



Volume 7 Issue 2 • February 2017 ₹125

Knowledge

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HOW TECHNOLOGY IS REWIRING YOUR BRAIN

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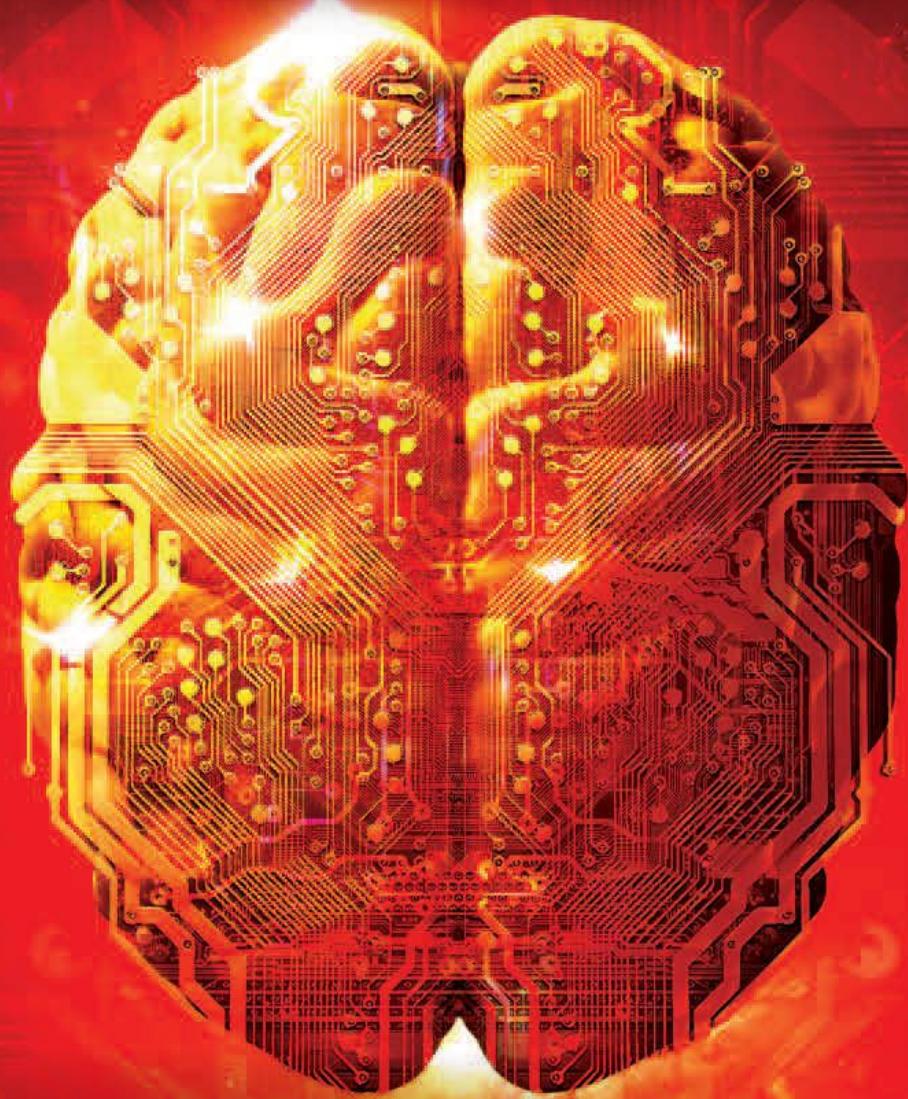
GREATES INDIAN
AUTHORS:
R. K. NARAYAN

RISE OF THE
**ROBBER
BARONS**

YOUR DOCTOR
WILL SEE
YOU NOW

GAME OF
QUEENS

SUDHA MURTY
INTERVIEW &
EXCERPT



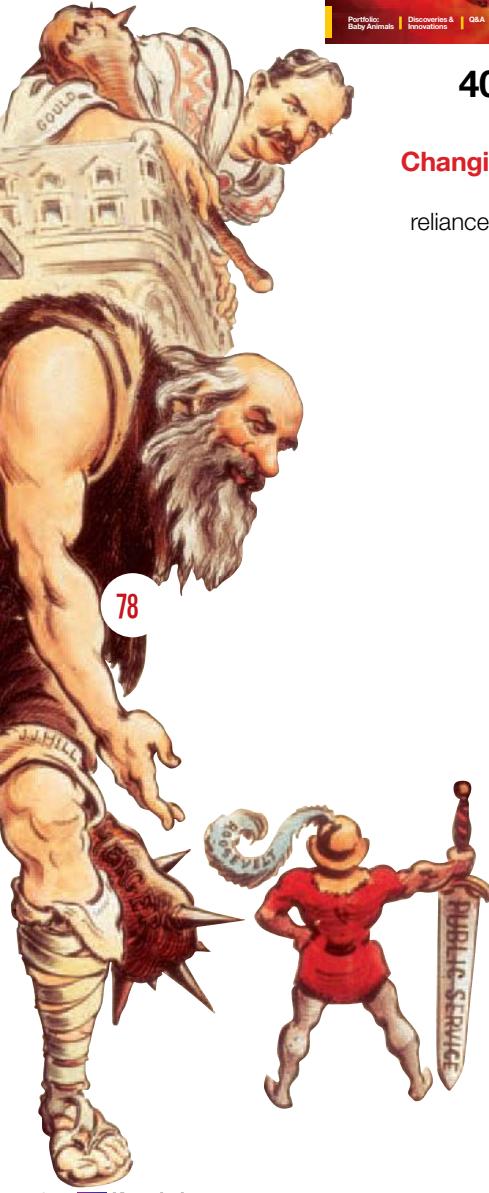


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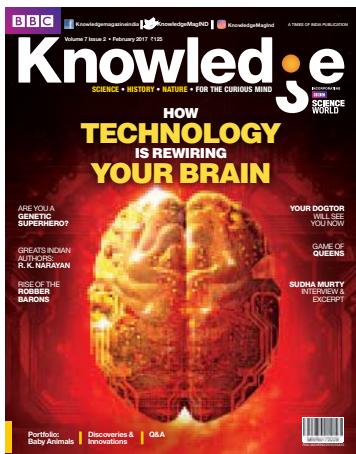
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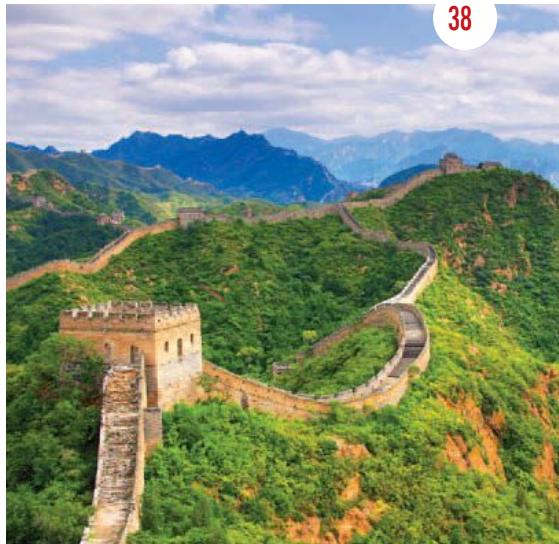
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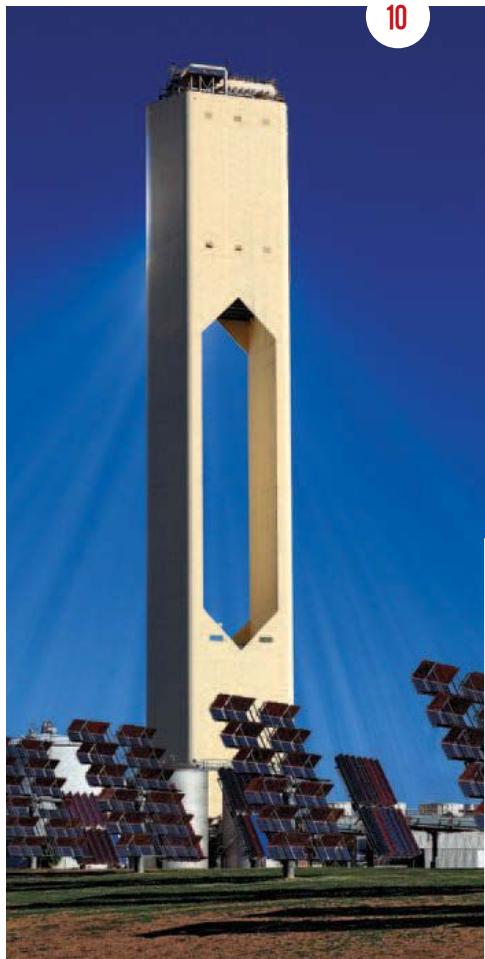
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ILLUSTRATION: ANDY POTTS, ISTOCK, 123RF, AMIT DESHPANDE



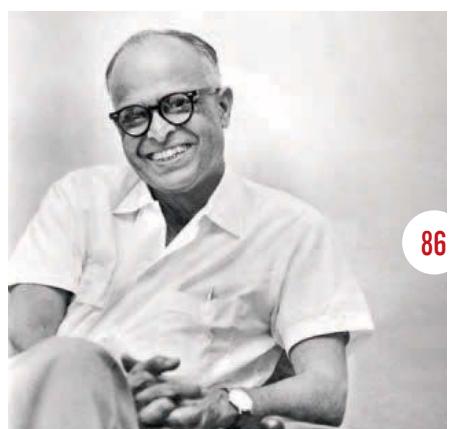
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FROM THE EDITOR



A very happy new year to you. The beginning of each year invites us to re-evaluate our thoughts on the everyday, and the pulling together of this issue forced me to think about how all-pervasive technology is – even in the lives of people who bemoan the loss of a simpler past. Why, then, do we sometimes baulk at the idea of how much we depend on technology? For parents, it may be worry about how many hours a child may spend absorbed in something with a screen.

For young people, it might well be all about FOMO – the fear of missing out.

There are, of course, the ardent advocates of technology – Steve Jobs, Elon Musk, Bill Gates, among them – but, for us, perhaps it is best to bring it down to daily living. It is about giving technology its place in our lives, just like eating the right amount of food, drinking enough water, even getting enough sunlight. **Is Technology Changing Our Brains?**, our cover story this issue, takes a cold, hard look at how technology is rewiring our minds, for better or for worse. In conjunction with this story, we're proud to present the first module of the *BBC Knowledge Panel of Principals*, educators from across India weighing in on the subject, as well as responses from our **BBC Knowledge Community** on social media. There's more on the new and the happening in our **Discoveries & Innovations** pages, augmented by a re-imagined **On The Shelves** section that explores new and classic technology, gadgets, games and literature.

Still, perhaps the beauty of our rapidly-evolving life on earth is that some things are constant. How **baby animals** are adorbs. How we'll always love the genius of **R. K. Narayan** and his Malgudi world. How there's always time for a good tale, especially when the storyteller is **Sudha Murty**. How so many of us love how dogs could now be **dogtors**. How *nature* is always steadfast – even in the face of relentless change.

I leave you with a thought from Jerry Baumgartner that will soothe both the advocates and naysayers of technology:
“Technology gives the quietest student a voice.”

Primrose Monteiro-D'Souza

EXPERTS THIS ISSUE



Jo Carlowe is a freelance journalist, editor and copywriter. She has contributed features to various publications including *Reader's Digest*, *The Guardian* and *BBC Focus*.

In this issue, she examines the influence that ever-increasing amounts of readily available information and technology can have on our brains.



Sarah Gristwood is an author, biographer and former journalist. She has authored two biographies about England's Tudor queens and also written historical novels.

In this issue, she reveals the women who wielded immense influence in 16th century Europe.



Adam IP Smith is a Senior Lecturer at University College London who specialises in American history. He has written several books, including a biography of Abraham Lincoln and also presents radio programmes for the BBC. In this issue, he looks at the great American capitalists of the latter 19th century.



Padma Shri Urvashi Bhutalia is a prominent Indian author and publisher, who has contributed writings to numerous publications such as *The Guardian* and *Outlook*, as well as writing seven books. In this issue, she kicks off our series on India's greatest writers with a profile of R. K. Narayan.



SEND US YOUR LETTERS

Has something you've read in *BBC Knowledge Magazine* intrigued or excited you? Write in and share it with us. We'd love to hear from you and we'll publish a selection of your comments in the forthcoming issues.

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We welcome your letters, while reserving the right to edit them for length and clarity. By sending us your letter we permit us to publish it in the magazine. We regret that we cannot always reply personally to letters.



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HERE'S HOW TO GET IN TOUCH

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BBC Knowledge Magazine, Worldwide Media, The Times of India Building, 4th floor, Dr. D. N. Road, Mumbai 400001



Printed and published by Joji Varghese for and on behalf of Worldwide Media Pvt. Ltd., The Times of India Building, 4th floor, Dr. D. N. Road, Mumbai 400001 and printed at Rajhans Enterprises, No. 134, 4th Main Road, Industrial Town, Rajajinagar, Bangalore 560044, India. Editor- Preeti Singh. The publisher makes every effort to ensure that the magazine's contents are correct. However, we accept no responsibility for any errors or omissions. Unsolicited material, including photographs and transparencies, is submitted entirely at the owner's risk and the publisher accepts no responsibility for its loss or damage. All material published in BBC Knowledge is protected by copyright and unauthorized reproduction in part or full is prohibited. BBC Knowledge is published by Worldwide Media Pvt. Ltd. under licence from Immediate Media Company Bristol Limited. Copyright © Immediate Media Company Bristol Limited. All rights reserved. Reproduction in whole or part prohibited without permission. The BBC logo is a trade mark of the British Broadcasting Corporation and is used under licence. © British Broadcasting Corporation 1996. CIN: U22120MH2003PTC142239

LETTERS



Jumping!



My favourite question in the latest issue of *BBC Knowledge* was "How high could you jump on other planet bodies?". It was shocking how *low* you can jump! The lowest was Jupiter (only 20m) and it was crazy how high you can jump on Phobos – 847m high! This issue also taught me about many new moons like Phobos, Ceres, Io, Europa and Titan. It was amazing!

MADHAV TANEJA, 9, The Somaia School, Ghatkopar, Mumbai

Outta space!



BBC Knowledge is a nice educational initiative for children. It contains lots of informative features on space, science, the environment, etc. It keeps us updated with its current affairs section. It attracts us with its interesting quiz, games and riddles.

I truly loved the information about space in the December issue, which answered many of my questions. I also loved the games section. To me, this magazine is a big hit. *BBC Knowledge* is proof that there is no better resource for education than books and magazines. I am eagerly awaiting the next issue of this magazine.

ROHINI V NAIR, 12, St Therese Convent High School, Dombivali, Thane



Thank you for the insights



The most intriguing world for us humans is outer space. The mention of the words "space", "universe" and "solar system" invariably raises more questions than answers. The children of today have come to embrace this vast universe and are seeking answers.

The December 2016 issue of *BBC Knowledge* seeks to answer a lot of the questions that are required to build up that extra interest in the exploration of our solar system. Satellites, space stations, reusable crafts for to and fro travel to space are bringing about a revolution in communications, material design, medicines,

solar energy, weather prediction, etc, and it's great that we have a resource to keep us updated about these breakthroughs.

BBC Knowledge is a great reference for basic insights and I am sure many children will get extremely motivated to evaluate space as a career option. Three or four decades ago, we fantasised about becoming pilots, but now children dream about becoming astronauts. I would go to the extent of saying that, what *BBC* is to World News, *BBC Knowledge* is to basic science, history and nature. I especially like the Q&A section; it has answered so many questions that even us adults wouldn't have answers to.

DIVYESH THAKRAR, 58, Powai, Mumbai



Q&A

SPACE

SPECIAL

EXPERT PANEL

Dr Oberrian Jefferies
Chairman of a pharmaceutical sciences firm in Cambridge & Cambridge University

Dr Alister Guest
Astrophysicist at the Mullard Space Science Laboratory and the University of London

Prof Robert McMillan
Professor of Physics at the University of London & Royal Holloway

Prof Pavan Deshpande
Professor in the Department of Electrical Engineering at the University of Michigan

Luc Mervin
Lecturer in the Department of Physics at the University of Bristol

Dr Mark Lorch
Head of the School of Chemistry and Chemical Engineering at the University of Hull, and a Royal Society Research Fellow

Dr Elizabeth Pernell
Astrophysicist at the University of Michigan & University of Oxford

Colin Stuart
Colin is a science teacher and a physics enthusiast. He must read book on Physics in his free time.

Mr Shashank Chakraborty
Shashank is a mechanical engineer at TCS in Bangalore. He loves science, technology and space.

Sneha Walker
Walker is a science teacher at the International Space Station

Great for history!



In the December 2016 issue of *BBC Knowledge*, the article I liked the most was on the Gupta Age by **Himanshu Prabha Ray**.

Historians indeed have had divided opinions on whether the Gupta Empire marked India's golden age. I am a history enthusiast, and I like to research the subject. The facts in the article about Gupta architecture, literature, mathematics and astronomy are fascinating. We come to know a lot about an empire if we know the coins used at the time, since coins usually have the face of the reigning emperor, and even some orders issued by the king. The literature of an empire shows the taste of people in poems, books and plays.

Another article I liked was "**How Safe Is Your Plane?**". I had never even realised that planes had to undergo such tests to be cleared to fly. These tests prepare a plane for every possible situation it may have to deal with. I've always heard the announcement about using life jackets in case the plane has to land on water, but I was never clear about how it could land on water, or what would happen if a bird gets inside the plane's engine. This article was the answer to all of my queries. The next time I sit in a plane, I will definitely marvel at the tests undertaken on each part of the plane.

