent developments in ancient protein amino acid analysis and radiocarbon dating to discriminate between Late Pleistocene clades," said researcher Matthew Collins. "These methods open up new avenues of research into contexts where hominin remains are scarce and where the biological nature of remains is unclear due to DNA not being preserved. This is of direct relevance to our understanding of hominin evolution."

Q&A FLASH

- **Dogs can understand us. "Who's a good boy? You are, yes, you are." A Hungarian study has found that pooches use the left hemisphere of their brain to understand the meaning of words and the right to understand their tone – just like humans do.**
- **Contrary to the black-and-white bears' reputation of having a blasé attitude towards the continued existence of their species, researchers have found giant panda numbers in southern China actually increased from 1,596 in 2004 to 1,864 in 2014. This means the animal is now classed as 'vulnerable' rather than 'endangered'.**

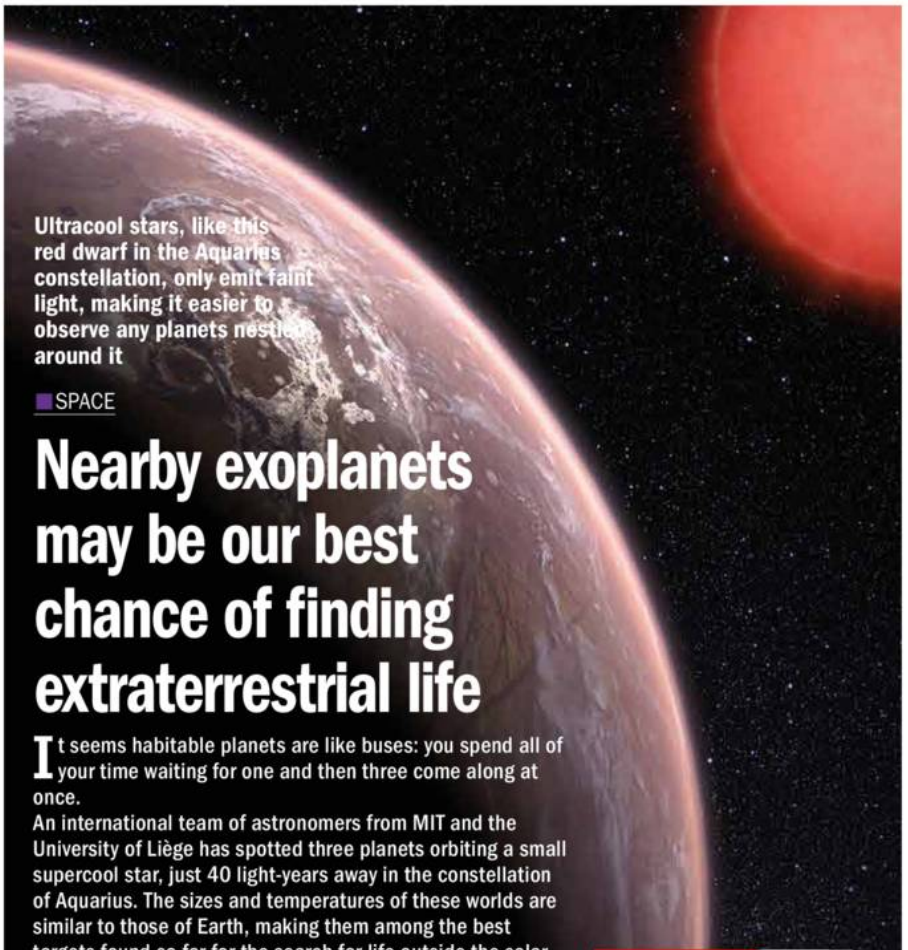


What happens at absolute zero?

Stephen West, Triomf

In one sense we can never know because reaching absolute zero is an impossible task, as an infinite amount of work is required to cool something down that far. However you can get close – the world record coldest temperature is 0.0000000001°C above absolute zero. At super cold temperatures strange things start occurring. Exotic states of matter appear, such as superfluids that have no friction and viscosity and so climb out of their containers; superconductors which have zero electrical resistance, and Bose-Einstein condensates, where atoms act totally in unison and never collide.

Quickies



Ultracool stars, like this red dwarf in the Aquarius constellation, only emit faint light, making it easier to observe any planets nestled around it

SPACE

Nearby exoplanets may be our best chance of finding extraterrestrial life

It seems habitable planets are like buses: you spend all of your time waiting for one and then three come along at once.

An international team of astronomers from MIT and the University of Liège has spotted three planets orbiting a small supercool star, just 40 light-years away in the constellation of Aquarius. The sizes and temperatures of these worlds are similar to those of Earth, making them among the best targets found so far for the search for life outside the solar system, the astronomers say.

"These planets are so close, and their star so small, we can study their atmosphere and composition, and further down the road, which is within our generation, assess if they are actually inhabited," said researcher Julien de Wit. "All of these things are achievable, and within reach now. This is a jackpot for the field."

Earth-sized exoplanets are often tricky to study as they are relatively small and can easily be overwhelmed by light from their host star, making them difficult to see in detail. But these new planets are orbiting a fainter dwarf star that emits radiation in the infrared wavelength, so they are much easier to view in detail.

The planets were discovered using TRAPPIST (TRAnsiting Planets and PlanetesImals Small Telescope), a 60cm telescope operated by the University of Liège, based in Chile. Due to their size and proximity to their ultracool host star, all three planets could potentially have regions with temperatures suitable for sustaining liquid water and life.

"Now we have to investigate if they're habitable," de Wit said. "We will investigate what kind of atmosphere they have, and then will search for biomarkers and signs of life. We have facilities all over the globe and in space that are helping us, working from UV to radio, in all different wavelengths, to tell us everything we want to know about this system. So many people will get to play with this."