SIDDHARTH SHARMA, 13, Lokhandwala Foundation School, Mumbai

My question, your answer!



I have always been a big fan of *BBC Knowledge*. My favourite part of this magazine is the Q&A section.

There are so many questions in my head and Google doesn't always give me the right answer! But *BBC Knowledge* always helps. If you are a science guy like me, you're going to love this section. I was really amazed to know that life would be possible on Mars soon and that animals can sense human beings' feelings and much more!

ADITYA ANAND, 12, St Gregorius High School, Chembur, Mumbai

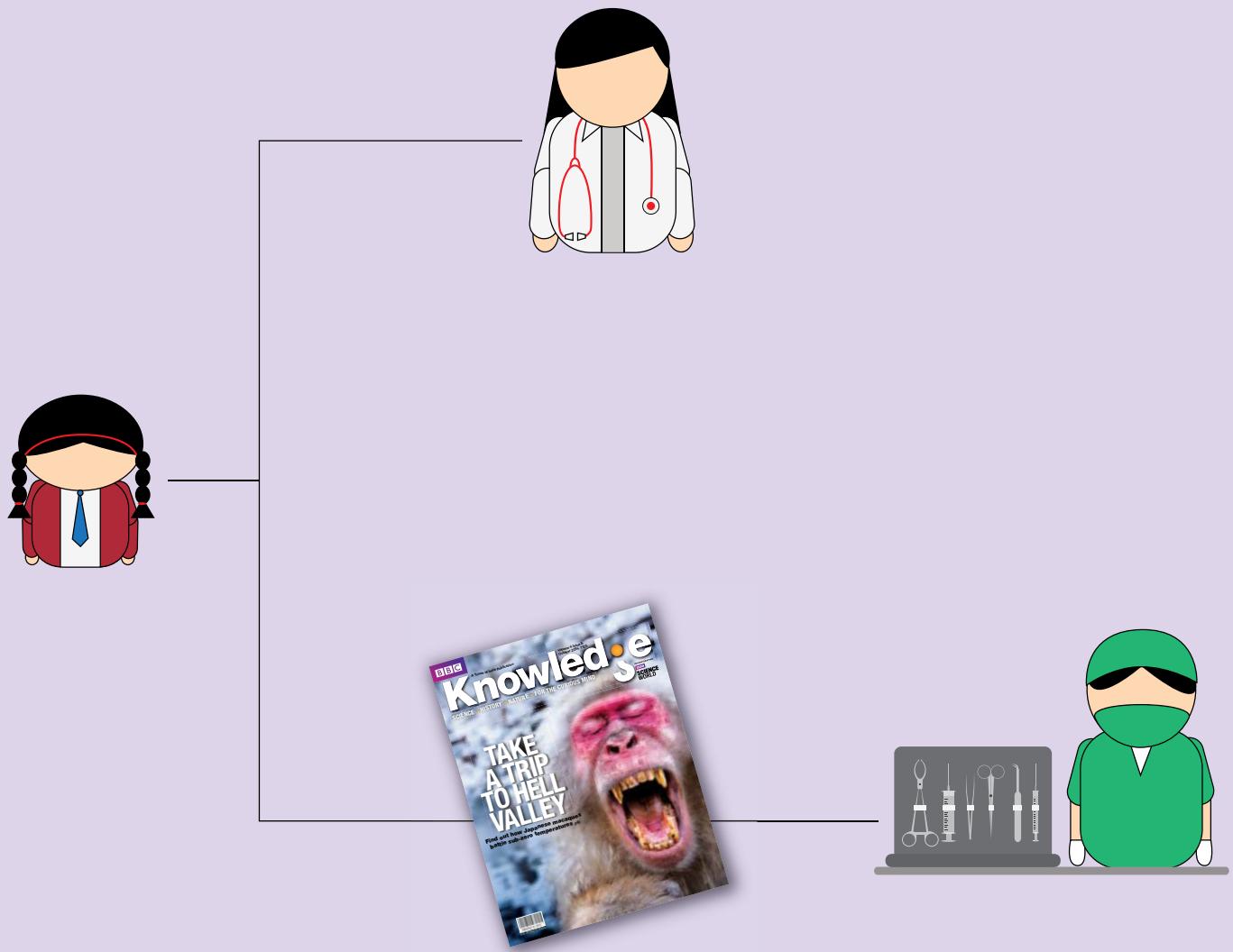
We know now!



As we have always wanted to know more about the solar system and spacecraft, we liked the article entitled "**Where Are All The Active Spacecraft In Our Solar System?**". It was great finding out which countries have spacecraft out there and where these are currently located. We also enjoyed discovering more about the Hubble Space Telescope, Lisa Pathfinder and Kepler.

Thanks for all the information – we can now share this with our friends at school and in our neighbourhood.

SONIA AND TANIA ABREO, 14, Auxillium Convent English High School, Wadala, Mumbai



There's no telling what knowledge can do.

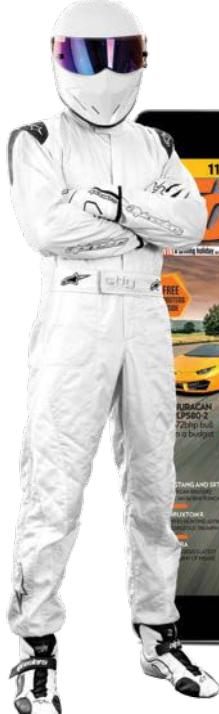
If anything can give your kids an edge over their peers, or propel them to do more than you thought possible, it's knowledge. So, give them a head start with BBC Knowledge's endless supply of riveting features, captivating photographs and awe-inspiring facts. One thing's for certain, the sooner you start, the further they'll go.

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QA

EXPERT PANEL

Dr Christian Jarrett (CJ)

Christian edits The British Psychological Society's Research Digest blog. His latest book is *Great Myths Of The Brain*.

Alastair Gunn

Alastair is a radio astronomer at Jodrell Bank Centre for Astrophysics at the University of Manchester, UK.

Robert Matthews

Robert is a writer and researcher. He is a Visiting Reader in Science at Aston University, the UK.

Dr Peter J Bentley

Peter is a computer scientist and author who is based at University College London, the UK.

Luis Villazon

Luis has a BSc in computing and an MSc in zoology from Oxford, the UK. His works include *How Cows Reach The Ground*.

Alexandra Cheung

Alexandra has a degree in environmental science, and has worked for CERN and Imperial College London, the UK.

ASK THE EXPERTS?

Email our panel at
bbcknowledge@wwm.co.in
We're sorry, but we cannot reply to questions individually.

- Are left-handers smarter? • Why do knots weaken a rope? • Does chicken soup really help a cold? • Do we all see the same colours?
- If you fell into a black hole, would time really feel slow?
- Why do phones explode?



What time is it on the Moon?

Fundamentally, and ignoring the complications of Einstein's Special Relativity, it's the same time as it is here on Earth. But this is a bit of a cheat, of course, because we haven't defined how we are measuring time.

There are many ways to define the 'time' at a particular location. Here, on Earth our usual system ('solar time') is defined by the motion of the Sun in the sky (although we usually keep track of time with an atomic clock). This means that the local time depends on where you are on Earth and we get around this complication by having many different time zones. Now, we could also define a similar time system based on the motion of the Sun as seen from the Moon. Such a system exists (Lunar Standard Time) but it is not much more than an interesting exercise in physics. What is more useful, however, is a definition of time that doesn't vary with location. This is called Universal Time (UT) and is a modern form of Greenwich Mean Time. It is the same everywhere in the Universe. So, the UT time on the Moon is the same as the UT time on Earth. AG

VITAL STATS**16**

The number of days after conception that a human embryo's heart could start beating.



Why does the smell of lavender help you sleep?

It's not just because it reminds you of the comforting smell of your granny's house. Lavender oil is mainly linalyl acetate and linalool, which are chemicals that are both rapidly absorbed into the bloodstream. Studies on mice have shown that these compounds inhibit several neurotransmitters and have a sedative and pain-relieving effect. In humans, lavender also lowers the heart rate and reduces anxiety. LV

Lavender harvesting in France: the world's most relaxing job?

Why does cold weather make joints sore?

There is a psychological link: people who claim the weather affects their joints do feel more pain than those who don't make these claims. If weather sensitivity was a purely physical phenomenon, then people would be affected whether they believed that the variability was related to the weather or not. But a 2007 study also found that every 10°C drop in temperature resulted in worse arthritis pain. This may be because cold weather causes changes in the fluid that lubricates each joint. LV





Are left-handers smarter?

The idea that left-handed people are more intelligent than right-handers is a myth. There have been lefty geniuses in history like Leonardo da Vinci, but this is not part of a larger pattern. If anything, the opposite is true. In 2015, Dutch researchers combined the results from over 30 previous studies involving over half a million people and found no link between handedness and verbal ability and a small advantage for right-handers in terms of spatial ability. Another recent study based on data from tens of thousands of people actually found that left-handedness was more common among people with very low IQ than among people with typical IQ. CJ

Does rain ever fall as pure water?

No. Water is an excellent solvent and rain always contains dissolved gases from the atmosphere. Even in a remote, pollution-free region, rainwater will still be slightly acidic because carbon dioxide in the air reacts with water to form carbonic acid. Rainwater isn't even pure when the raindrop forms, because each drop precipitates around a speck of dust, or an airborne bacterium. LV



GETTY X4, ISTOCK

Why do knots weaken a rope?

Anyone who relies on the strength of a rope takes great care to prevent knots forming in it, as they can reduce the breaking strength by more than 50 per cent. The reason is that knots create curved regions of rope whose outer circumference is greater than the inner part. This difference in length creates stress across the rope's width when put under tension, undermining its strength. RM

Why do sneezes smell like honey?

Most people's don't... but a significant minority do report a sweet or floral smell when they sneeze. This could be the smell of ketones from your bloodstream, which might be a sign of diabetes. But it is much more likely to be the cocktail of chemicals produced by the bacteria living in your sinuses or ears. Be grateful that yours smell of honey – some people's sinus bacteria give them the sneeze equivalent of halitosis. LV



Snot on toast,
anyone?



VITAL STATS

2,500

The distance, in
kilometres, that
autonomous sub Boaty
McBoatface will
travel under the
Arctic sea ice.

What is the greenest energy source?

All renewable energy sources are strong contenders for the title of 'greenest energy source' since they harness carbon-neutral sources of energy such as the Sun or wind and don't cause air pollution, putting them leagues ahead of coal or gas power.

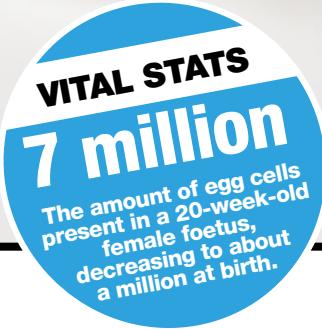
Picking a clear winner is, however, tricky.

Once you consider the emissions associated with their manufacture and installation, hydropower has the lowest carbon footprint, according to one major study. But there are also many other environmental impacts to bear in mind. For example, building hydropower dams can cause disruption to river ecosystems, while manufacturing solar panels typically involves toxic chemicals. AC

The PS10 Solar Power Plant is located in Spain. A total of 624 mirrors concentrate the Sun's rays onto a solar receiver on the top of the tower

How fast could you cycle in a vacuum?

When you ride a bike normally, the wind resistance increases with the cube of your speed. At 32km/h, the power needed to overcome the drag accounts for more than 75 per cent of the total cycling effort, and this rises to over 80 per cent at 40km/h. Recumbent bikes, which have much lower profiles to reduce their wind resistance, can already reach speeds of over 80km/h. If you removed air drag completely, the only friction would be from the tyres and the bearings. Provided you had a high enough gear ratio to allow your legs to pedal at an efficient pace, you could probably reach well over 150km/h. An easy way to simulate this would be to try pedalling on a stationary bike, but there are no published records for this sport. LV



Are humans naturally monogamous?

Humans aren't sexually monogamous in the sense that many birds are. Geese form lifelong couples and virtually never mate with anyone except their partner. We are termed 'socially monogamous' by biologists, which means that we usually live as couples, but the relationships aren't permanent and some sex occurs outside the relationship.

There are three main explanations for why social monogamy evolved in humans, and biologists are still arguing, which is the most important. It may be because human babies need a lot of looking after and stable couples can share the parenting burden.

Or it could be because men want to stay close to prevent their partners from cheating. And it could also be a strategy that women evolved to discourage men from killing infants that they suspected were not theirs.

Monogamy in humans is beneficial because it increases the chances of raising offspring, but it is actually very rare in mammals – less than 10 per cent of mammal species are monogamous, compared with 90 per cent of bird species. Even in primates, where it is more common, only about a quarter of species are monogamous. Our early ape ancestors weren't monogamous and the practice probably didn't take off until *Homo erectus* emerged, around 1.9 million years ago. LV

Why is space three-dimensional?

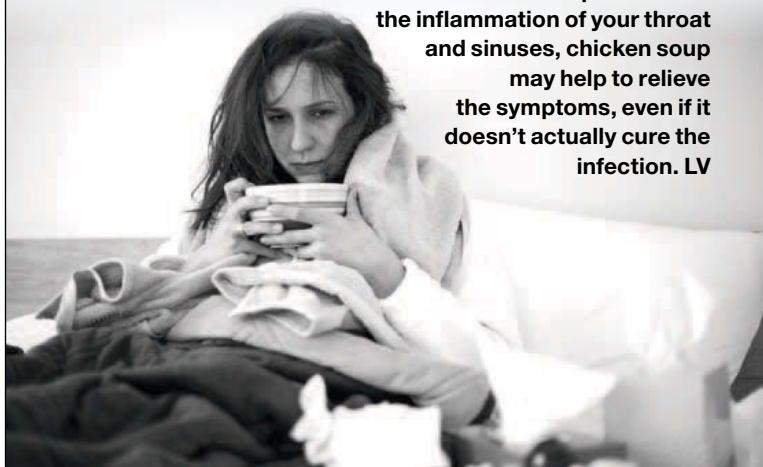
In principle, it's possible for the Universe to have many more space dimensions; some attempts to explain the fundamental forces of nature assume no fewer than six extra ones.

Yet for reasons still unclear, any additional dimensions that may have existed at the Big Bang somehow failed to take part in the cosmic expansion and remained far smaller than the three dimensions we inhabit. What is certain is that, had they grown in size, the Universe would be a very different place. Theoreticians have shown that any extra dimensions would make atoms unstable, while any fewer would eliminate the force of gravity.

Max Tegmark, a cosmologist at the Massachusetts Institute of Technology, the USA, has gone further, arguing that the very fact we exist to ask about extra dimensions of space proves they don't exist. RM

Does chicken soup really help a cold?

There is some evidence for this. Several studies have found that something in chicken soup interferes with the ability of white blood cells to flock to the scene of an infection. Since these white blood cells are responsible for the inflammation of your throat and sinuses, chicken soup may help to relieve the symptoms, even if it doesn't actually cure the infection. LV

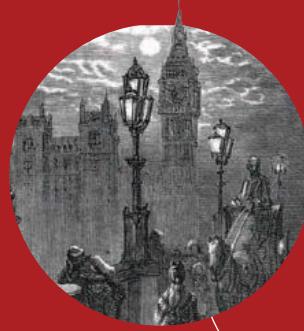


WHAT CONNECTS...

...GAS STREET LIGHTING AND NUCLEAR POWER?

1.

In 1885, Austrian scientist Carl Auer von Welsbach invented a new form of gas lighting which produced a much brighter light than the ordinary flame lamps used before.



2.

The lamps introduced by von Welsbach surrounded the flame with a thorium oxide mantle. Thorium oxide has a 3,300°C melting point, which lets the mantle glow white hot without melting away.



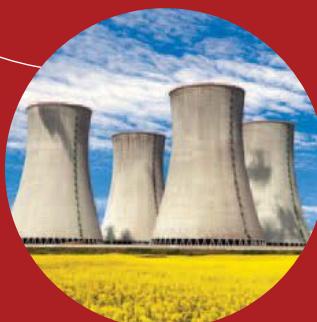
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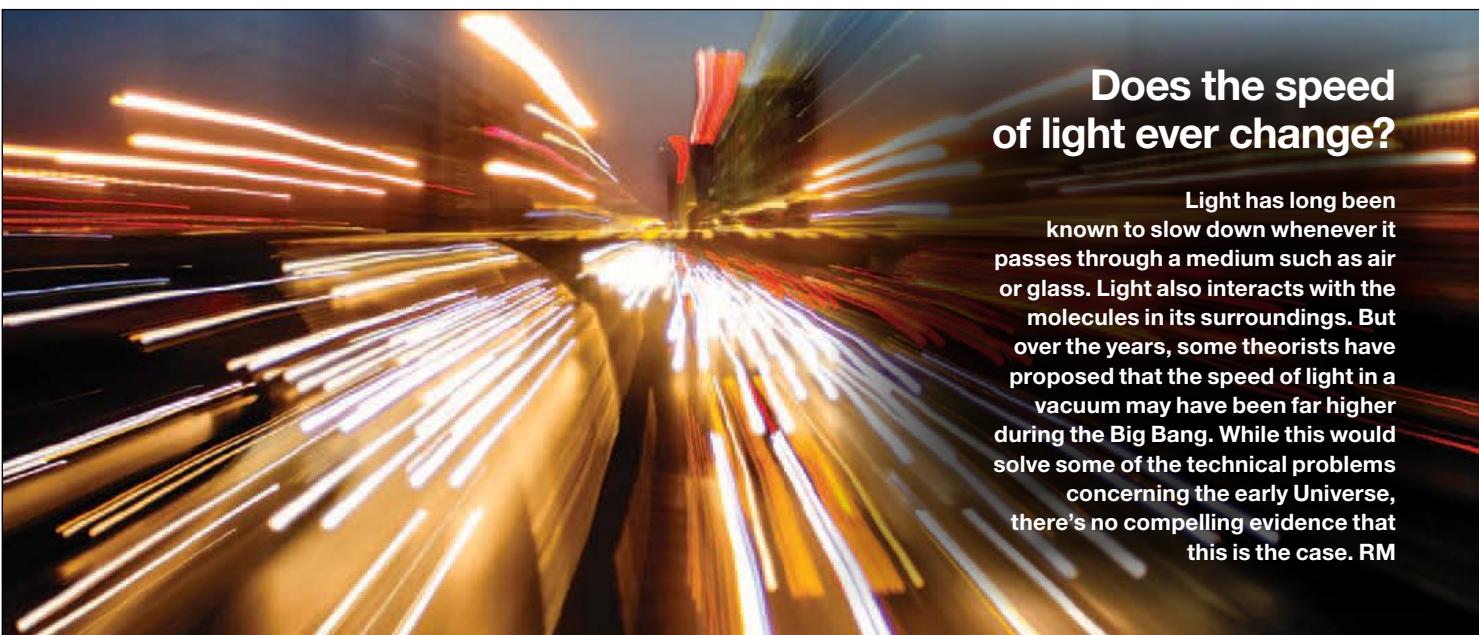
Unfortunately, thorium is also radioactive and decays to radon-220, which is also radioactive. Using a thorium gas lamp isn't dangerous, but old gas mantle factory sites have problems with contamination.