Shorts

- **Labs are among the tubbiest of dogs – almost two-thirds of them are overweight. Researchers have found this may be due to a mutant version of the gene POMC, which helps switch off hunger following a meal.**
- **Next time your nanna moans about her aches and pains, you might want to show a bit of sympathy. A study at the University of Florida has found that inflammation following an injury occurs faster and lasts longer in older people.**

PHOTOS: M KORNMESSER/ESO, NICK FRASER

HISTORY

Earliest plant-eating marine reptile discovered in China

This bizarre hoover-beaked beastie is *Atopodentatus unicus*, a crocodile-sized marine reptile that patrolled the seas of southern China 242 million years ago, making it the earliest plant-eating marine reptile ever discovered.

Fossils of the animal were first found in 2014, but as the head was poorly preserved the nature of its jaw was impossible to figure out. Now, after the discovery of two more complete fossils, an international team of researchers from China, Scotland and the US have solved the riddle.

"It's a very strange animal," said researcher Olivier Rieppel. "It's got a hammerhead, which is unique. It's the first time we've seen a reptile like this."

The animal, whose name means 'unique strangely toothed', lived up to its moniker. It had a row of peg-like teeth running around its mouth with bunches of needle-like teeth further inside.

To get to the bottom of how the reptile fed, the team used an unconventional material: Play-Doh.

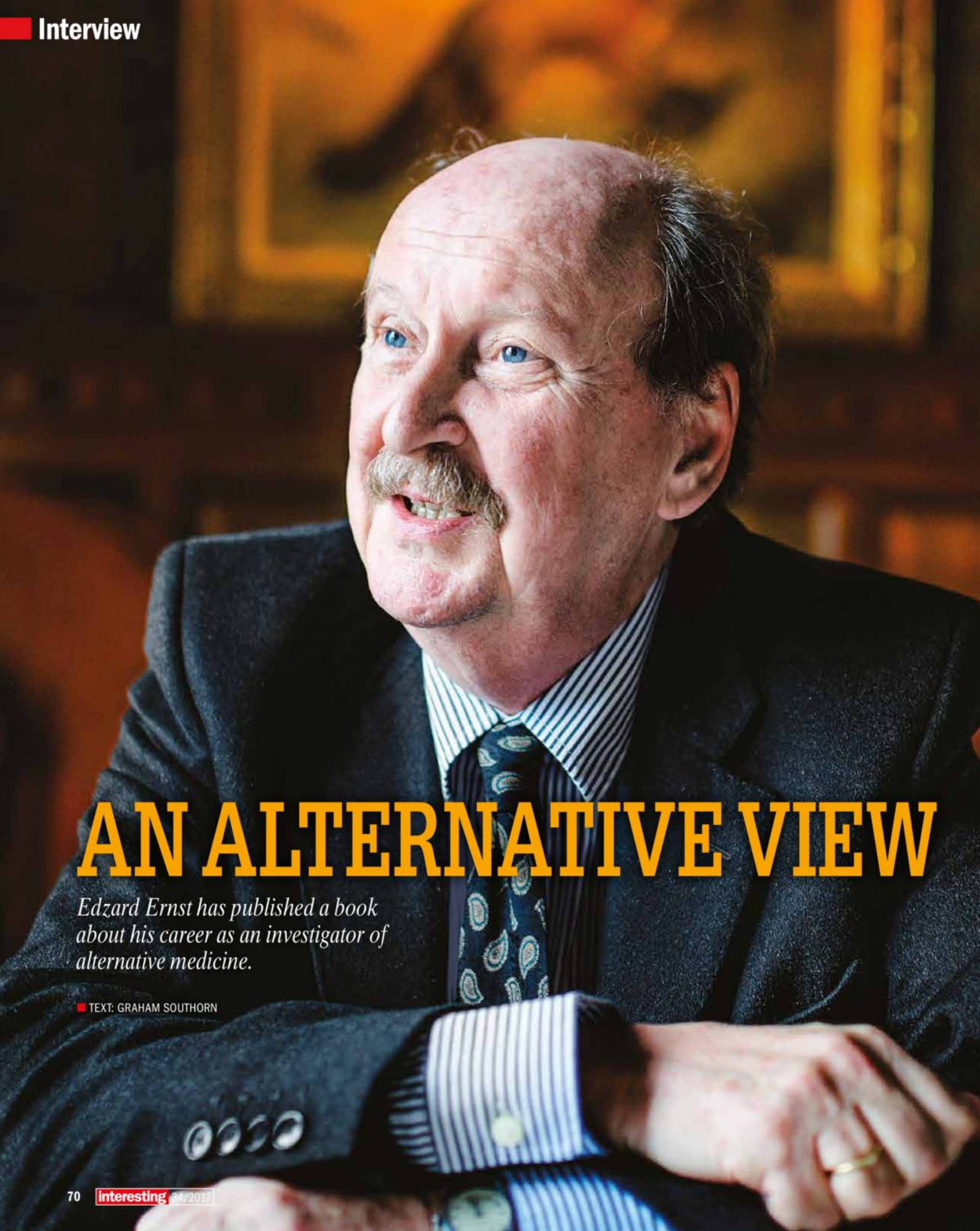
"To figure out how the jaw fitted together and how the animal actually fed, we bought some children's clay, kind of like Play-Doh, and rebuilt it with toothpicks to represent the teeth," said Rieppel. "We looked at how the upper and lower jaw locked together, and that's how we proceeded and described it."

After analysing the structure and shape of the model, the team concluded that the unusual jaw of *A. unicus* would have helped it eat plants. "It used the peg-like front teeth to scrape plants off rocks on the sea floor, and then it opened its mouth and sucked in the bits of plant material. Then, it used its needle-like teeth as a sieve, trapping the plants and letting the water back out, like how whales filter-feed with their baleen [comb-like structures in the mouth]," said Rieppel. "The jaw structure is clearly that of an herbivore. It has similarities to other marine animals who ate plants with a filter-feeding system, but *Atopodentatus* is older than them by about eight million years."

No, it's not a novelty vacuum cleaner – it's an ancient marine reptile called *Atopodentatus unicus*. That jaw shape helped it to scrape up plants from the seabed

Hanging gardens

This overpass has been installed over a busy road in the city of Hangzhou in eastern China. Pedestrians are treated to a yellow-coloured walkway that features escalators, lifts, gardens and rest areas, instead of having to trudge their way over a bleak concrete structure. The overpass is even outfitted with devices that spray a cooling mist, to refresh weary walkers when the city heat gets too stifling.



AN ALTERNATIVE VIEW

Edzard Ernst has published a book about his career as an investigator of alternative medicine.

TEXT: GRAHAM SOUTHORN

"St John's wort is at least as effective as conventional treatments for mild-to-moderate depression"

How would you define alternative medicine?
There is not a good definition because it is an umbrella term for lots of treatments that have very little to do with each other. I think of it as anything outside mainstream medicine, except for experimental treatments such as high-tech cancer therapies.

You were Chair in Complementary Medicine at the University of Exeter – what did your job involve?
It was entirely research-based – we did rigorous research into the ethics, safety and cost effectiveness of these [alternative] treatments. We also wanted to further analytical and critical thinking in this area, because I thought that was badly needed.

Did you encounter resistance?
I quickly realised that alternative practitioners weren't enchanted by my mission statement. They see themselves as anti-establishment and they don't like science. I'm a conventional doctor by training, so there were tensions, and some made my work difficult. But for the first 10 years or so, it went swimmingly.

What was your biggest achievement?
One is that, paradoxically, I gave a lot of credibility to the field of alternative medicine. It became something that even sceptics would consider when they saw there was research going on that was truly questioning, rather than trying to prove hypotheses. The other is that we produced a lot of results. We published over 1,000 papers, 40 clinical trials and 300 meta-analyses. Even by producing negative results I was doing something positive. I was telling people, "You can keep your money for this remedy and look for something that's actually helpful for treating your symptoms."

Are any alternative medicines effective?
Yes – the area where we found most of the positive results was herbal medicine. Lots of our drugs originate from the plant kingdom, so it's not really surprising. The best example within that realm is St John's wort, which is at least as effective as conventional treatments for mild-to-moderate depression. This is just one of several examples. I was once called a "quackbuster" in *The Times*, and that annoyed me a bit. So I published an article in the *British Journal Of General Practice* covering about 20 treatments which, according to our studies, are worth having on the NHS.

What's the strangest therapy you've come across?
If you locked up 10 intelligent people in a room and said "I will only let you out once you have come up with the oddest therapeutic concept you can possibly imagine," you couldn't beat homeopathy. It's just one of the oddest things to believe that like should cure like, and that diluting a drug makes it more effective. Spiritual healing – healing with some sort of divine energy channeled into the body of the patient – is just as odd. And there's reflexology, which assumes that there's a map on the soles of your feet representing the organs of your body, and that by pressing on certain spots you can influence the function of these organs.

How important is the placebo effect?
It explains why these treatments are apparently so effective. People who use homeopathy are not stupid. They perceive some benefit from it – people have the expectation of getting better and therefore they do get better. If a patient is suffering from a cold and I give them a homeopathic placebo, that patient might indeed benefit. But if I give that patient my understanding, empathy and time plus something that actually worked, like Ibuprofen, the patient benefits from the placebo effect plus the specific effect of the Ibuprofen. In other words, just giving a placebo is cheating the patient.

What would your advice be to someone who is considering alternative medicine treatment?
It's not very prudent to generalise – it depends on what condition that person wants to treat and what treatment he or she is proposing to use. But as a rule of thumb, if it sounds too good to be true, it probably is.

Should there be more research into alternative medicine, given that £1.6bn is spent on it a year?
I think that estimate of £1.6 billion is more than 10 years old! We spend all this money on treatments and very little on research so, yes, some that are biologically plausible should be better researched. But there are others, like homeopathy, where the basics are totally implausible. The evidence, despite 200 years of research, is not good enough to invest in further studies. With herbal remedies and perhaps even acupuncture, further research might be quite useful.

So acupuncture works?
Acupuncture is interesting and the data is still highly conflicting, but it might be useful for certain types of pain. Even the NICE (National Institute for Health and Care Excellence) guidelines recommend it for the treatment of chronic back pain, which indicates that the evidence is at least promising. Further research is needed to determine whether it is entirely reliant on the placebo effect.

What are you working on now?
I give lectures, I write a blog at edzardernst.com and I've just started on my next book with a co-author, which will focus on homeopathy. ■

VI@panorama.co.za

Edzard Ernst is the author of A Scientist In Wonderland *(£14.95, Imprint Academic)*