4.

For nuclear reactors, thorium is a safer alternative to uranium or plutonium. Thorium can't be weaponised, and its high melting point makes it less prone to catastrophic meltdown.





Does the speed of light ever change?

Light has long been known to slow down whenever it passes through a medium such as air or glass. Light also interacts with the molecules in its surroundings. But over the years, some theorists have proposed that the speed of light in a vacuum may have been far higher during the Big Bang. While this would solve some of the technical problems concerning the early Universe, there's no compelling evidence that this is the case. RM

61006E20736563726374ACB207340
D00AA206861E20626568696E4201
E020732C206275736865732C2073
EA3732C20616E64207061746368
C1076C6206C6974746C6E16E64
100A16C20Data BreachE204E6520
2202E6F6163686573204C697474C0
01Cyber Attack696EA1486FA1
106564207368206E61C F766
C6E207468652A261736B601
6368AF93010808B4FA017745C
00AEFA33C08E00F2A5E97D013A

Is hacking getting harder?

Computer security is becoming more and more advanced, and computer systems are complicated, so it is a more difficult task to attack or intrude into well-established computer networks. In this respect, hacking is more difficult and requires greater expertise compared to 20 years ago. However, there are more and more internet-enabled devices in the world, many of which run relatively simple software. Therefore, there are endless opportunities for hackers to exploit the security loopholes in central heating controllers, smartwatches, websites, smartphones, games consoles, CCTV cameras, vehicle controllers or even electronic toilets. PB

Do we all see the same colours?

A minority of people are 'colour blind', in that they see colours as duller than usual and have difficulty distinguishing certain colours. These problems aside, whether your experience of red is the same as mine is a tricky philosophical question because we can never truly know each other's subjective experience. What's for sure is that the same object can be perceived as being a different colour by different people, depending on the assumptions their brains make about the background lighting. Just look at the ferocious internet argument in 2015 over whether a striped dress – pictured on Tumblr – was white and gold or blue and black (Google 'the dress' to read more). CJ

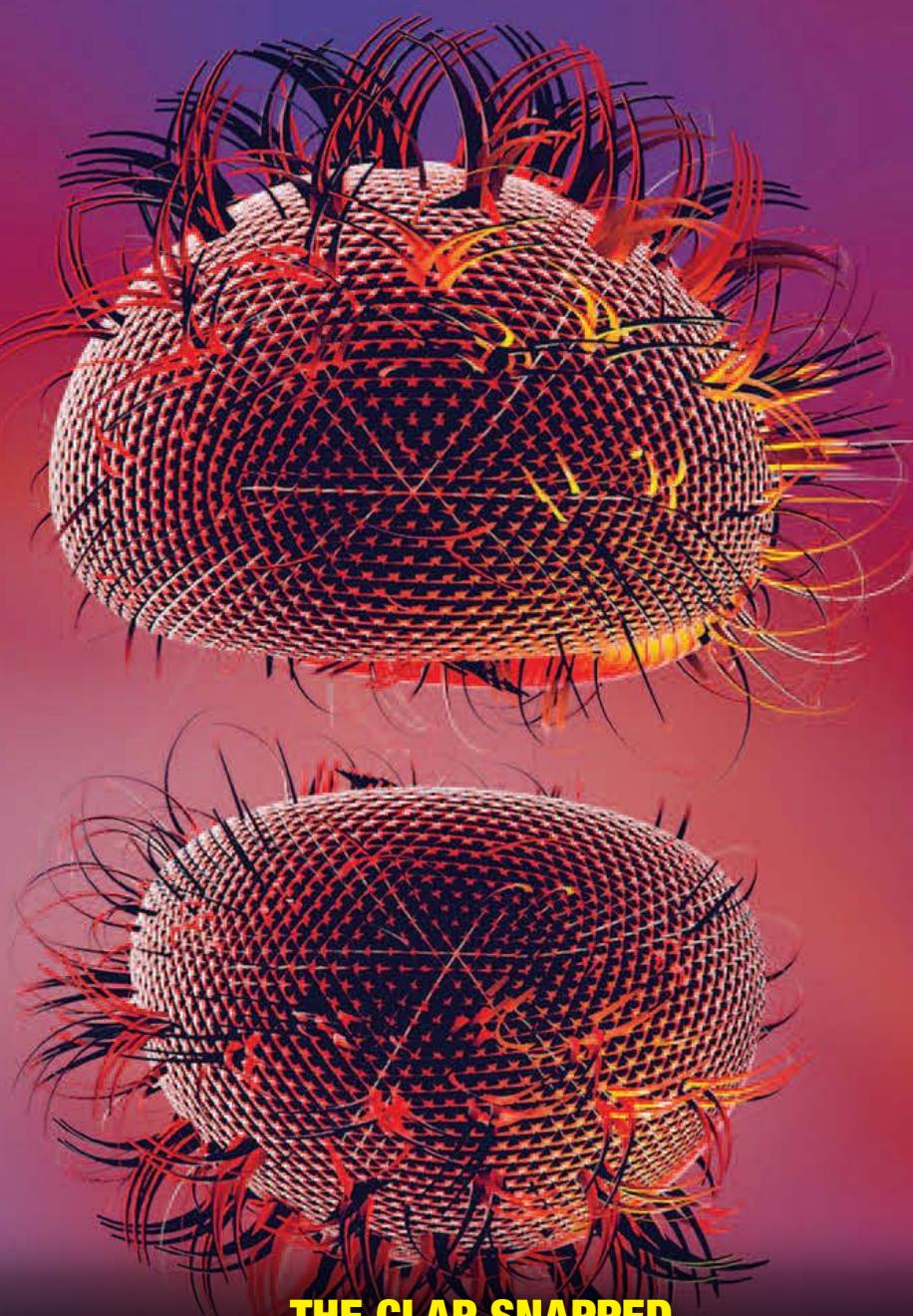


VITAL STATS

7.74

The time, in seconds, of the longest ever lightning flash. It occurred in France in 2012.

WHAT IS THIS?

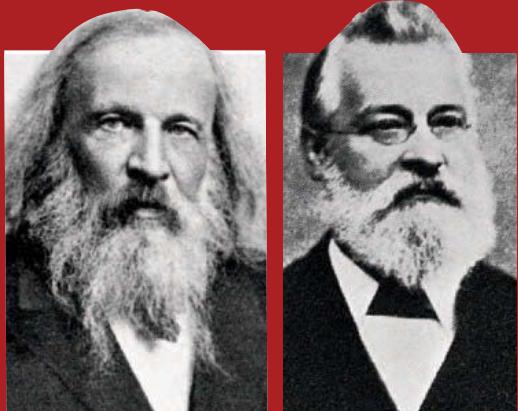


THE CLAP SNAPPED

Seen in this photograph are *Neisseria gonorrhoeae* bacteria that cause the infection gonorrhoea, also known as 'the clap'. The bacteria are spread via contact with an infected person, most commonly through sexual intercourse. Each bacterium measures between 0.6 and 1 micrometre. The hairlike appendages are called 'fimbriae' and they allow the bacteria to attach to surfaces.

WHO REALLY INVENTED

THE PERIODIC TABLE



DMITRI
MENDELEEV

JOHN
NEWLANDS

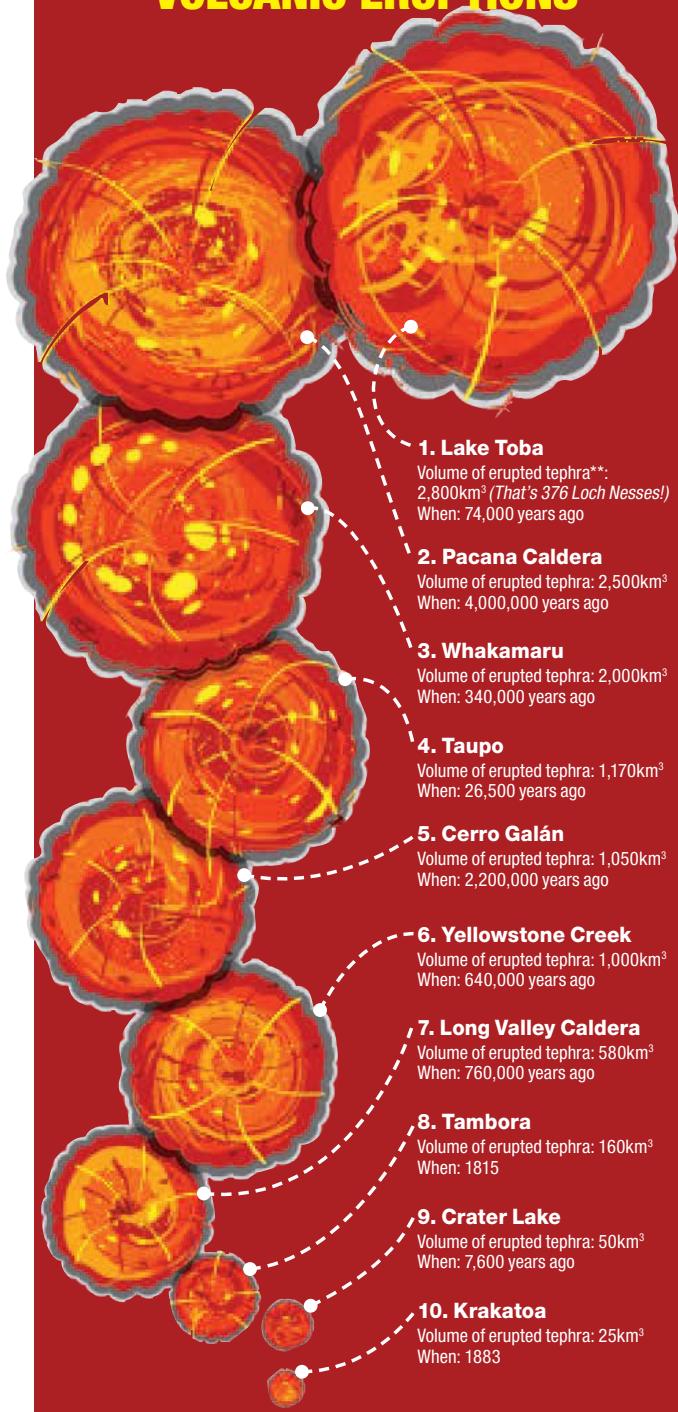
On the wall of every school chemistry laboratory is a poster of the periodic table of elements. It has been the go-to reference on chemical elements for almost 150 years. Yet while the Russian chemist Dmitri Mendeleev is often credited with finding the rules behind the block-like patterns of elements, he was hardly alone: others had found them some years before, but failed to win recognition.

One of these scientists was John Newlands, an English chemist who, in the mid-1860s, pointed out that elements with similar properties lie close together if arranged according to their atomic mass. But in describing his findings to fellow scientists, he drew parallels with octaves of musical notes, which prompted howls of derision. Newlands' discovery had in any case been presaged by the work of another English chemist, William Odling, but he, too, failed to garner much interest.

Mendeleev's claim to fame lies in the fact that he realised that the patterns were more complex than others had realised, leading to some columns on the table being longer than others. He also suspected that gaps within the resulting blocks implied the existence of as-yet undiscovered elements, and bravely attempted to predict their properties. His confidence was vindicated with the discovery of gallium, germanium and scandium, ensuring his place among the great names of 19th-century science. RM

TOP 10

MOST EXPLOSIVE VOLCANIC ERUPTIONS*



VITAL STATS

1,200

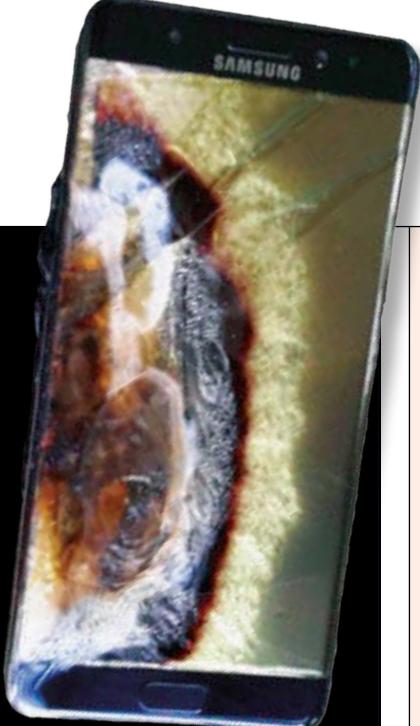
The number of cheetah cubs illegally trafficked out of Africa over the last decade. Just 15 percent survived the journey.



If you fell into a black hole, would time feel really slow?

No, because you would have no way of 'feeling' the passage of time. It is true that large gravitational forces (such as when you approach a black hole) slow down time, but you can only be aware of this by comparing your experiences with someone far away from the black hole.

You will see a distant friend 'speed up' rather than feel yourself 'slowed down'. They will see you 'slowed down' rather than feel themselves 'sped up'. The closer you approach the black hole's 'event horizon', the more sped up you see your friend. But, for you, time would 'feel' just as it does to you right now. AG



Why do phone batteries explode?

Lithium ion batteries have two electrodes sandwiching a layer of flammable organic solvent electrolyte between them. Mobile phone batteries are so slim that the gap between the wide, flat electrodes is tiny. In the case of the Samsung Galaxy Note 7, manufacturing defects squashed these electrodes and allowed them to touch. When that happens, the battery short circuits and creates lots of heat. This speeds up the chemical reactions, which generate even more heat, leading to a thermal runaway condition. Lithium batteries can also catch fire if they are overcharged, or charged below 0°C. This causes lithium metal to build up on the negative electrode, which will also eventually cause a short circuit. Protection circuitry in the battery is supposed to prevent this, but this can also fail. LV

THE THOUGHT EXPERIMENT

HOW FAST WOULD I HAVE TO RUN TO CATCH FIRE?



1. ATMOSPHERIC COMPRESSION

At high speeds, it isn't friction with the air that produces most of the heat, it's the compression. Like a ship moving through water, you push a bow wave of air in front of you. The air molecules can't get out of the way in time and they bunch up, banging into each other and getting hotter. Any parts of your body facing into the wind will be heated up.



2. HYPERSONIC

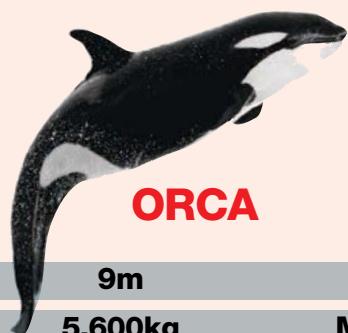
The best place to run would be a long beach, like Pendine Sands in South Wales, the UK. The air is denser at sea level, which means there are more molecules to compress and heat up. Bodies are typically cremated at around 1,500°C and aircraft research from NASA reveals that you'd need to be running at Mach 5 (6,000km/h) to reach that temperature.



3. WRAP UP WARM

But that's the temperature to completely incinerate your entire body – your clothes will catch fire long before you reach that point. Nylon has an ignition point of about 500°C and wool will catch fire at 230°C. Which means that, with the right attire, you could trot along at a leisurely 2,500km/h and still burst into flames.

HEAD TO HEAD



ORCA



GREAT WHITE SHARK

9m	LENGTH	6m
5,600kg	MAXIMUM MASS	2,200kg
48km/h	TOP SPEED	40km/h
48	TEETH	40-56*
240,000	DAILY CALORIE INTAKE	15,000

Although the great white shark has a fearsome reputation, in a straight fight, it is outclassed by the orca. Not only are orcas much bigger, they are also smarter. Great whites are now known to be warm blooded but orcas still have much higher metabolic rates because they breathe air. In the wild, orcas have been seen preying on great white sharks.

* Exposed teeth at one time. Great whites have further rows of developing teeth behind the visible ones.

DISCOVERIES

DISPATCHES FROM THE CUTTING EDGE

BIOLOGY

HEALTHY MICE BORN FROM LAB-GROWN EGGS

In a world first, Japanese researchers have transformed mouse skin cells into egg cells, and used them to raise healthy mouse pups

JAPANESE researchers have successfully raised mice using stem cells that they transformed into egg cells. Though the technique has so far only been proven using mice, it could one day help infertile human couples to have children without the need for egg donors, researchers say.