PHOTO: HENRIK EVERTSSON

Quickies

NEUROSCIENCE

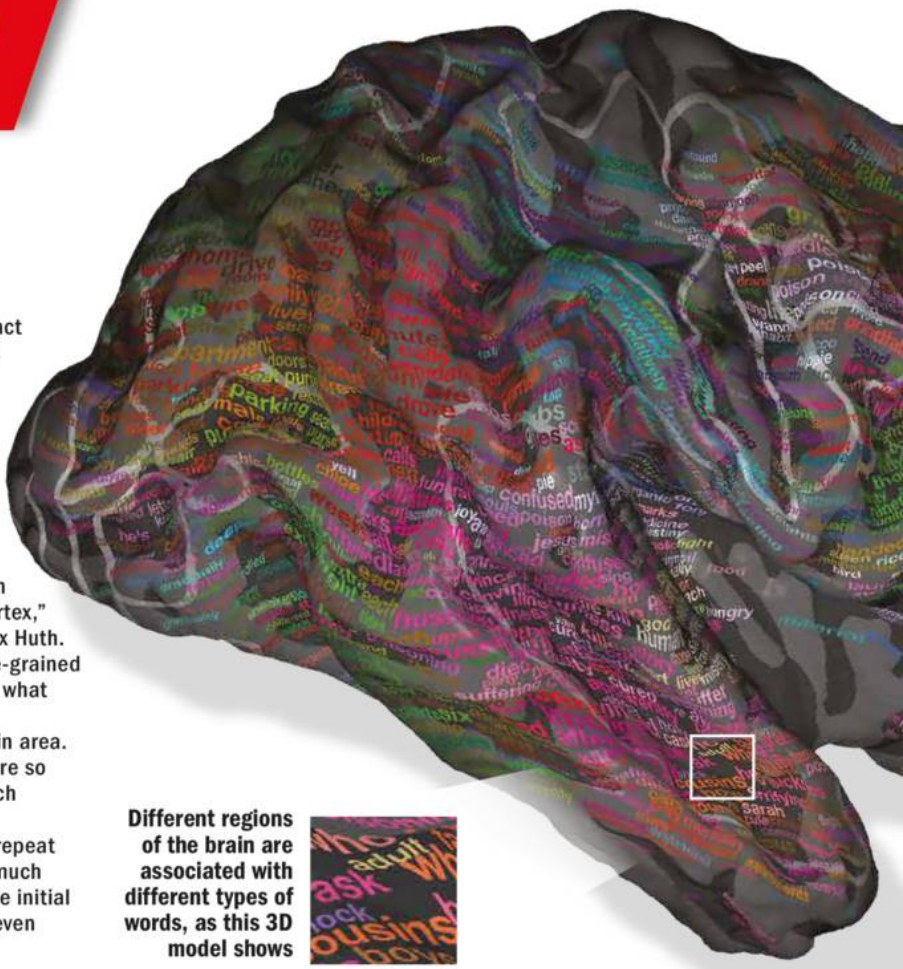
Neuroscientists create a 'word map' of the brain

It's a dictionary with a difference. Researchers at University of California Berkeley have created a 3D map showing how the brain stores and processes language. It's hoped the research could lead to new treatments for strokes or motor neurone disease.

The research involved subjects lying in an fMRI scanner while listening to hour-long story-based podcasts. This generated a second-by-second 'map' of bloodflow in the brain, enabling the scientists to build a picture of which brain regions are activated in response to particular words. Around 150 different regions in the brain are thought to be involved in linguistic processing. The new research reveals that words describing particular things, such as emotions, visual characteristics or quantities, are linked to their own distinct regions. While there was variation between individuals, patterns of brain activity proved surprisingly consistent from one research subject to another.

"Our semantic models are good at predicting responses to language in several big swaths of cortex," said lead researcher Alex Huth. "But we also get the fine-grained information that tells us what kind of information is represented in each brain area. That's why these maps are so exciting and hold so much potential."

The next step will be to repeat the experiments with a much larger sample size, as the initial research involved just seven subjects.



Different regions of the brain are associated with different types of words, as this 3D model shows

MEDICINE

Coming soon – robot surgeons

This is cutting-edge stuff. A team at Children's National Health System in Washington has created a robot surgeon that can outperform its human counterparts.

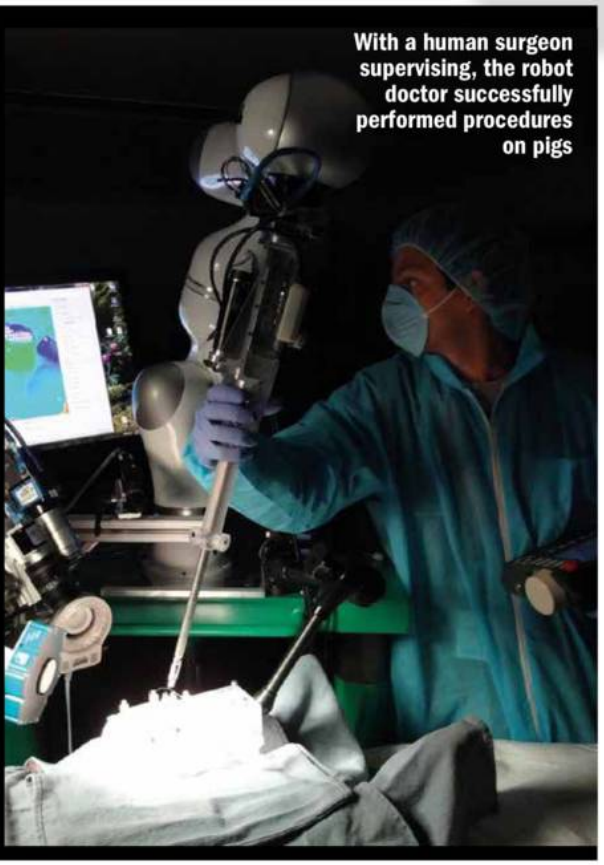
Acting under the supervision of a human consultant, the Smart Tissue Autonomous Robot (STAR) successfully stitched together the intestines of both live and dead pigs. And although it took longer than a human surgeon, at 35 minutes compared to eight, STAR produced stitches that were more evenly spaced, which helps to promote healing and prevents leakage.

"Our results demonstrate the potential for autonomous robots to improve the efficacy, consistency, functional outcome and accessibility of surgical techniques," said surgeon Peter C Kim. "The intent of this demonstration is not to replace surgeons, but to expand human capacity and capability through enhanced vision, dexterity and complementary machine intelligence for improved surgical outcomes."

The robot uses a combination of infrared and 3D light field imaging systems along with an intelligent algorithm. These allow it to track movement of tissue and make adjustments in real time.

"Until now, autonomous robot surgery has been limited to applications with rigid anatomy, such as bone cutting, because they are more predictable," said technical lead Axel Krieger. "By using novel tissue tracking and applied force measurement, coupled with suture automation software, our robotic system can detect tissue motions in real time and automatically adjust."

Now that the system has been successfully tested, the team plans to improve the sensors and miniaturise the tools. With the right backing, some of the tech could make its way into operating theatres in the next two years.