The team, led by Katsuhiko Hayashi at Kyushu University in Japan, took skin cells from the tips of the tails of adult mice and transformed them into induced pluripotent stem cells. These are cells that have been genetically modified to behave like embryonic stem cells, which are capable of forming any adult cell type.

To coax the stem cells into growing into eggs, the researchers treated them with growth factors and hormones taken from mouse ovaries.

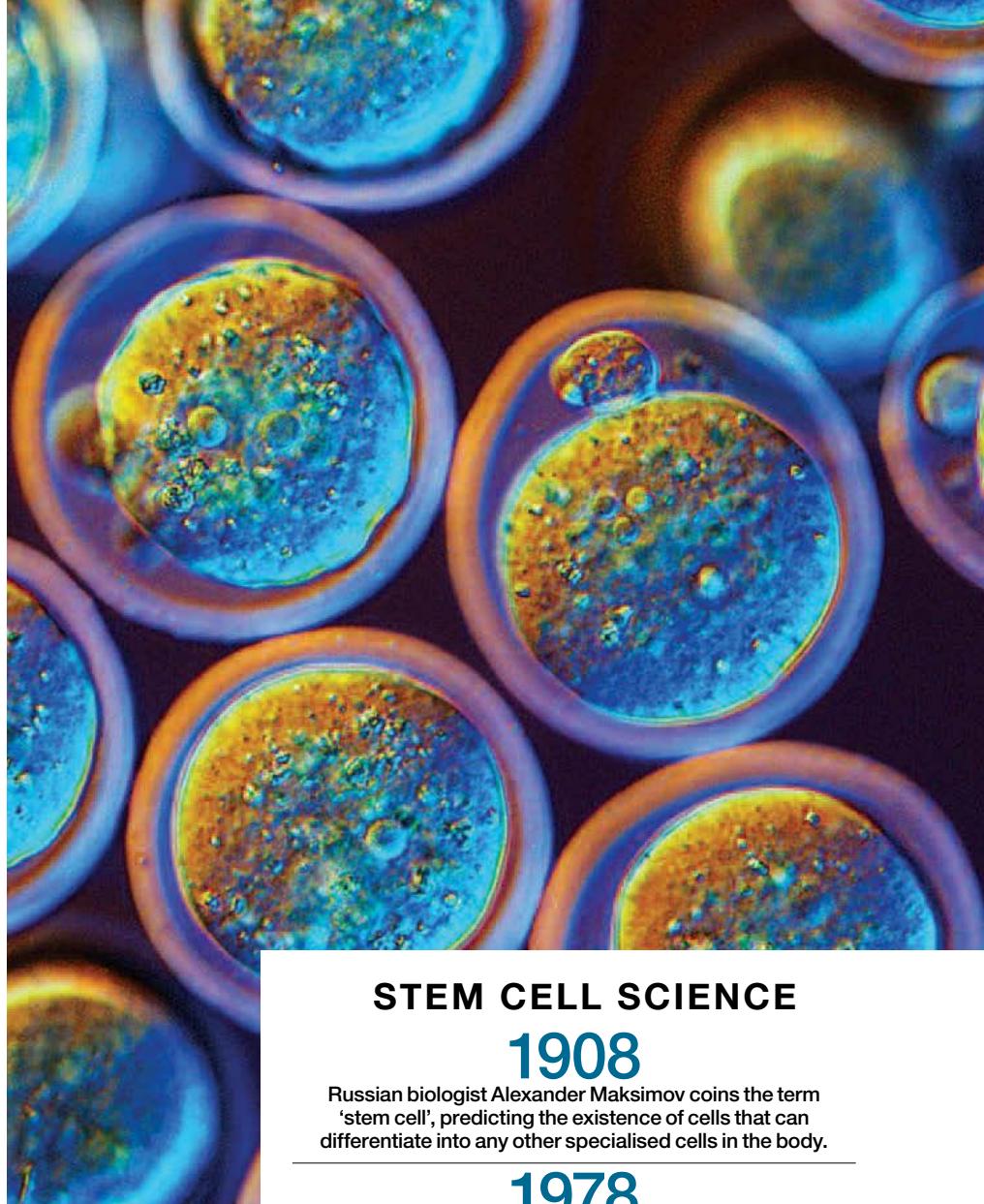
The eggs were then fertilised using established IVF techniques, before being implanted into the wombs of living mice. "This is the first report of anyone being able to develop fully mature and fertilisable eggs in a laboratory setting right through from the earliest stages of oocyte [egg cell] development," said reproduction expert Richard Anderson, from the University of Edinburgh, who was not involved in the research. "One day, this approach might be useful for women who have lost their fertility at an early age, as well as for improvements in more conventional infertility treatments."

The method's far from perfect. Only 11 of the 300 embryos implanted resulted in successful births. What's more, many of the artificially produced eggs showed slight differences in gene expression from their naturally produced counterparts, suggesting they develop slightly differently.

The next step is for other teams to repeat the result, perhaps in animals such as pigs or sheep, to confirm its validity. But debate of the ethics of using the technique in humans should begin now, says the University of Cambridge's Azim Surani.

"Ethically, this issue has yet to be discussed fully by the scientists and society. These discussions have occurred in the past, and are continuing within the regulatory bodies, certainly in the UK," he said. "This indeed is the right time to start a debate and involve the wider public in these discussions, long before and in case the procedure becomes feasible in humans."

"THIS APPROACH MIGHT BE USEFUL FOR WOMEN WHO HAVE LOST THEIR FERTILITY AT AN EARLY AGE"



Above: Fertilised mouse egg cells

STEM CELL SCIENCE

1908

Russian biologist Alexander Maksimov coins the term 'stem cell', predicting the existence of cells that can differentiate into any other specialised cells in the body.

1978

Gregor Prindull and colleagues discover haematopoietic stem cells, those that can differentiate into all kinds of blood cells in the body, in the blood of the umbilical cord.

1998

A team led by James Thomson at the University of Wisconsin-Madison in the USA, collects pluripotent stem cells, those that can differentiate into nearly all kinds of cells, from a human embryo.

2005

Researchers at Kingston University and the University of Illinois discover pluripotent stem cells in umbilical cord blood.

2007

Kazutoshi Takahashi and Shinya Yamanaka of Kyoto University, as well as researchers from James Thomson's lab, transform human muscle cells into pluripotent stem cells.

2013

Will Shu's team in Heriot-Watt University in Scotland, develops a 3D printer that uses pluripotent stem cells as building blocks.

SPACE

NASA'S MINING BOT GETS ROLLING

We definitely dig this. NASA has started testing the Regolith Advanced Surface Systems Operations Robot (RASSOR). This robot is designed to mine resources on the surface of asteroids, the Moon or even Mars.

The bot is in development at Kennedy Space Center in Florida. The agency has released a video showing a simulated mission in which RASSOR was used to scoop up regolith, which is the loose, rocky material on the surface of a planet. It then loaded the regolith into a device called a MARCO POLO/Mars

Pathfinder in-situ resource utilisation system. This pulls water and ice out of the regolith and turns their chemicals into fuel or air for astronauts working on the surface.

The primary challenge for any digging robot operating in low gravity is that it has to be light and small enough to fly on a rocket, but heavy enough to operate in gravity lower than Earth's. RASSOR tackles this problem by using digging bucket drums at each end of the robot's body that rotate in opposite directions, giving enough traction on one end

to let the opposite side dig into the soil. It has a top speed of 4cm per second, five times faster than the Mars Curiosity rover, and is capable of hauling around 20kg of material.

"[On Mars] there are some areas at the poles where they think there's a lot of ice, so you'd be digging in ice," said NASA engineer AJ Nick. "There's other areas where the water is 30cm down, so you actually have to dig down 30cm and take off the top and that depth is really where you want to start collecting water ice."

To see the RASSOR in action, visit bit.ly/2eQ7wev



NASA technologist Rob Mueller (left) inspects the RASSOR with Apollo astronaut Buzz Aldrin

NEUROSCIENCE

PHYSICAL ROOT OF DEPRESSION FOUND IN BRAIN

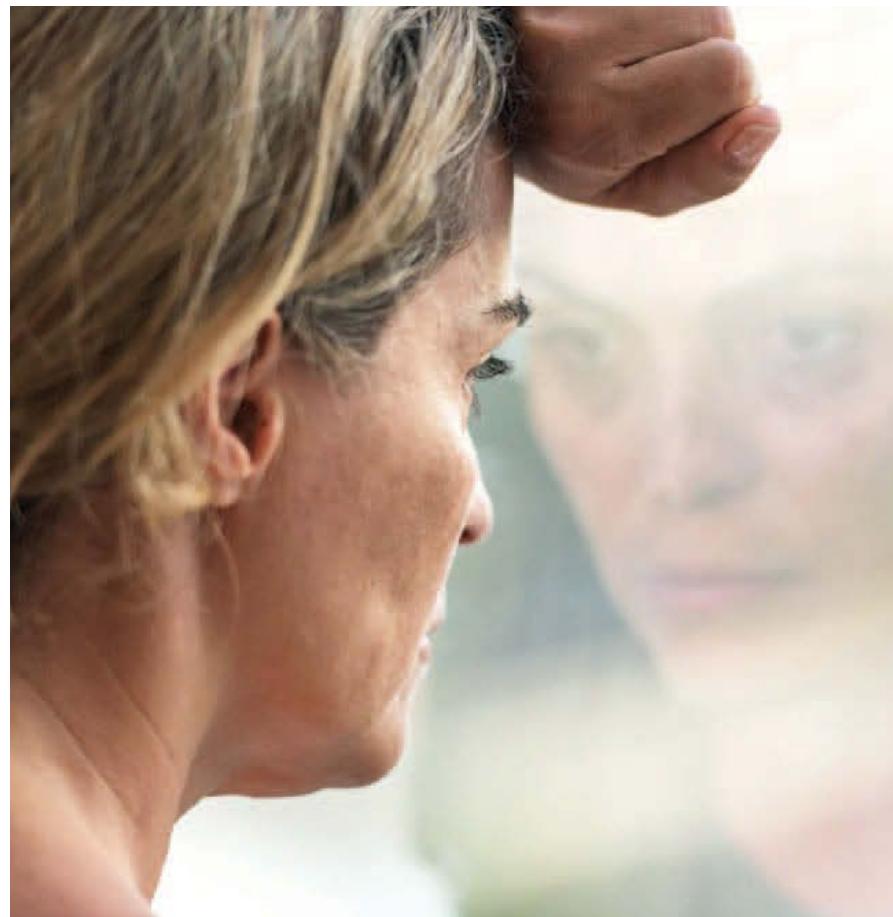
It seems abnormalities in grey matter may lead to black moods. A team based at Warwick University and China's Fudan University has found evidence that depression has a physical root in the brain.

The findings could lead to new treatments for depression by targeting the root cause of the illness and helping depressed people to stop focusing on negative thoughts, the team said.

"More than one in 10 people in their lifetime suffer from depression, a disease which is so common in modern society and we can even find the remains of Prozac – a depression drug – in the tap water in London," said researcher Jianfeng Feng. "Our finding enables us to locate the roots of depression, which should open up new avenues for better therapeutic treatments in the near future for this horrible disease."

After using high-precision MRI to scan the brains of nearly 1,000 volunteers, half with depression and half without, the team found that the medial and lateral orbitofrontal cortices, areas of the brain associated with emotion and reward, are wired up differently in those suffering from depression.

The lateral orbitofrontal cortex is activated



during feelings of disappointment such as when expected rewards are not received. The researchers found that in depression sufferers it is more closely connected to areas of the brain involved in one's sense of self, and could therefore explain their negative self-perception

and lower self-esteem.

They also found reduced connectivity between the reward brain area in the medial orbitofrontal cortex and memory systems elsewhere, meaning depression sufferers are less likely to recall happy memories.

NASA, GETTY; ILLUSTRATION: RAJA LOCKEY; FLPA, LORI SANDERS/HARVARD; ILLUSTRATION: RAJA LOCKEY

THEY DID WHAT?!

SCIENTISTS SEARCH FOR REGIONAL ACCENTS IN COD

What did they do?

A team at the University of Exeter eavesdropped on the conversations of cod.

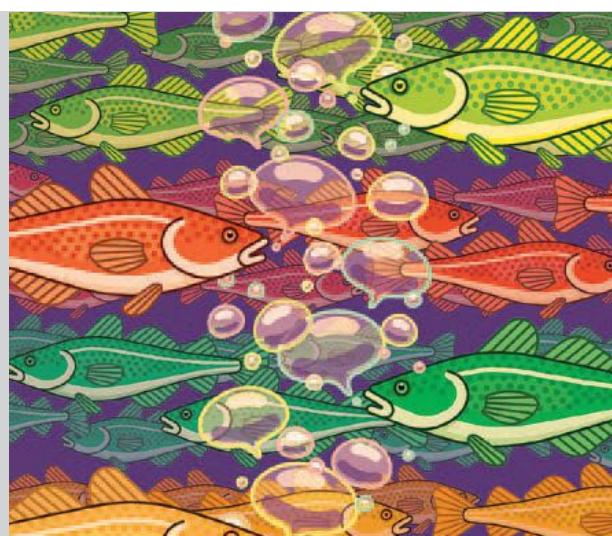
Why did they do that?

They were looking for regional differences in the sounds that fish make to establish territories, raise the alarm and attract mates. If separate populations communicate differently, fish meeting for the first time

due to climate change driven migrations may struggle to hit it off with their new neighbours.

What did they find?

American cod make a "staccato, banging, bop bop bop sound" while European cod make a "deep rumbling growling." The difference is thought to be due to localised breeding grounds being established for thousands of years, leading to regional accents.



MATERIALS

GRAPHENE-MUNCHING SILKWORMS SPIN 'SUPER SILK'

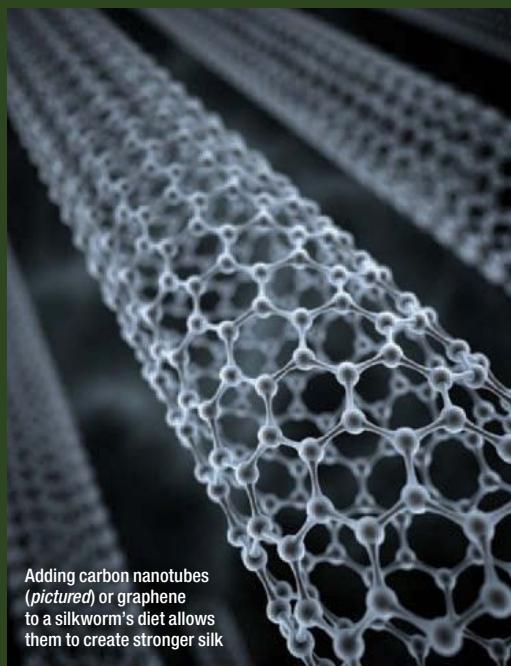
If you want your silkworms to spin super-strong silk, just feed them graphene.

Researchers at Tsinghua University in China have found that spraying a solution containing 0.2 per cent graphene or carbon nanotubes (basically rolls of graphene) onto a silkworm's regular diet of mulberry leaves causes them to spin silk that is 50 per cent stronger than usual.

After putting the silk into a spectrometer, the team found that the 'super silk' had a more orderly structure than regular silk with parts of the fed carbon nanomaterials incorporated into the fibres. This graphite-like structure also allows the fibres to conduct electricity.

The team is as yet unsure how the carbon materials made it into the silk but say the process could be scaled up to produce large batches. It could potentially be used to make eco-friendly protective fabrics, stronger medical implants or wearable electronics, they say.

The silkworm spins a cocoon, made of a single thread up to 900m long, before turning into a moth



GETTYX2

WHAT WE LEARNED THIS MONTH**DINOSAURS DIDN'T ROAR**

The *T. rex* just got a little less terrifying. A team at the University of Texas has found that, rather than roaring, dinosaurs made a honking sound similar to that made by geese.

CHEESE MAKES WINE TASTE BETTER

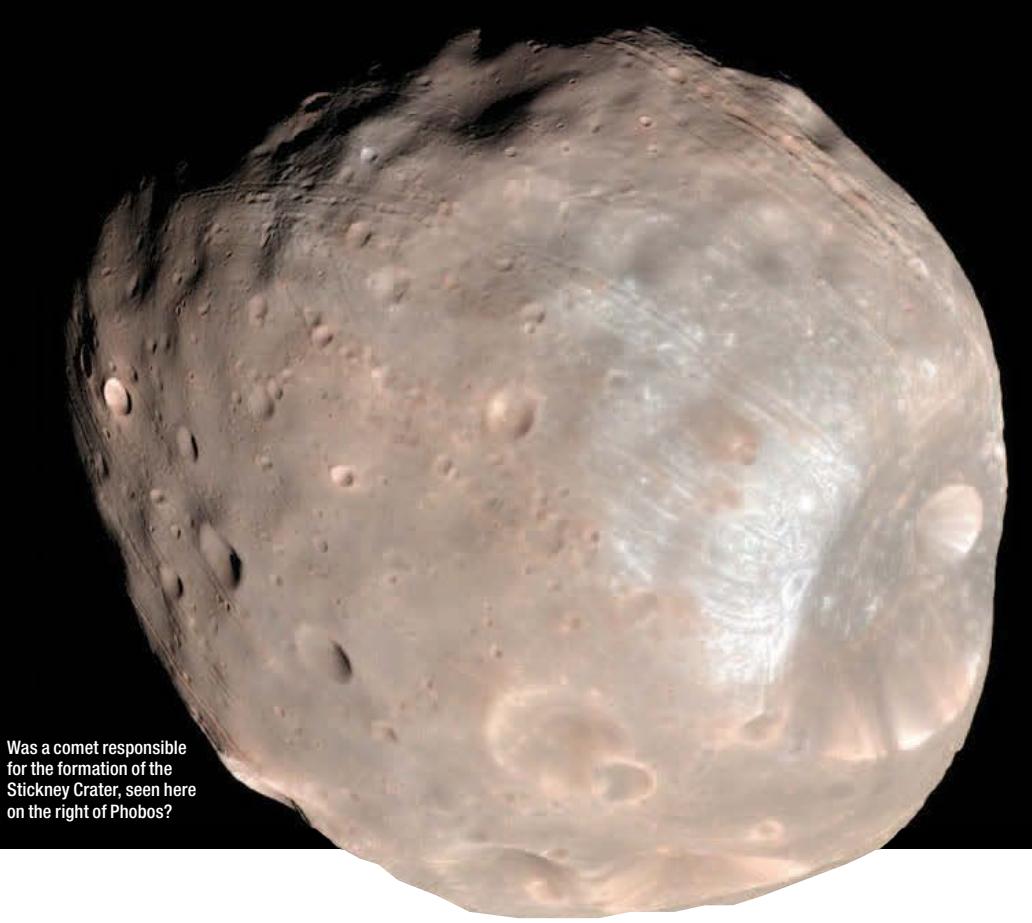
Want to hide the fact you are serving your dinner guests cheap plonk? Break out the brie. Researchers at the Centre for Taste and Feeding Behaviour in Dijon, France, have found that drinking wine after eating cheese increases the aroma of red fruits and reduces the astringency caused by tannins.

ASTRONAUTS FACE DEMENTIA RISK EN ROUTE TO MARS

Prolonged exposure to energetic charged particles, such as those found in cosmic rays, could cause significant long-term brain damage resulting in cognitive impairments and dementia, researchers from the University of California have found.

ELEPHANTS WALK ON THEIR TIPTOES

What do elephants and ballerinas have in common? They both walk up on their toes. Researchers at the University of Queensland, Australia, have found that elephants put most pressure on the outside toes of their front feet as they plod around.



Was a comet responsible for the formation of the Stickney Crater, seen here on the right of Phobos?

SPACE

THIS IS HOW MARS'S BIGGEST MOON CAME TO LOOK LIKE THE DEATH STAR

Thanks to an enormous ding on its surface known as the Stickney Crater, Mars's moon Phobos is said to look like the Death Star from the *Star Wars* movies. The crater is presumed to have been caused by comet impact, but exactly how a 9km-wide crater could have formed on a 22km-wide moon without destroying it has remained something of a mystery.

Now researchers at Lawrence Livermore National Laboratory think they have the answer. Using computer simulations, they found that the most likely culprit was a comet with a 250m diameter, travelling at close to six kilometers per second.

Previous studies using 2D simulations lacked the resolution to model the Stickney Crater successfully and failed to account for the fact that Phobos is made of much less dense material than its host planet.

"We've demonstrated that you can create this

crater without destroying the moon if you use the proper porosity and resolution in a 3D simulation," said researcher Megan Bruck Syal. "There aren't many places with the computational resources to accomplish the resolution study we conducted."

As well as solving a longstanding mystery, this research also acts as a proof of concept exercise for the team's modelling software, Spherical, which they use to simulate various methods of deflecting potentially hazardous Earth-bound asteroids. "Something as big and fast as what caused the Stickney Crater would have a devastating effect on Earth," Syal said. "If NASA sees a potentially hazardous asteroid coming our way, it will be essential to make sure we're able to deflect it. We'll only have one shot at it, and the consequences couldn't be higher. We do this type of benchmarking research to make sure our codes are right when they will be needed most."

IN NUMBERS

81,000 YEARS

The time it takes asteroid impacts to completely change the surface of the Moon, according to a seven-year study carried out at Arizona State University.

122

The age of Jeanne Calment when she died in 1997, making her the oldest person to ever live on official record. Results from a global study from the Albert Einstein College of Medicine, New York, suggest this may be near to the maximum age a human can ever reach.

2

TRILLION

The number of galaxies in the observable Universe, as estimated using data taken from the Hubble Space Telescope. The figure was previously thought to be 10 times smaller.

THE FAST TRACK

Daniel Bennett tests two of this year's smartest cars to find out how technology is shaping our future drives

The new Mercedes E-Class is dripping with gadgets. Touch-sensitive pads on the steering wheel control your ‘infotainment system’, displays offer customisable dashboards and you can even choose from 64 colours for your interior lighting on the fly (we went for *Tron* blue). But that’s not what makes this car interesting.

This Mercedes cares about you, a lot. Not only does it want you to get from A to B safely, but it wants to help you get there with minimal effort. In fact, if we were to give the car a name, we’d call it Alfred. This is just the net effect of Mercedes’s ‘Intelligent Drive’ system, which is the name given to the car’s safety and assistance features. On the road, 360° cameras and radar keep a watchful eye. These sensors also enable the car to take care of the driving on a motorway, though you need to keep your hands on the wheel at all times. Get into traffic and it’ll free you of the mind-numbing business of stopping and starting, as the E-Class’s sensors keep an eye on the gap ahead.

So far, so familiar. But the E-Class has some new tricks in its catalogue. If it senses

an accident is imminent, the car’s Pre-Safe features leap to your aid. Depending on where it sees the crash coming from, the car will inflate the seat to push you away from the impact zone. Just before impact, it’ll play some pink noise. This sound triggers your ears’ defensive reflex, shielding your inner ear from sounds over 100dB, seconds before the potentially deafening noise of a crash. Of course, we didn’t get to see if this works, but it’s nice to know it’s there.

THE E-CLASS USES TECH TO STOP YOU SQUEALING; THE GODZILLA USES IT TO MAKE YOU SCREAM

When you finally reach your destination, Alfred kindly uses its sensor array to park itself. You can sit comfortably in the driver seat while the car completes the manoeuvre, or jump out, fire up Mercedes Benz’s Parking Pilot system on the app and watch

the look on people’s faces as the car parks itself. All you have to do is keep an eye on your surroundings and a finger on your phone’s touchscreen to keep the car moving.

Call me Godzilla

While the E-Class uses tech to stop you squealing, Nissan’s 2017 Skyline GT-R Prestige, affectionately dubbed ‘Godzilla’, uses tech to make you scream. Each of the wheels is watched by a CPU that reads the connection between the tyre and the road, delivering more or less power where needed to provide traction. Pair this with a new gearbox that changes gears faster than you can, and you get a car that approximates what it’s like to be fired out of a catapult.

Outside of Tesla Model S 90D, the only other cars that can manage this kind of acceleration will need you to take a mortgage out to even look at them. It’s a feat that’s been achieved through sheer attention to detail. Each engine is hand-assembled by one of four “*takumi*” – master craftsmen certified to build GT-R engines. This might not sound high-tech, but these engineers work in the margins of microns (one millionth of a metre). They’ve even designed the car to minimise bad road noise while pumping in good engine noise through the speakers to make it *feel* faster.

Obviously, to actually get your money’s worth out of a GT-R, you’ll need to head to a track. With a Nismo edition, the sat-nav will pick up your location and switch your display to a map of the track, complete with your sector times and telemetry. You can record this data and, back at home, plug it into your PlayStation 3 to virtually race yourself on *Gran Turismo 6*, just like F1 drivers do.

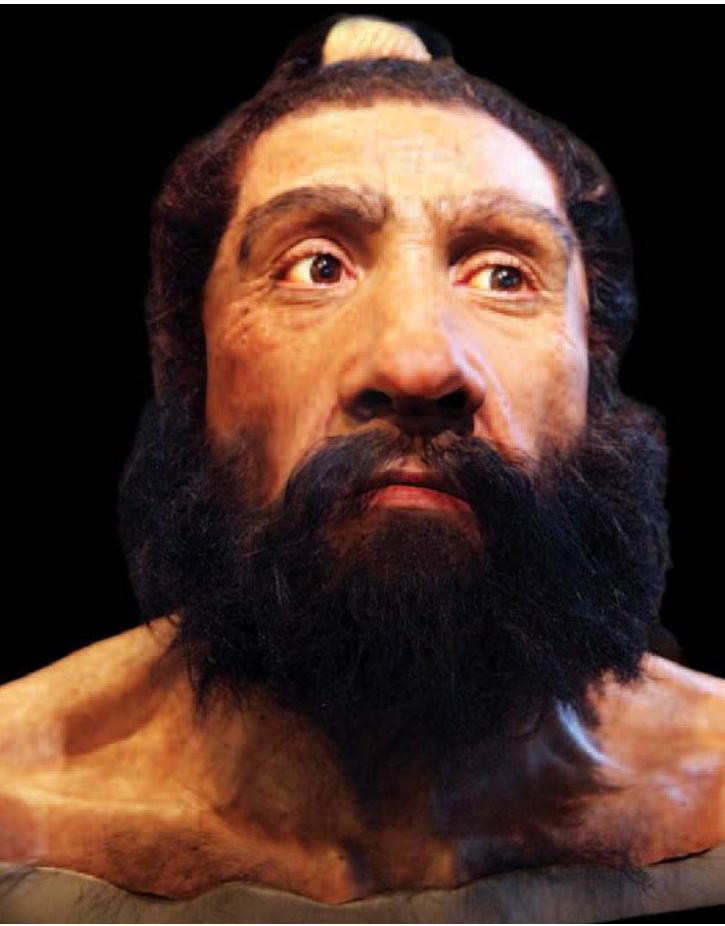
Crucially, on the track, all this technology metaphorically falls away, giving you a drive that’s friendly and scary all at once.

MERCEDES
E-CLASS





**NISSAN
SKYLINE
GT-R**



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



ANTHROPOLOGY

WERE NEANDERTHALS THE ORIGINAL HIPSTERS?

DR MARIAN VANHEREN, TIM EVANSOON/WIKIPEDIA, ALEXANDRA WEY/EPICAMERA PRESS

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 was 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 artefacts that 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."

WHAT WE LEARNED THIS MONTH

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.

GIANT PANDAS ARE NO LONGER ENDANGERED

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'.

THE MOON CAN TRIGGER EARTHQUAKES

Large-scale quakes are more likely to occur during full and new Moons, researchers in Japan have found. The effect is due to the pull of the Moon's gravity being stronger at these times, putting extra stress on the Earth's tectonic plates.

INNOVATIONS

PREPARE YOURSELF FOR TOMORROW

LET THE CYBER GAMES BEGIN!

On 8 October, 2016, the city of Zurich in Switzerland played host to the first ever Cybathlon, which saw disabled athletes from around the world competing against each other. Unlike the Paralympics, though, the Cybathlon is as much about showcasing technologies such as prosthetics and robotics as it is about winning medals. One event, for instance, saw paraplegics competing in a specially-designed

computer game using brain-computer interfaces, as shown by Sebastian Reul of German team Athena-Minerva in this image. Another event involved bicycles that could be pedalled by someone with no movement in their legs, using a technology called functional electrical stimulation. There were also more familiar races for those with prosthetic arms or legs, and for wheelchair users.



VIRTUALLY HERE!

With all the VR devices out there, it can be difficult to know where to start. Let tech guru **Ian Evenden** be your guide



HTC VIVE

The Vive has been developed as a partnership between electronics manufacturer HTC and videogame maker/seller Valve. It offers room-scale VR for the PC, thanks to a pair of base stations that you mount onto the walls of the room you're going to use it in. They track the movement of the player, who controls the game via two wireless, motion-sensing controllers.

Integration with the real world, through links to your phone for messages plus a front-facing camera, mean you never feel cut off and are less likely to fall over the coffee table.

As with the Oculus Rift, you'll need quite a powerful PC to play VR games. A GeForce GTX 970 or AMD R9 290 is the minimum graphics processor supported, along with a recent quad-core CPU.

www.vive.com

OCULUS RIFT

Facebook-owned Oculus VR has been a standard-bearer for the new wave of head-mounted VR displays on the PC. With the release of its Touch controllers, it's also the first system to get an upgrade.

Previously, Rift games have been played with an Xbox One controller from Microsoft; while these are great gamepads, they're not kitted out to track the movement of your hands. The Rift's new controllers allow it to catch up in this area.

The Rift offers head-tracking through a sensor that stands on your desk, but the need to remain seated in front of it means there's no following of your body movements. Despite this, the Rift feels like a complete VR package, just one that may need another upgrade in the future.

www.oculus.com



RAZER

Razer, in partnership with VR firm Sensics, is building a headset based on the Open Source VR Project. This is an attempt to free virtual reality from the domination of major tech companies and create an open standard around which hardware and software can be developed. Using the OSVR software development kit, all hardware on the market can be supported by software makers.

Its headset, the Hacker Dev Kit, is similar in specs and looks to the Rift and Vive, connecting to your PC via USB and HDMI. A software plugin lets it work with games from the Steam store.

The Hacker Dev Kit, as suggested by its name, is perhaps best for those who really know what they're doing. It's an exciting idea, though, that could open up virtual reality to all customers.

www.razerzone.com/gb-en



DAY DREAM

VR that uses a smartphone in a headset has been around for a while in the form of the Gear VR, but Google has recently announced its Daydream device, the software for which will be built into Android phones running version 7.1 or later of the operating system.

Daydream is platform-agnostic, unlike Gear, that which requires a Samsung handset. Phones will need certain hardware features, such as nine-axis motion sensors and low-energy Bluetooth, to be compatible with the headset, which will come packaged with a wireless controller. Its low price is due to it being made out of cloth – a step up from the Google Cardboard headset that was the firm's first foray into smartphone VR. Games, movies and other content will come from the Google Play Store. www.vr.google.com



HOLOLENS

Microsoft's head-mounted display looks different from all the others, being more like a set of smart glasses than an all-enveloping helmet. The HoloLens acts differently too, mixing VR with reality rather than replacing it completely. It also contains powerful processors in the headset itself, rather than relying on the host PC.

The current version is aimed at software developers rather than consumers, and is both expensive and lacking in software support. But there is a version of Minecraft that allows you to play the block-building game on your kitchen table, while a 3D-modelling program can output to a 3D printer.

HoloLens may not be the best way to experience VR, but it could offer a glimpse into the future of computing. www.microsoft.com/microsoft-hololens

PLAYSTATION VR

Sony's recently-launched PlayStation 4 add-on could be the release that launches VR into the mainstream. It requires a console to play on and software support is currently a little limited, but it should ramp up over the coming months. Although Sony recommends that players remain seated while playing, the PlayStation Camera is capable of motion tracking over an area of about three metres by two metres, as long as you remain 0.7m away from the camera. Therefore, make sure you've got enough space when you start playing games that require movement.

The PSVR is user-friendly and easy to set up, when compared to PC-based VR systems. It's the only place you'll get to be Batman too, as Rocksteady's *Arkham VR* is a title exclusive to the platform.

The PlayStation system is capable of displaying on a television as well as in the headset, allowing VR and non-VR players to play together. www.playstation.com

READ

WORDS: NICOLO GOVONI

NEW READS

JERUSALEM

By Alan Moore

Twenty years after his first novel, graphic novel master Alan Moore hits the shelves again with exactly what you'd expect from him: a massive, over 6,00,000-word-long epic tale about pretty much everything, but, more specifically, about "poverty, wealth, history, madness, ghosts, and the confusion of dreams, visions, memories, and premonitions." Longer than *The Bible*, *Jerusalem* is set in Northampton, the author's hometown, and develops over the centuries, combining a variety of writing styles – Samuel Beckett's and James Joyce's, among others – and literary genres (magical realism and fictionalised history, for instance) to explore, through a wide roster of characters, Moore's experiences, ideas, and philosophy of life.

THE WONDER

By Emma Donoghue

Lib, a young English nurse, and her young patient, 11-year-old Anna, who allegedly has lived without touching food for months, are stuck within the four walls of a room, waiting for the truth to come out. Is the little girl a moneymaking hoax or is she truly a miracle child? *Room*, Donoghue's most acclaimed novel, became a sensation a year ago when it was made into a feature film, earning Brie Larson an Academy Award. So it comes as no surprise that *The Wonder*, the plot of which once again revolves around a child, was one of the most anticipated books this fall. Fans looking for the claustrophobic atmosphere of *Room* won't be disappointed, for *The Wonder* has it all: a kid and an adult trapped inside a room, surrounded by a sense of abuse and helplessness, and an added twist of mystery.

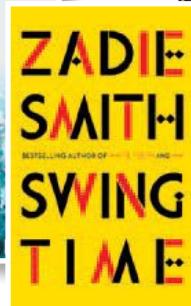
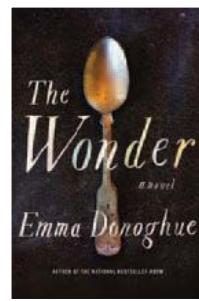
WE KNOW IT WAS YOU

By Maggie Thrash

Can't wait for the *Twin Peaks* revival next year? Treat yourself to the mysterious demise of another high school sweetheart, Brittany Montague, who, on a Friday night, while the whole school is celebrating the football game, jumps off a bridge to her death in the river. No one can believe this has happened, and so Mystery Club team members Benny and Virginia don't waste a minute believing it—because they saw Brittany jumping off that bridge, and also the man standing next to her. *We Know It Was You* mixes teen drama with fast-paced intrigue, leading the reader on a trail of hints and half truths that will unveil a reality far more unsettling than what you would expect from an average American

"FREEDOM IS THE RIGHT TO TELL PEOPLE WHAT THEY DO NOT WANT TO HEAR"

—GEORGE ORWELL



high school. The pivotal question is: Who killed Brittany Montague?