With a human surgeon supervising, the robot doctor successfully performed procedures on pigs

PHOTOS: ALEXANDER HUTH, SHEIKH ZAYED INSTITUTE FOR PEDIATRIC SURGICAL INNOVATION, UNIVERSITY OF BONN

Brown fat burns energy, unlike more familiar white fat

HEALTH

Introducing brown fat

This is so-called 'good' fat. Unlike white fat, which stores calories and can lead to the dreaded spare tyre, brown fat burns energy to produce heat.
Brown fat is difficult to find and study and its exact role is still being figured out. It's found in different areas in people's bodies. It is activated by cold and may act as a kind of internal jacket to keep us warm.
A team at the University of Bonn has found that when there are low levels of miRNA92a, a type of molecule responsible for the coding and expression of genes, brown fat cells burn more energy. The finding may help researchers develop drugs that kick-start brown fat's energy-burning activity.

FOAM FACTS

ALCOHOL

The alcohol in beer actually works against the foam. So beers with a higher alcohol content will have a smaller head.

CLEAN GLASSES

If your glass hasn't been rinsed properly and still has traces of detergents, it can stop your head from forming.

LIPSTICK / LIP-ICE

Waxy substances like lipstick can kill your beer head.

GREASE / FAT

Fats from foods or even your skin can spell the end of your beer head.

TEMPERATURE

Chilled glasses not only make your ice cold beer even colder, they go a long way towards forming the perfect head.

If the glass is too warm, it can create too much foam and make your beer flat.

A beer head is that frothy foam that gathers on top of your beer once it has been poured into a glass

Beer all you can be with this handy guide to keeping your head when all around you are losing theirs

The head on your beer forms because beer is naturally carbonated, meaning that there are tiny bubbles of carbon dioxide which form during the fermentation process when the yeast in beer is converted into sugar and alcohol. When this is poured, the carbon dioxide gas is released and creates the bubbles, which help form the foam. The different ingredients in beer don't only affect the taste, but they impact on the size and shape of the head as well as the time it takes for the foam to dissipate.
A slightly roughened surface at the base of a glass (referred to as embossed glass) makes the carbon dioxide bubbles form at a faster rate. This makes more foam and helps the foam head last longer.
Your beer foam delivers thousands of tiny bubbles filled with the scent of your beer straight to your nose, making it taste even better. Your foam also affects the way the beer feels in your mouth, by making it creamier or fluffier.

TEXT AND INFOGRAPHIC | SAB

Is this the future of furniture?

These days, connected technology isn't just smart kettles and intelligent fridges …

Lift-Bit

Developed by Italian design house Carlo Ratti Associati, Lift-Bit brings modular furniture into the Internet of Things age. The system consists of hexagonal stools which can be put together however you like, and raised or lowered in height (within a range of 480-780mm) using an accompanying tablet app or, thanks to built-in sensors, simply by waving a hand over them. So what's been a sofa all day can convert into a bed at night, for example. But such convenience doesn't come cheap: each stool will cost around R11,000 when they go on sale later this year, so enough to make a double bed will set you back around R135,000.
carloratti.com

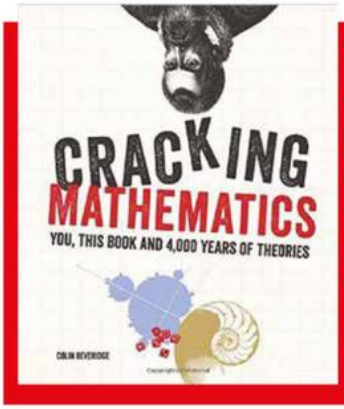
LG Styler

Available now for around R22,000, the Styler 'clothing care system' steams your clothes, eliminating expensive trips to the dry-cleaner's and the hassle of ironing clothes. There's a rail for large garments, a rack for smaller items and a built-in trouser press, while aroma capsules help keep clothes smelling fresh as a daisy.
lg.com

Lian-Li DK-04 desk

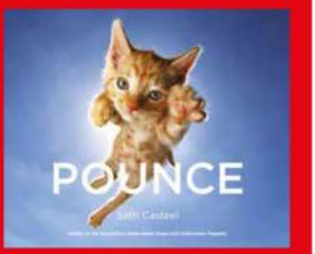
This standing desk brings new meaning to the term 'desktop computer'. Inside its chassis lies a PC motherboard with enough slots and bays to satisfy any builder (including support for eight disk drives), while USB and audio ports sit on the front panel. Add a monitor and away you go.
lian-li.com

Books



Cracking Mathematics by Colin Beveridge

Maths = boring, right? Spectacularly wrong, as it happens, and Colin Beveridge's expertly researched and wittily written book confirms that. There's hardly a formula to be seen in these pages, which focuses instead on four millennia of the history behind maths as we know it today, including the fascinating personalities behind several revolutionary ideas and the exotic locations in which they worked or in which the results of their hypotheses can be examined today. Read about how mathematics was involved in everything from the pyramids to the French Revolution – it's all here.



Pounce by Seth Casteel

Pictures of cats – heartbeat of the internet and now the subject of a hardcover photographic treatise by the author of *Underwater Dogs* and *Underwater Puppies*. You're surprised there's a market for this sort of thing? Well, bring your cynicism and observe Twerky-butt (yes – the kitten's actual name) launching himself through some yellow flowers, or marvel at the improvised choreography of Donut, or swoon as Captain Cookieface pours all his energy into studying a spot on the floor in front of him. Intellectual? No. Will it make you happy? Yes.

Abandoned Asylums by Matt Van der Velde

There are few spaces as evocative as an abandoned asylum, and photographer Matt Van der Velde's record of the current state of a number of American institutions that operated in the 19th and early 20th centuries is proof of that. There's more than just spooky pictures to consider here, as is pointed out in the excellent foreword by Carla Yanni, a professor of architectural history. Many of the chapters include a detailed explanation of the origins of a particular asylum and the stand-out characteristics of those who worked there, but others are simply picture essays, inspiring powerful feelings of hope and despair.