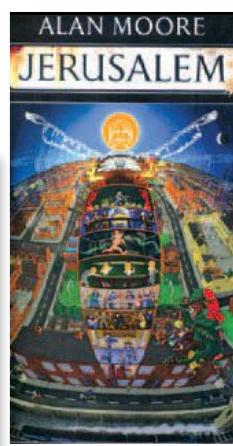
SWING TIME

By Zadie Smith

Two mixed race girls in the 1980s. Then, the same two, now grown women, in today's London, coping with life, struggling with the burdens and failures generated by their own passions. Through an intimate first-person narration, jumping back and forth in time to trace all the individual, familial and class differences that brought the two childhood friends from being sister-like close to being almost strangers, *Swing Time* captures the essence of same-sex friendship with all its nuances of loyalty and jealousy, thoughtfulness and competition. Smith takes the chance to touch on a number of social issues such as race, class and cultural appropriation, which take a more realistic turn when, in the second half of the book, the action shifts to Gambia, and the narrator is exposed to all the dynamics that characterised her life, but on a much wider scale.

FANTASTIC BEASTS AND WHERE TO FIND THEM

by J. K. Rowling





teen best seller booklist



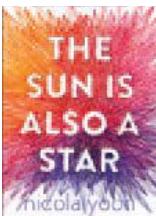
HARRY POTTER PAPERBACK BOXED SET, BOOKS 1-7

By J K Rowling, Mary GrandPré (Illustrations)



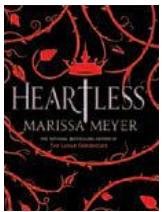
THE FEVER CODE (MAZE RUNNER SERIES #5)

By James Dashner



THE SUN IS ALSO A STAR

By Nicola Yoon



HEARTLESS

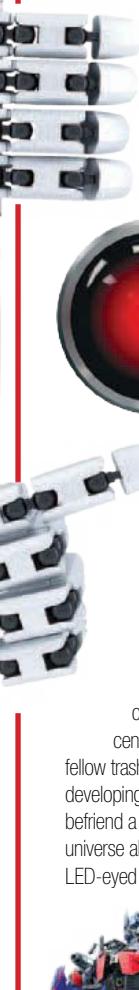
By Marissa Meyer



SCYTHE (ARC OF A SCYTHE SERIES #1)

By Neal Shusterman

COURTESY WWW.BARNESANDNOBLE.COM



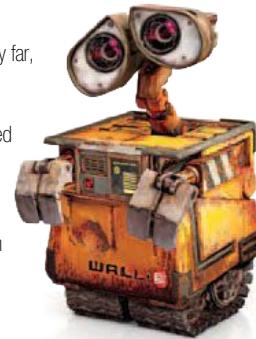
THE TOP 5 ROBOTS IN LITERATURE

HAL-9000 in *2001: A Space Odyssey*

Supercomputer-turned-psychopath, HAL-9000 is, hands down, one of the most iconic robots out there. In charge of the Discovery One spaceship, he initially comes across as a rather comforting addition to the gang. He speaks in a soft and measured voice, takes care of the crew members, and keeps an omnipresent eye on the wellbeing of the spacecraft to make sure everything is a-ok. In other words, HAL is a highly reliable nanny, theoretically incapable of making mistakes. Only, he does. Created by writer Arthur C. Clarke and brought to cinema by Stanley Kubrick's cult sci-fi movie, HAL goes bonkers in the middle of a mission to Jupiter, offing an astronaut or four, and ultimately ending up deactivated as he sings *Daisy bell*.

WALL-E in *Wall-E*

The Waste Allocation Load Lifter – Earth-Class, aka Wall-E, is, by far, the cutest robot on this list and, in spite of his relatively recent introduction, one of the most beloved Pixar characters of all time. Left on a future version of planet Earth, where trash has submerged cities and the pollution has gone up beyond livability, Wall-E spent centuries cleaning the environment. Over time, as he watched his fellow trash-recycling mates gradually falling into oblivion, Wall-E started developing emotions – curiosity and loneliness among others – that had him befriend a cockroach named Hal (Got it?), wonder about the vastness of the universe above him and, eventually, fall in love with the beautifully-shaped, LED-eyed EVE.



OPTIMUS PRIME in *Transformers*

Toy, transforming truck, self-righteous leader and an excuse for Michael Bay to throw massive explosions at random – these are only some of Optimus Prime's titles. Head of the Autobots, the good guys in the *Transformers* franchise, Optimus has been entertaining the public for over 30 years now, always finding new ways to engage in massive robot fights that usually result in entire cities being levelled, with close to no human casualties. He is not famous for his psychological complexity, but he sure has a cool set of technologically-advanced alien weapons – the Ion Blaster, the Barrage Cannon, the Energon Hooks, and the Dual Energon Swords to mention some.



T-800 in *The Terminator*

With those sunglasses, that shotgun and with Arnold Schwarzenegger's face, T-800 couldn't but earn his seat in the pantheon of most memorable robots. Sent from an apocalyptic future where machines have taken over the world, he has one mission: Stop mankind from putting up resistance to said robot-dominated society. How is he planning to do that? By taking the mother of the resistance's leader, out of the picture of course. T-800 is the antagonist in *The Terminator*, the first installment of an over 30-year-old franchise, but other versions of the same android, always played by Arnie's signature muscles and jaw, end up joining the good guys in the sequels.



MAJOR MOTOKO KUSANAGI in *Ghost in the Shell*

Motoko Kusanagi, often referred to simply as Major, is an augmented-cybernetic human, an employee of the Japanese National Public Safety Commission, and the protagonist of the anime-turned-classic *Ghost in the Shell*. She also has the ability to connect her cyberbrain to a virtually unlimited network, which makes her an absolute force to reckon with. Contemplative and gloomy, Major may sometimes come across as an emotionless fighting machine, but, deep down, she is contemplative in nature, torn with doubts about her own humanity, wondering whether her cybernetic body has a soul at all.



NINTENDO SWITCHES IT ON

THERE'S one name that gave the gaming industry touch screens, made motion control popular, and redefined the way we play over and over: Nintendo. Recently, the company unveiled its new home console – **Switch**. Nintendo has always preferred the pursuit of innovation instead of just a periodical hardware upgrade. This time is no different. Nintendo now aims at lounging with you not only in your living room, but also tagging along as you go on a trip, or to a party, or simply when you walk your dog to the park.

The big news is that **Nintendo Switch** is both a home and a handheld console. At its core is a touch screen tablet, which can either be plugged into a docking station connected to your TV, or used on the go. However, the

new **Joy-Con** controller is truly revolutionary. It's detachable, comes in two pieces and has the ability to shape-shift according to the player's requirements. You can use it as a traditional gamepad by sliding it into a supporting case, or clip it to the sides of a tablet for use as a portable console. **Joy-Cons** can also be used separately, with one in each hand, or shared with friends, one **Joy-Con** each.

After over a decade using optical discs, **Switch** will feature cartridges, so as to avoid spinning motors, which would hinder the battery life of the tablet when used as a handheld console. An Nvidia Tegra processor promises a seamless in-game shift from home to handheld, and on-the-go connectivity between two or more devices.

Switch will likely appeal to an untapped audience: the mobile game players. But why would you bother buying **Switch** when you already have a smartphone? Because **Switch** gives gamers an unprecedented feature: local portable multiplayer. **Switch** is not meant to kill time as you endure a boring lecture, but to be an alternative to a book, a TV show, or a movie. The announcement that third party developers like Bethesda, Electronic Arts, Activision and Ubisoft will be working on titles for the console makes the **Switch**'s launch in March 2017 an even more highly-anticipated event. The point here is that **Switch** is as fulfilling as your home console – because it *is* your home console.

WORDS: NICOLO GOVONI

FROM PLAYING CARDS TO SWITCH,

We chart Nintendo's innovative streak

1889 – Everything began in 1889, when entrepreneur **Fusajiro Yamauchi** opened his first Hanafuda shop, called Nintendo Koppai. Based in Kyoto, Nintendo's first product was playing cards.



1996 – NINTENDO 64

The **Nintendo 64** introduced the possibility of guiding its characters seamlessly in space through all three axes, and it brought to the industry not one but two fundamental innovations. First, the implementation of an 8-direction analog stick, the key component to every contemporary gameplay; and second, the "Rumble pack", an attachment that gave the player a force feedback, basically making the controller vibrate.

2001 – GAMECUBE / GAME BOY ADVANCE

The **GameCube** introduced the possibility of connecting portable and home consoles. Via a "link cable", the GameCube and the Game Boy Advance could be connected and could interact with one another, turning the latter into an additional controller or a second screen. This was the first step towards the Switch's hybrid vision.



2004 – NINTENDO DS

The **Nintendo DS** stunned the gaming industry by featuring and popularising the touchscreen technology, implementing it in a handheld console featuring a double screen. More than 10 years later, the device has made it into over 150 million households, making the DS Nintendo's most successful hardware line to date, and a full-blown cult.



CHARACTERS

Mario: Having appeared in over 200 video games since his creation in 1981, the plump and brave Italian plumber is hands down Nintendo's most popular mascot and one of the most iconic characters Japan has ever come up with – he even showed up at the Rio 2016 Olympics closing ceremony.

Link: With his green cap and pointy ears, Link is the main hero in *The Legend of Zelda*, a fantasy saga that, since 1986, has mesmerised millions of fans around the world. *Breath of the Wild*, the latest installment of the series, will be one of Switch's launch titles.

Donkey Kong: Few know that the nasty lady-kidnapping and barrel-throwing gorilla of the first installment of the series is not the same, friendly primate racing against and partying with Mario today. The current Donkey Kong is, in fact, the original's grandson.

Pikachu: Often compared to Mickey Mouse in terms of worldwide popularity, the electric-yellow rat is Pokémon's undisputed ambassador and a Japanese pop culture icon. Fun fact: no one knows Pikachu's gender. The creators have kept it vague so that it will appeal to both boys and girls.

Samus Aran: Less known today, but rather game-changing back then (1986), Samus is the protagonist of the *Metroid* series, a sci-fi adventure featuring space pirates, life-sucking aliens and whatnot. In the jaw-dropping ending scene of the original installment, the spacesuit comes off and Samus is revealed to be a woman. She is considered the first playable human female character in a mainstream videogame.



1980 – GAME & WATCH

The **Game & Watch**, a series of handheld videogames featuring a maximum of two built-in games per device, was Nintendo's first appearance on the international gaming stage. It not only singlehandedly started the era of portable consoles, but it also foreshadowed the Switch's gamepad-plus-screen concept by decades.

1985 – NES

The **Nintendo Entertainment System**, NES for friends, was the first Nintendo home console. The NES, with the intuitive simplicity of its gamepad, set a model for each and every controller that followed till date.



1989 – GAME BOY

The **Game Boy** series ditched inbuilt software to adopt cartridges, which allowed a potentially unlimited game library, gave players the possibility to connect two devices through a cable, and overall popularised portable gaming. Unmatched, Nintendo virtually created and dominated the handheld industry as we know it today, pulling off some of the greatest franchises of all time. *Pokémon*, anyone?



2011 – NINTENDO 3DS

As the name suggests, the **Nintendo 3DS** brought glasses-free 3D to portable gaming. Thanks to the stereoscopic technology implemented in the upper screen, the console can simulate a feeling of depth to enhance the gaming experience, while the lower screen keeps the player engaged through the beloved touchscreen. Additionally, using 3D cameras, the Nintendo 3DS took a first step towards augmented reality.



2006 – NINTENDO WII

In 2006, the world was divided into two categories of people: those who owned a **Nintendo Wii**, and those who knew someone who owned it – and used to play over the weekend. The *Wii* introduced motion control to the masses and changed the way we play entirely, it opened the gaming industry to casual users, working as the ultimate "gateway console" for a share of the audience that had never been involved before.



NEW TECH ON THE BLOCK

WORDS: DUSHYANT SHEKHAWAT



HERE ONE

Ever wished you could literally mute the sounds of the world around you so you could enjoy your music better? Doppler Labs has made that dream a reality with Here One, a new pair of wireless earphones that allows you to personalise your listening experience via a connected app. Alongside real-world volume control, the **Here One** earphones also offer smart noise filters, allowing you to tune out a particular noise in the background, like construction work or traffic. They also offer speech amplification, so that you needn't strain to have conversations in loud and crowded spaces. Add wireless streaming, phone call capabilities and an in-built equalizer, and it's easy to see that these are earphones for the future.



SPECTACLES

One of the biggest complaints about millennials is that they experience the world through their smartphone screens. Well, Snapchat, the wildly popular image-sharing app, just put paid to that grouse with **Spectacles**. The phone camera need no longer come between you and your subject – here, a built-in video lens allow you to record upto 30 seconds of video or take still photos from your sunglasses, without your phone ever leaving your pocket. Even if you don't have your phone with you, the images and video are saved on the Spectacles and can be transferred later. Spectacles come with a charging cable and charging case, and are to be sold at pop-up kiosks known as Snapsbots. This might be the coolest and simplest application of wearable technology to accessories and fashion yet.

MOTO Z

The smartphone's multitasking potential effectively ended the era of feature phones – devices that touted a single special feature like a camera or a music player in addition to their calling and messaging facilities. Still, although smartphones integrate nearly every imaginable feature into a single device, the specialisation that came with feature phones was lacking. Motorola's solution to this problem is to go modular. The new **Moto Z** is a highly-capable smartphone that pairs with a range of special Moto Mods. These Moto Mods attach to the phone's surface via magnets, and, after some quick set-up, open up a whole new world of specialised gadgetry. The Moto Mods include attachable lenses, power pack back covers, projectors and speakers. Partnering with quality manufacturers like JBL and Hasselblad ensures that customers picking up Moto Mods will get their money's worth from this smartphone.

IPHONE 7



Apple's latest update is a less radical upgrade than in previous years, and the disappearance of the headphone jack has caused consternation. On the plus side, the camera is a big selling point with its twin wide-angle and telephoto lenses, while other key improvements include stereo speakers and a 25 per cent brighter retina display. Those things plus brand loyalty mean it shouldn't bomb – but can it retain its market-leading position?

	IPHONE 7	IPHONE 7 PLUS
OPERATING SYSTEM	iOS 10	iOS 10
SCREEN SIZE	4.7-INCH	5.5-INCH
SCREEN RESOLUTION	750 x 1,334	1,080 x 1,920
RAM	2GB	3GB
ONBOARD STORAGE	32-256GB	32-256GB
CAMERA	12MP, F/1.8	12MP, F/1.8
VIDEO MAX RES (30FPS)	2,160P	2,160P
TALK TIME	14HRS	21HRS
HEADPHONE JACK	NO	NO



	PIXEL	PIXEL XL
OPERATING SYSTEM	ANDROID 7.1	ANDROID 7.1
SCREEN SIZE	5-INCH	5.5-INCH
SCREEN RESOLUTION	1,080 x 1,920	1,440 x 2,560
RAM	4GB	4GB
ONBOARD STORAGE	32-128GB	32-128GB
CAMERA	12MP, F/2.0	12MP, F/2.0
VIDEO MAX RES (30FPS)	2,160P	2,160P
TALK TIME	26HRS	32HRS
HEADPHONE JACK	YES	YES

When you stack the specs side-by-side, the Pixel, from Google, nudges ahead of the iPhone in most departments, but it's a close call. So the Pixel's real selling points are a camera that's being touted by Google as "the best phone camera ever," and Google Assistant. This replacement for Google Now reflects the fact that Google's banking heavily on AI being the next big tech wave. Whether Google's right, of course, remains to be seen.



PIXEL

APPLE

NEWS FROM THE WORLD OF TRAVEL & FOOD

INFO NUGGETS FROM ACROSS THE GLOBE

KOKKREBELLUR, KARNATAKA



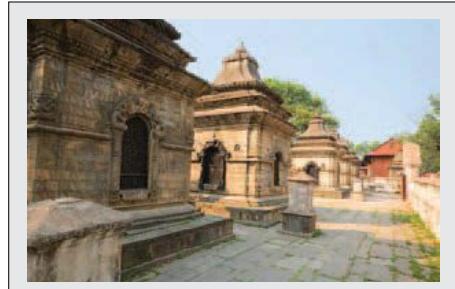
Spot-billed pelicans come to Kokkrebellur every year end (November – December), and are welcomed by the locals. The villagers treat the birds well, protecting them and looking after orphaned chicks that fall out of the nests. In return, the urea-rich droppings of the birds are used as fertiliser in the fields around.

NORTHERN IRELAND



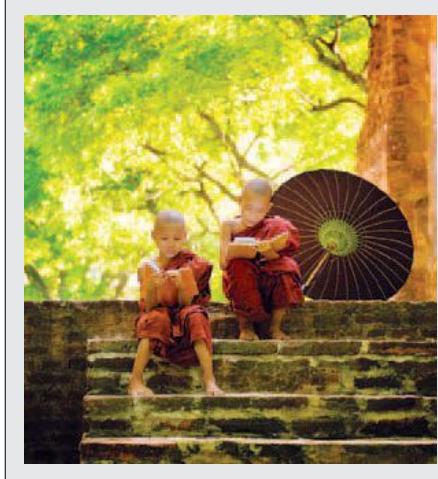
Crossing the 20m-long Carrick-a-Rede Rope Bridge is an adventure in itself – it shakes with every step, exciting since you're walking 30 metres above the rocks below! First erected by salmon fishers in 1755, it originally had only a single rope hand rail, but now is a two hand-railed bridge.