DVD

Jason Bourne (13V)

The *Bourne* franchise was in danger of going into freefall after *The Bourne Legacy,* a film in which the titular agent was not even a protagonist, but this latest instalment reunites Matt Damon in the title role with director Paul Greengrass, who helmed the second and third films in the series – both huge hits. The long-running game of cat and mouse between the superbly adaptable Bourne (still battling to grasp aspects of his personal history) and the American intelligence agencies whose ethical fluidity could be revealed or confirmed by his actions continues, with Damon as convincing as ever, if less unpredictable.

Vincent Cassel is the ruthless assassin tasked with taking him out, and Tommy Lee Jones is the CIA director overseeing the operation – strong performances both. But it is Alicia Vikander as Heather Lee, the Agency's head of cyber intelligence, who is the best addition to both the cast and the storyline, dragging the narrative from a place where guns, fists and fast cars were the weapons of choice to a contemporary battlefield where the internet, computers and mobile phones can be as useful or as damaging as any of those.

The structure of the piece sees viewers thrown into a series of consecutive set-pieces, each more ambitious than the next, with a hugely ambitious and brilliantly realised smash-up in Las Vegas the best of the bunch. There are a few suggestions that Lee and Bourne's paths will cross in future projects, though Greengrass handles that possibility elegantly, rather than spending half the next film's marketing budget on major hints in this one.

THE NUMBER GAMES

GIVE YOUR BRAIN A WORKOUT

We'd love to hear your feedback on these puzzles. Please email VI@panorama.co.za

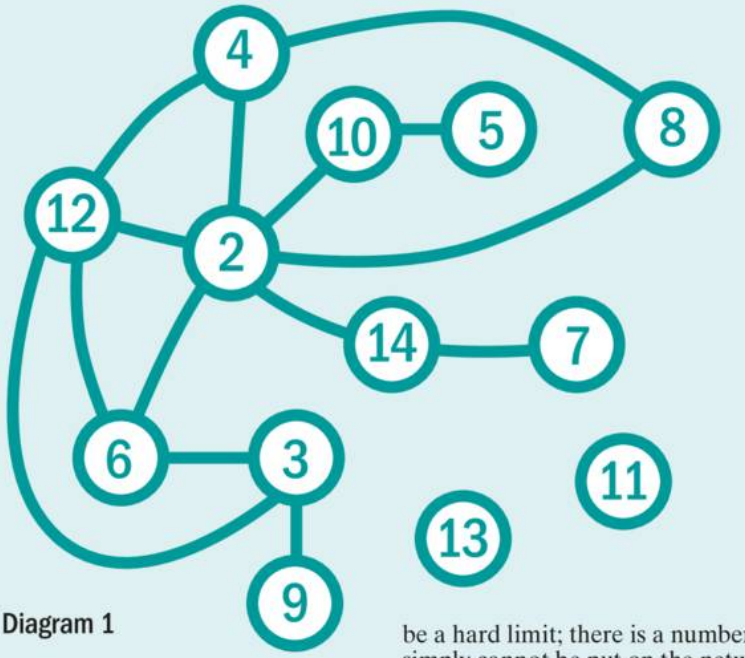


Diagram 1

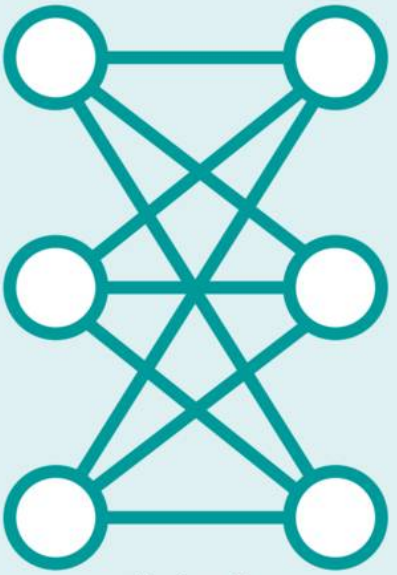


Diagram 2

Diagram 3

GAME 1: JOINING THE DOTS

This is a deceptively simple puzzle which is infuriating because at some point it becomes impossible, but it does not have the decency to tell you when.

The goal is simple: start writing numbers starting with 2 on a blank piece of paper: 2, 3, 4 ... and so on, but whenever a number you write is divisible by a number already on the page (other than 1), you need to link them with a line. And those lines are not allowed to cross.

The first line you need to join is linking 4 to 2. Then 6 needs to connect with both 2 and 3, while 8 joins 4 and 2. So far so easy. But then after a while you will number yourself into a corner. Already on my attempt I can see that wherever I write 15 I can't link it to both 3 and 5 (see diagram 1). Time to try again.

Often with this puzzle you will think you're stuck, but then you find a way to redraw the network to fit in the next number up. But eventually there will be a hard limit; there is a number which simply cannot be put on the network, but I'm not going to tell you what it is. I will, however, equip you with the maths to work out when you can go no further. When you try to draw a network like this with no lines crossing, you are looking for a 'planar network' – one which can be drawn on a flat plane, with no crossing points. Mathematicians know that 'non-planar' networks contain one of two sub-networks, a 'utility network' (diagram 2) or a 'complete five network' (diagram 3). If you can spot one of these patterns – albeit without the lines crossing it – then you know it is impossible to draw flat without lines crossing. If you can't find one, then there is still a way to draw it.