NEPAL



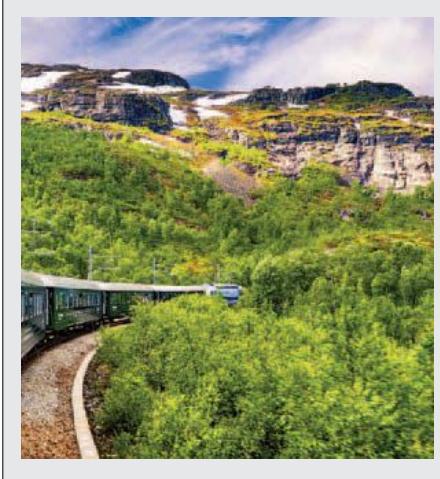
The 5th-century Pashupatinath Temple in Kathmandu survived the massive 7.9-magnitude earthquake in 2015 that flattened several World Heritage sites in Nepal like the iconic Dharahara Tower and Durbar Square. The temple is a sacred Hindu religious site and of great cultural significance in the country.

MYANMAR



Most boys in Myanmar under 20 undergo a coming-of-age ceremony called *shinbyu*, after which they become novice monks. Allowing a boy to be a monk for a while, if not for the rest of his life, is considered one of the most important religious gifts parents can give a son.

NORWAY



The 20.2km-long Flåm Railway is one of the world's steepest tracks, taking in 10 stations and 20 tunnels along its short route. Its highest elevation is 866 metres, and, deservedly, it is currently one of Norway's most popular attractions.

TURKEY



Beneath Cappadocia's world-famous rock formations is a network of subterranean cities, some of them 5,000 years old, which once housed up to 10,000 people each. The deepest city that has been excavated is Derinkuyu, parts of which are open to the public.



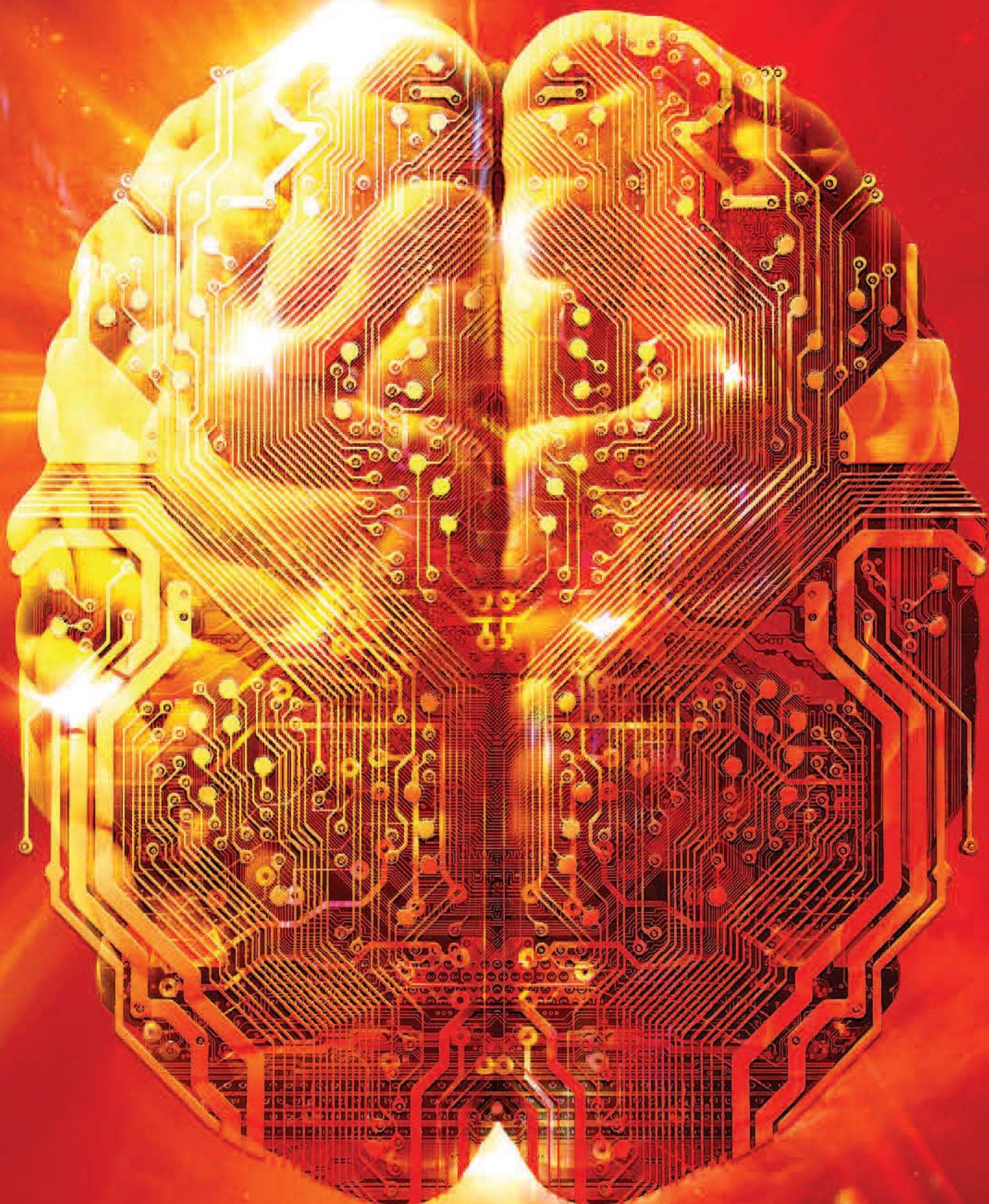
5 GREAT-TO-KNOW FACTS ABOUT **THE GREAT WALL OF CHINA**

- China's most iconic structure, the Great Wall is 13,000 miles of fortifications built over 1,800 years across mountain ranges and deserts.
- It is not one continuous wall -- rather, it takes in natural barriers, trenches and, now, isolated chunks of wall in various states of decay.
- It was built to defend China's northern frontier, but enemies, most significantly the Mongols and the Manchus, crossed the wall in the 13th and 14th centuries respectively.
- The oldest parts of the wall date back to 221 – 206 BC, the time of the Qing Dynasty, and are made of earth *and*, if you will believe this, the bones of the people who died building them.
- It's not true -- you cannot see the Great Wall from space!

TRAVEL WITH FOOD **GOULASH, HUNGARY**

This beef stew is a staple in every household in Hungary, and also very popular in Austria and Croatia. The name comes from '*gulyás*', which means 'herd of cattle' in Hungarian. It's an old recipe, dating back to the 9th century, when it was a favourite with shepherds; it used to be cooked and dried in the sun, then refreshed with water to make a filling and comforting meal. Paprika is an important ingredient. Each homemaker in Hungary has her own recipe, which she believes is the best. These days, it is often served more as a soup than a stew.





Is technology changing our brains?

We increasingly rely on social media to talk to friends, GPS to navigate and the web for information.

But, asks Jo Carlowe, is that wise?

GOOGLE is making you stupid, your iPhone's making you fickle and your social networks are making you anti-social. If the newspaper headlines are to be believed, our brains are under attack. Modern technology is pummeling each of us into a cognitive wreck, and, if we aren't careful, we'll be beaten into a stupor. Of course, the real story isn't as clear-cut as all that. But stories persist because the sense that something is eroding our mental abilities *feels* right. We struggle to remember our own phone number, when, only a few years ago we could recall dozens. Online, readers prefer short, simple stories to long, nuanced pieces (although we're sure *BBC Knowledge* readers are the exception), and we all know someone who breaks out in a sweat when separated from their smartphone.

So what's really happening? The first thing to consider is that this kind of 'neuro-anxiety' about the tools we use is nothing new. In 370 BC, Plato warned that the Greeks' "trust in writing" would "discourage the use of their own memory". Sound familiar?

The reality is that our brains *do* change when we use a smartphone or computer – but they also change when we use a pen, a screwdriver, or any other tool for that matter. They change when we mow the lawn, play golf or cook dinner. Our experiences continually shape the way the brain works. So the question isn't really "is tech rewiring our brains?" but 'how are our brains adapting to living in today's screen-first, always-online, networked world?"

Scientifically speaking, we're a long way from definitive answers, but we looked at the latest research and talked to leading experts in their fields to discover how they think our collective brains are being affected... ►

Attention

PHONES BUZZING with text messages, Facebook notifications and news alerts continually tempt the world to distraction. Many experts believe that this incessant bombardment, and the need for instant answers, has eroded our ability to focus.

A 2015 study by Microsoft surveyed 2,000 Canadians and used electroencephalograms (EEGs) to watch the brain activity of a further 112 people. Their analysis found that the average human attention span had dropped from 12 seconds in the year 2000 to just eight seconds. Goldfish are thought to possess an impressive nine-second attention span.

This wasn't just a company chasing a catchy headline. The research in the area is mostly anecdotal, but a number of surveys do back up the idea that attention spans are shrinking. In a 2012 Pew Research Center survey of more than 2,000 teachers in the US and Puerto Rico, 87 per cent reported that their students had short attention spans and were easily distracted. The same year, a UK poll from the learning company Pearson reached the same conclusion. Of 400 UK English

teachers questioned, and 2,000 parents of preschool and primary-aged children, seven out of 10 said that children's attention spans were shorter than they used to be.

Meanwhile, in the USA, the Centers for Disease Control and Prevention has reported that 11 per cent of school-age children have, at some point, been diagnosed with Attention Deficit Hyperactivity Disorder. Before 1990, the figure was less than 5 per cent.

These studies shine a spotlight on our diminishing attention spans, with modern technology in the crosshairs as the culprit. More research is needed if we're to be sure of a causal relationship, but experts feel certain they'll find one. "I am personally convinced that technology has led to a decreased ability to focus and wait, and an increased need for immediate information," says neuroscientist Prof Russell Poldrack, of Stanford University.

Verdict: Yes, the information age has shortened our attention span.



GETTY X3, ALAMY



Is internet addiction real, and should we be worried?

IN A FAMOUS test, rats given a lever to activate their nucleus accumbens (the brain's pleasure centre, responsible for dopamine production) pressed it continuously until they died of starvation or exhaustion. The same brain structure lights up when addicts score a fix.

Reports have emerged of young men dying following excessive bouts of video game playing: like the rats, they forgot to eat, sleep or move. In one well-known case, a South Korean man died after 50 hours of non-stop gaming.

Studies suggest that brain activity seen in excessive internet users resembles that of drug addicts, with less grey matter volume in parts of the prefrontal cortex linked to willpower. But cause and effect is not clear: the difference could be a precondition for, rather than a result of, excessive internet use.



Mood

SCIENTISTS HAVE BEEN reporting strong links between heavy internet use and depression, with a particular focus on social media. This came as no surprise to health education expert Dr Aric Sigman, who says high exposure to social media can leave people feeling inadequate.

"There is a relationship between the amount of time you spend on social media and increased body dissatisfaction. High consumption of idealised images seems to activate neural networks in the brain like the amygdala, associated with fear and anxiety."

Sigman cites a study in which girls who instant messaged their mothers released the stress hormone cortisol, rather than the feel-good hormone oxytocin associated with face-to-face interaction. "We may be hard-wired to need a certain amount of contact with people we care about. A deficit in human contact may result in health problems."

Facebook, it seems, might not be giving us enough facetime.

Verdict: Technology can affect mood, but it depends how we use it.

Memory

WITH PHONE NUMBERS, routes and facts just a touch away, we're becoming less reliant on our memory – and German neuroscientist Manfred Spitzer warns this 'cognitive offloading' could be leading to a kind of 'digital dementia'.

Studies on internet and gaming addicts has uncovered atrophy (shrinking) in the brain's grey matter, says the University of Bedfordshire's Prof James Barnes. Overdosing on tech seems to cause the frontal lobe – a brain area that governs functions such as planning and organising – to suffer in particular. However, he adds that more research is needed on 'real' as opposed to 'addicted' internet users.

Digital offloading may also make memories less vivid. A US study asked museum visitors to photograph some exhibits and just look at others. The next day their memory was tested. Visitors were worse at recognising objects they had photographed, and worse at recalling details about the objects they'd photographed.

But Dr Sam Gilbert, of University College London, says there are also positives. "Research shows that when you save information to an external store like a computer, this can help you to store new memories. Your mind is no longer cluttered with information that you don't need." ▶

Verdict: Short-term changes are likely, but more research is needed on long-term impact.



Social skills

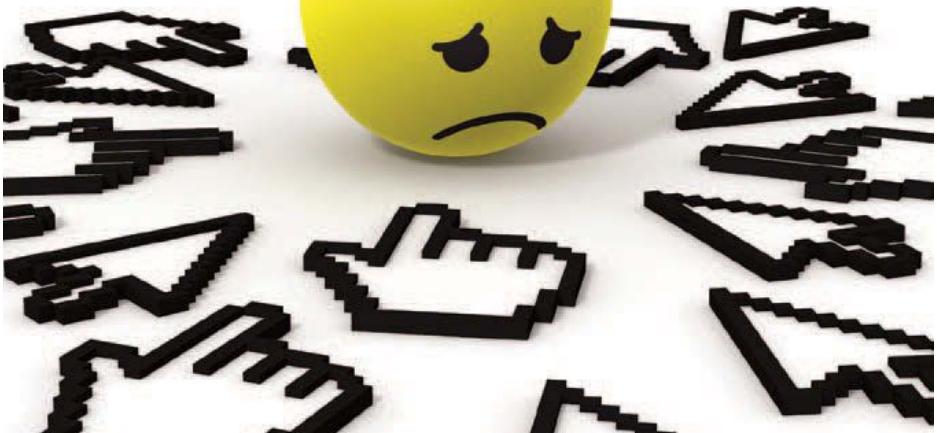
"THROUGHOUT THE WORLD – in caves, huts and houses – it was almost a reflex to turn your face to a returning parent," explains health education expert Dr Aric Sigman. But, he says, kids are now so glued to their screens they no longer look up.

Though some parents might be glad of the respite that screen-time provides, research suggests that excessive screen use seems to damage our ability to interpret faces.

"They [excessive internet users] find it more difficult to read faces in experiments," explains Sigman.

In one study, children showed a significant improvement in reading facial emotions after spending five days away from all devices. In another experiment, Chinese psychologists scanned the brains of 'normal' versus 'excessive' internet users, while they viewed images of faces and objects. The internet junkies showed smaller brain wave responses to faces than their peers.

Sigman's view is that technology use itself isn't damaging – just like sweets, it's simply a case of ensuring children don't consume too much, too often. Prof Mizuko Ito of the University of California, meanwhile, believes that a reasonable serving of



new media can actually be beneficial for the development of youngsters' brains.

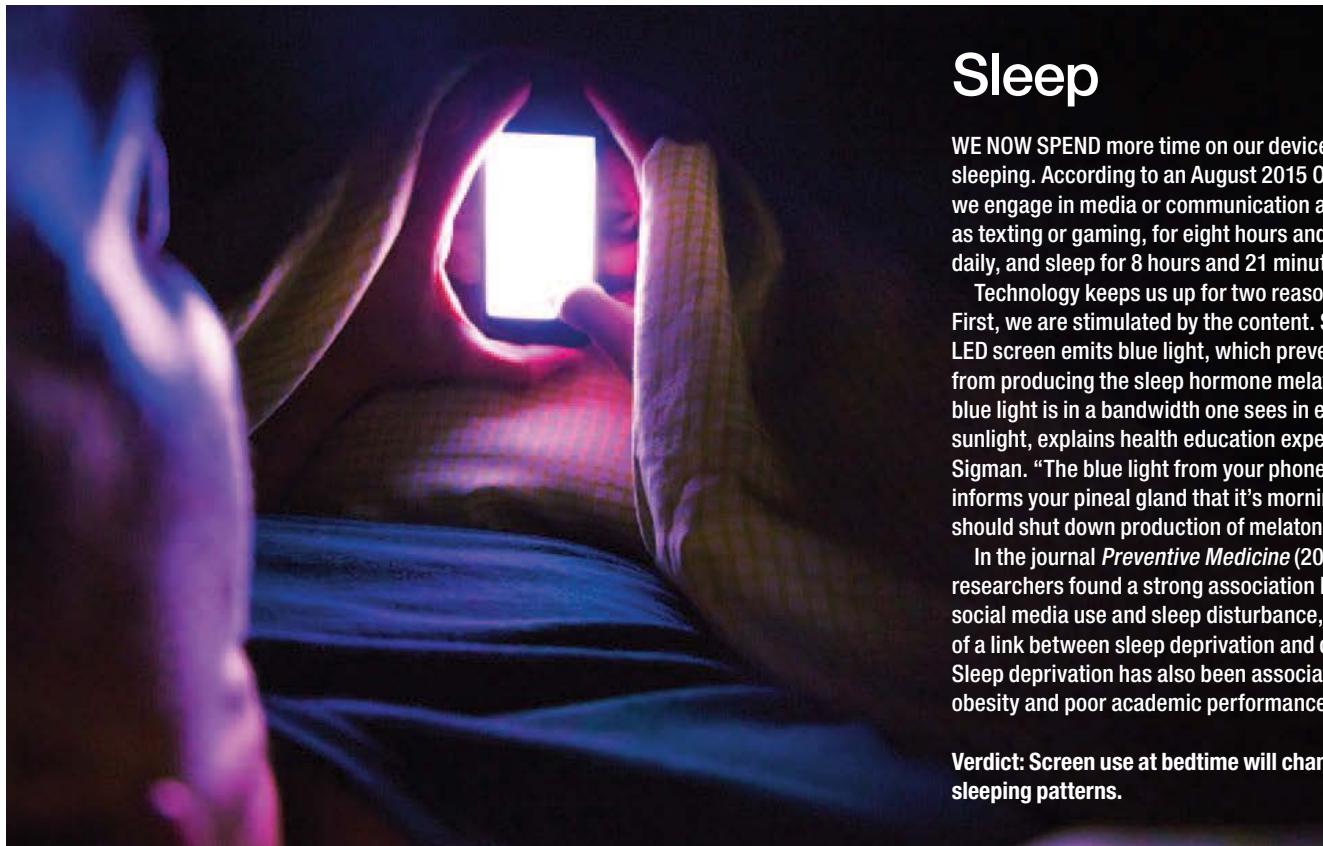
"Young people who are taking advantage of online tools like search, forums, open educational resources and complex games are learning at a more accelerated rate, and in specialties that they would never have had access to in earlier eras," she argues.