GAME 2: HIGHLY DIVISIBLE

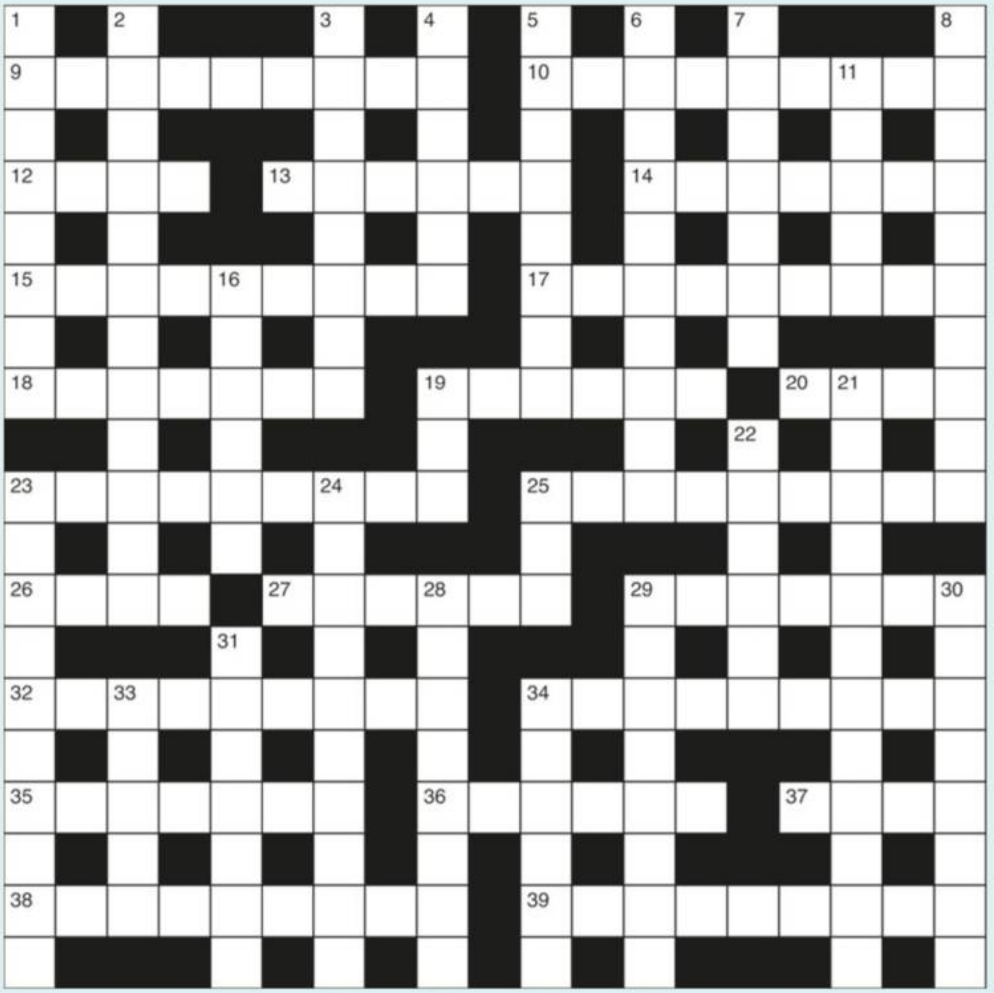
Can you find the smallest number that is divisible by all of the digits 1 through 9? Multiplying 1 x 2 x 3 x ... x 9 gives you 362,880 but that is inefficient. A much smaller number will do.

Should that prove too straight-forward, see if you can find the smallest number which is a multiple of all the numbers from 1 to 19.

And once you have a system in place, you can find the solution for any run of numbers. If you fancy stress-testing it, the smallest number which is divisible by all numbers from 1 through to 99 is 69,720,375,229,712,477,164,533,808,935,312,303,556,800.

THE Vi CROSSWORD

BACK BY POPULAR DEMAND



ACROSS

9 Concerning bullock having guidance problem (9)
10 He follows on to hit gold (9)
12 Doctor has no problem getting satellite (4)
13 Sausage used as mail (6)
14 Performing a trio around province (7)
15 Bird in the pan cooked with a bit of petroleum (9)
17 Your hands deteriorate without water (9)
18 Athlete depicted as Roman (7)
19 Breaking bread with Jack on Homer's island (6)
20 Metal oxide is contemptible (4)
23 Drag loony out of masculine study (9)
25 Talk about posse using rifle (9)
26 Get extra with a message (4)
27 Inheritor gets iron from youngster (6)
29 Two creatures provide waterproofing (7)
32 New boom caught by fresh form of rule (9)
34 Arranging to run the bar is a pain (9)
35 Old equipment, new aim – Japanese art (7)
36 That woman's lad turned into an announcer (6)
37 Officers' room in a state (4)
38 Establish a college (9)
39 Way to go, having learnt the time (9)

DOWN

1 Soldier reputedly lacking underwear (8)
2 Old problem of zones solved by new road in peace (5,7)
3 Whale has strange accent containing vowels (8)
4 Prioritising, get air-conditioning (6)
5 Forcefully articulate, like a buccaneer (8)
6 I poach boar out of fear (10)
7 Energy bound to be heard in compound (7)
8 Boilers not affected by a few stars (6,4)
11 Controller takes over new school first (5)
16 Rough girl to play with unruly mob (6)
19 Confused a year with a shorter time (3)
21 Airplane much affected by a type of code (12)
22 Across junction, pursuing fictional lion (6)
23 Any osmotic form of protein (10)
24 Old game played without elementary particle (5,5)
25 Copper right to get a dog (3)
28 Insect to turn to energy storage device (8)
29 Heir gets everything but an onion (8)
30 Metal tent with snug construction (8)
31 Relating to hip spies following small spasm (7)
33 Composer's ecstasy (5)
34 Satirist is hard on old people (6)

ANSWERS

Please visit bit.ly/TheNumberGames for the answers to this month's puzzles and crossword.

Next issue

On sale from 01 May 2017

ENVIRONMENT

Is Antarctica melting?

Is it time to sell your beach house in Clifton?

HISTORY

Unsolved mysteries of the dinosaurs

There are still many things about prehistoric beasties that perplex the world's best palaeontologists

HEALTH

Could the Black Death happen again?

Could another plague slip past modern medicine?

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A brief history of Stephen Hawking

Be amazed at what the world's most famous scientist has achieved

ALSO IN THE NEXT ISSUE OF *VERY INTERESTING*: Much more about matters technological, psychological, historical, natural and scientific. Plus all your questions answered ... What do you want to know? Mail **VI@panorama.co.za**

THIS ISSUE'S HIGHLIGHTS ON ONE PAGE

The 10 strangest ideas in science

A researcher from Stanford reckons we might all be vampires. Twilight fans will be thrilled. p.17

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Raiding the ocean's medicine cabinet

Current antibiotics don't work terribly well anymore, but there could be solutions beneath the waves p.60

The power of music

Music can affect our emotions and behaviour – and we're not just talking about Headbanger Bob from accounts ... p.28

Are we becoming more violent?

The news is packed with war, school shootings and road rage incidents, but where does 2017 sit on the hostility chart when measured against other eras? p.40

Plus

How did cavemen cut their toenails? Can your tonsils grow back? **If a lift is falling, what's my best chance of staying alive?** Can you die from a nosebleed? **What happens to people's online data after they die?**

brain entertainment
VERY interesting
the quest for knowledge
Refresh your mind

Vi

MAR/APR 2017 ISSUE 34

know more | refresh your mind

10 STRANGEST IDEAS IN SCIENCE

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HOW VIOLENT ARE WE TODAY?

Is 2017 the worst year ever? p.16

Go and jump! ... off a 421m-high building p.24

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EAT WELL OR EXERCISE?

What's the best way to lose weight?

p.16

WHY ARE WE MOVED BY MUSIC?

Do songs change the way we behave?

Plus:

- Why is nail-biting so addictive?
- **Could an asteroid knock Earth out of its orbit?**
- What's the difference between Formula 1 and Formula E?
- **How does snake venom kill so quickly?**

NEANDERTHALS:

The first hipsters?

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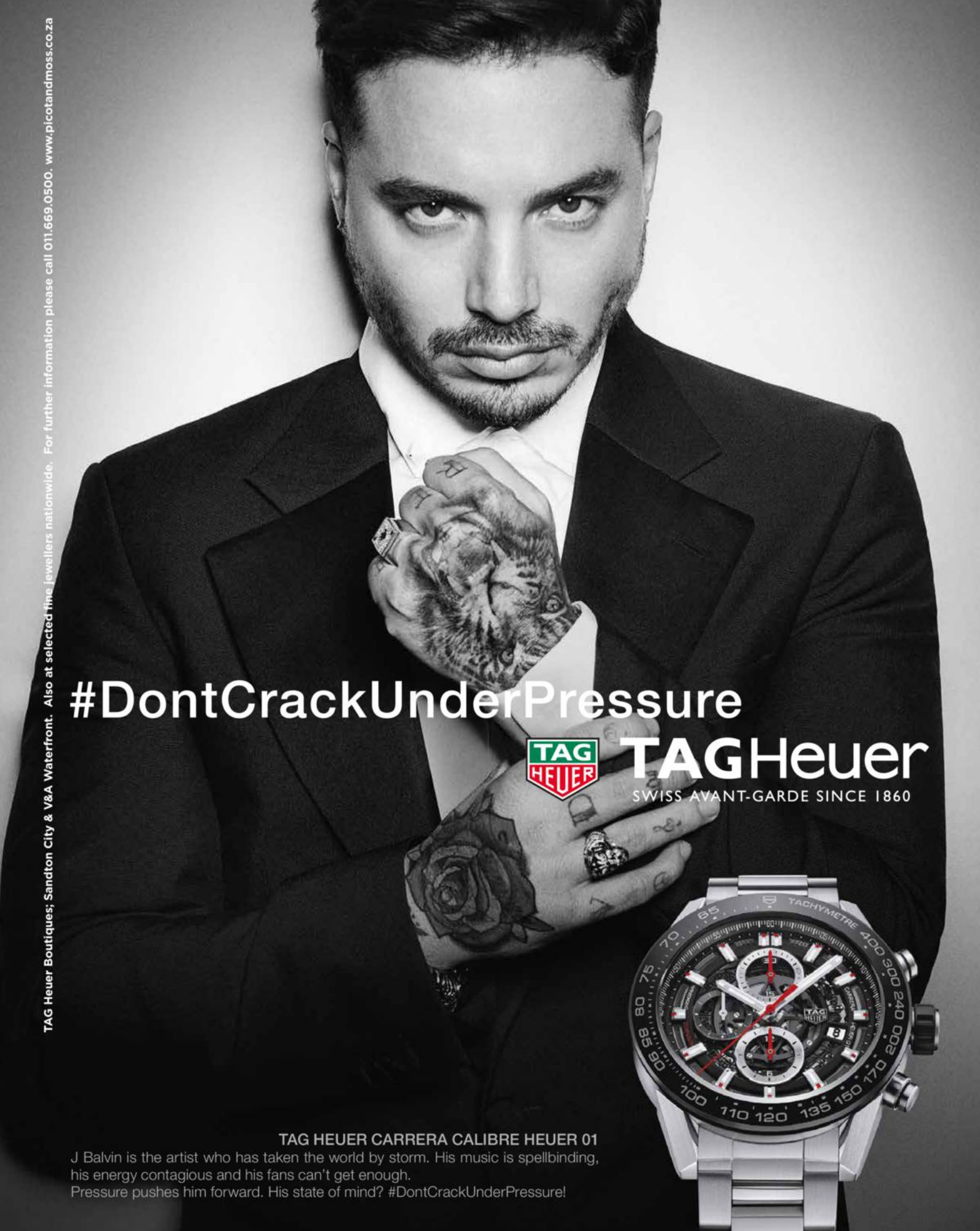
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J Balvin is the artist who has taken the world by storm. His music is spellbinding, his energy contagious and his fans can't get enough.
Pressure pushes him forward. His state of mind? #DontCrackUnderPressure!