However, she adds that, for disengaged kids in distressed circumstances, digital media

can be a distraction from positive learning and social engagement.

"It's not the availability of media that determines this, but whether they have life opportunities, positive peer influences and caring adults who support and guide them to positive media engagements."

Verdict: New media is just a place to 'hang out', but, for the socially disengaged, there are risks.



Sleep

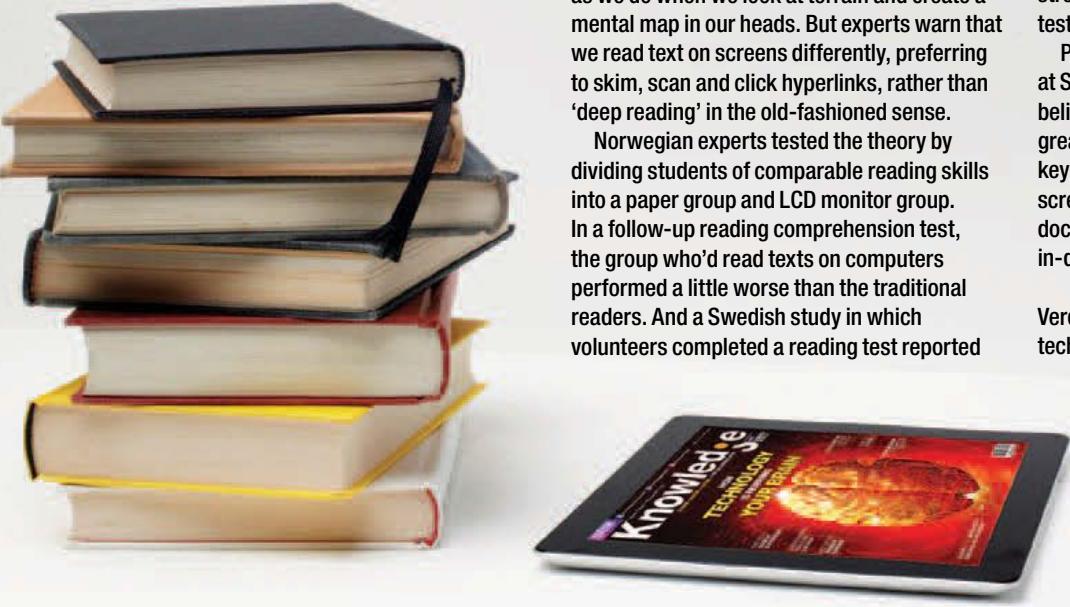
WE NOW SPEND more time on our devices than we do sleeping. According to an August 2015 Ofcom survey, we engage in media or communication activities such as texting or gaming, for eight hours and 41 minutes daily, and sleep for 8 hours and 21 minutes.

Technology keeps us up for two reasons. First, we are stimulated by the content. Second, the LED screen emits blue light, which prevents the brain from producing the sleep hormone melatonin. The blue light is in a bandwidth one sees in everyday sunlight, explains health education expert Dr Aric Sigman. "The blue light from your phone or tablet informs your pineal gland that it's morning and it should shut down production of melatonin."

In the journal *Preventive Medicine* (2016) researchers found a strong association between social media use and sleep disturbance, and warned of a link between sleep deprivation and depression. Sleep deprivation has also been associated with obesity and poor academic performance.

Verdict: Screen use at bedtime will change your sleeping patterns.

Reading



WHEN WE READ, we construct a mental representation of the text in our minds, much as we do when we look at terrain and create a mental map in our heads. But experts warn that we read text on screens differently, preferring to skim, scan and click hyperlinks, rather than 'deep reading' in the old-fashioned sense.

Norwegian experts tested the theory by dividing students of comparable reading skills into a paper group and LCD monitor group. In a follow-up reading comprehension test, the group who'd read texts on computers performed a little worse than the traditional readers. And a Swedish study in which volunteers completed a reading test reported

similar findings: those who took the test on a computer scored lower, and reported higher stress levels, than those who took the same test on paper.

Prof Ziming Liu, of the School of Information at San José State University in California, believes digital screen readers engage in greater use of shortcuts such as browsing for keywords. His research also reveals that screen users are more likely to read a document only once and expend less time on in-depth reading.

Verdict: More research needed, but technology may make us less thorough.

Multitasking

OUR 'ALWAYS-ON' culture has been dubbed "infomania" by psychologist Dr Glenn Wilson, who tested the IQs of subjects in either a quiet room or one with mobiles ringing and emails arriving. The technological distractions diminished IQ by 10 points.

Similarly, a US study found that students who instant messaged with friends during a reading task took between 22 and 59 per cent longer to complete the task, even accounting for the additional time spent messaging.

Brain-imaging reveals that multitasking uses different brain regions to focus on one task. Learning while focusing on one task uses the hippocampus, which stores ideas and creates rich and flexible memories. This area allows us to compare old ideas with incoming data to put what we learn into context, effectively leading to deeper understanding. Multitasking, on the other hand, uses the striatum — a brain region that stores procedures and skills. New information acquired using the striatum is less flexible and can't be generalised in the same way. This suggests that knowledge acquired while multitasking is less

deeply embedded in our memories.

Researchers from University College London recently linked frequent multitasking to smaller grey matter density in the anterior cingulate cortex (ACC), which is the brain region that is involved in empathy and decision-making. However, it is unclear whether having a smaller ACC makes you more likely to multitask, or whether it's multitasking that causes the ACC to shrink.

But some experts say technology has made us all more skilful at multitasking. Hong Kong researchers report multitaskers are better at multisensory integration, while a 2016 study from Microsoft found our ability to multitask has "improved drastically" since the turn of the millennium. ►

Verdict: Technology may make us more adept multitaskers, but perhaps at a cost.



Navigation

IN 2000, a study found that taxi drivers who acquire The Knowledge, which requires memorising thousands of London streets – have a greater volume of grey matter in the posterior hippocampus but less in the anterior hippocampus, making them better at memory tasks involving landmarks but poorer at recalling complex visual information. This provided evidence for plasticity in the adult human brain.

Could our reliance on GPS also be changing the way our brains work? Researchers from McGill University in Canada used fMRI scans to compare GPS users with non-GPS users. Those who navigated without GPS had higher activity and a greater volume of grey matter in the hippocampus than those who relied on GPS.

In another study, people who drove a route using sat-nav could not remember scenes from the journey as well as those without sat-nav, and were poorer at retracing their steps from memory alone.

"It's possible that reliance on technology could cause some brain areas to grow and others to shrink," says University College London's Dr Sam Gilbert. "Something similar was shown in the original taxi driver study. But occasional use of sat-nav probably won't have as strong an effect as learning The Knowledge and relying on it as part of your job."

Verdict: Yes, technology may change our brains when it comes to navigation

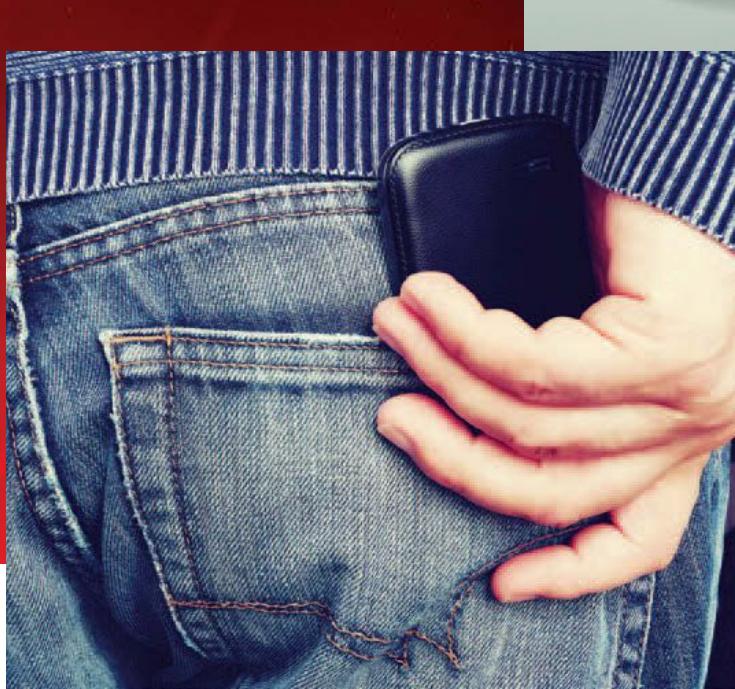


Jo Carlowe is a freelance journalist with a degree in psychology. Her work regularly appears in UK broadsheet newspapers as well as in medical and scientific publications.

Ghost phone calls

Have you ever imagined your phone is vibrating in your pocket, only to pull it out and find you imagined it? You're not alone: it turns out 'phantom vibration syndrome' is a common phenomenon. A study of doctors at a hospital in Massachusetts found that 70 per cent of doctors reported experiencing such 'ghost calls', while a US study of college students found up to 90 per cent were familiar with the phenomenon.

But fear not – psychologists say this is not a sign of madness, but rather that we are so alert to phone calls and messages that we misinterpret slight muscle spasms as proof of a call. We are so anxious not to miss a call that our brains overcompensate by biasing us towards false alarms. ☺





BBC Knowledge

READERS' SURVEY

**ALL
COMPLETED REPLIES
WILL WIN A FREE
E-MAGAZINE OF
BBC Knowledge**

DEAR READER,

What you think of BBC Knowledge matters. This survey is your chance to tell us what you'd like to see in the magazine. The more you tell us about your interests and your likes, the more relevant we can make the magazine for you.

ABOUT THE MAGAZINE: (TICK APPLICABLE BOX)

Q1. Are you a subscriber of BBC Knowledge?

- Yes, I subscribe to the print version.
- Yes, I subscribe to the digital version.
- No, I don't subscribe to the magazine.

Note: If YES, answer Q.2 to Q. 8. If NO, go to Q.9 & Q.10

Q2. If yes, please choose your reason for subscribing?

- I like the articles/stories in the magazine.
- My teacher recommended it.
- My parent bought it.
- It helps me get information on science/history/nature.
- I like the discounts/offers.
- Other reasons (Please specify) _____.

Q3. For how many years have you been a subscriber?

- 1 year
- 2 years
- 3 years
- Other (Please specify) _____

Q4. Do you receive your subscription copies regularly?

- Yes
- No
- Other (Please specify) _____

Q5. How happy are you with the customer service provided? Rate 1-5 (1 being unhappy and 5 being excellent)

- 1
- 2
- 3
- 4
- 5

Q6. How would you rate the process of subscribing to the magazine? Rate 1-5 (1 being very difficult and 5 being very easy/convenient)

- 1
- 2
- 3
- 4
- 5

Q7. Have you ever renewed your BBC Knowledge subscription?

- Yes
- No

Q8. If yes, how would you rate the renewal process?

Rate 1-5 (1 being very difficult and 5 being very easy/convenient)

- 1
- 2
- 3
- 4
- 5

Q9. From where did you pick up this copy?

- Newsstand
- Bookstore
- Library
- E-store
- Other (Please specify) _____

Q10. What made you pick up this copy of BBC Knowledge?

- I liked the cover.
- I liked the articles/stories in the magazine.
- Someone recommended it to me.
- Other (Please specify) _____

Q11. Which of the following educational magazines do you read regularly?

- (1) National Geographic Kids
- (2) Nat Geo Young Explorer
- (3) Sanctuary Cub
- (4) Education World
- (5) Tell Me Why
- Other (Please specify) _____

Q12. List the magazines you are currently subscribing to

1. _____
2. _____
3. _____
4. _____



BBC Knowledge

READERS' SURVEY

Q13. Listed below are all the sections which appear in BBC Knowledge. For each of them, please tick the column which comes closest to your interests...

	Very interesting	Quite interesting	Not interesting	Don't read it
Discoveries & Innovations	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Inside The Pages	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Games Reviews	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Gadgets	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Science	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Nature	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
History	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q&A	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
In Focus	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Q14. How often do you visit the BBC Knowledge digital platforms?

	Every day/ Most days	2-3 times a week	About once a week	About once fortnight	About once a month	2-3 times a month	Never
Facebook	<input type="checkbox"/>						
Instagram	<input type="checkbox"/>						
Twitter	<input type="checkbox"/>						

Q15. How would you rate the digital design/content for BBC Knowledge?

	Very interesting	Quite interesting	Not interesting	Don't read it
a. Facebook	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b. Instagram	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c. Twitter	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

ABOUT YOU:

Q16. What is your monthly household income (if applicable)?

- Up to Rs. 75,000
- Rs. 75,001 to Rs. 1,00,000
- Rs. 1,00,001 to Rs. 1,25,000
- Rs. 1,25,001 to Rs. 1,50,000
- Rs. 1,50,001 to Rs. 1,75,000
- Rs. 1,75,001 to Rs. 2,00,000
- Rs. 2,00,001 and above

Q17. What is your status?

- | | |
|----------------------------------|---|
| <input type="checkbox"/> Student | <input type="checkbox"/> Post graduate |
| <input type="checkbox"/> Working | <input type="checkbox"/> Homemaker |
| <input type="checkbox"/> Retired | <input type="checkbox"/> Other (Please specify) _____ |

Q18. What is your age?

- | | |
|--------------------------------------|-----------------------------------|
| <input type="checkbox"/> Under 18 | <input type="checkbox"/> 18 to 25 |
| <input type="checkbox"/> 26 to 30 | <input type="checkbox"/> 31 to 35 |
| <input type="checkbox"/> 36 to 40 | <input type="checkbox"/> 41 to 50 |
| <input type="checkbox"/> 51 and over | |

Q19. Full name: _____

Q20. Gender: Male Female

Q21. Email address: _____

Q22. Phone number: _____

POSTAL DETAILS:

Your postal address: _____

City/Town: _____

State/Province: _____

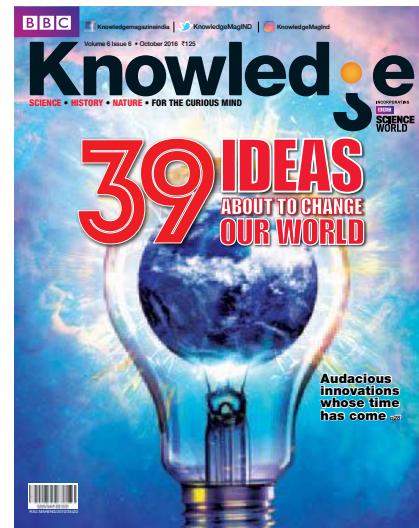
ZIP/Postal Code: _____

Country: _____

Thank you for taking the time to complete this survey.

Together, we can make BBC Knowledge even better!

Post your completed survey form to:
BBC Knowledge Editorial,
Worldwide Media Pvt. Ltd., The Times of India Bldg, 4th floor, Dr Dadabhai Navroji Road,
Mumbai 400001.





LIFE WITHOUT TECHNOLOGY?

We posed the question to our BBC Knowledge Community and here are some of the interesting responses we received



f

Time is precious and knowledge is power and the presence of technology helps to connect these together. We have the internet at our fingertips to search for any information that we would want to make ourselves knowledgeable.

Soumyabrata Chakraborty



Technology enhances our way of thinking, creativity and implementing skills.

@Oishal_konaparthi



Technology > Connection > Universe > Evolution > Mankind

Nabankurb



Because it has become similar to salt. Its existence is pleasurable and absence miserable.

Manali @BeLikeManali



If it weren't for technology, I wouldn't be working for an America-based firm from India.

Neha Chamaria @NehamsChamaria



I love technology because I get to convince people that my life is amazing and that I am really gorgeous when I am not.

@Simprajapati

Technology connects people. It makes going about performing our daily tasks easier – from ordering food online, through scrolling news sites for information, to connecting with our friends. Technology has made the world more connected and it would be impossible to live without it.

@Rutuja_016

IS TECHNOLOGY CHANGING STUDENTS' BRAINS?

In our inaugural panel discussion,
the country's leading education experts weigh
in on the impact of technology on young minds

“Technology has made our brain lazy”

“I recall a time when we knew the telephone numbers of our family members and close friends by heart; they remained registered in our mind. However, technology has made our brain lazy and we don't bother to remember them any more. “The fast-moving pictures and information available at the click of a button have decreased tolerance levels. The brain is malleable, it adapts to change, and, in this time of fast-paced technology, it moves faster, resulting in low concentration levels. We are coming across more cases of children with Attention Deficit Disorder (ADD) and Attention Deficit Hyperactivity Disorder (ADHD) than ever before. “Another very important aspect of the brain getting addicted to technology is instant gratification. Additionally, the human mind may not be able to compete with the machine, causing unhappiness and discontentment.”

Ms Seema Sapru
Principal, The Heritage School, Kolkata



Yes, it wouldn't be far-fetched to say that technology and the dawn of the information age brought with it the single largest factor in the way human thinking and learning has evolved. The concept of merely remembering facts has given way to why this information matters and how it can be used. While some argue that the 21st-century learner is considerably lazier than his/her counterpart of two decades ago due to easy access to information, I believe that students today are more efficient in their use of this information to innovate and create. Easier access to information gives students the opportunity to explore things beyond the standard curriculum in schools and universities. Today, we see more young minds become creators and entrepreneurs than ever before. Simultaneously, technology has enabled different learners to consume and process information in the way most comfortable to them, leading to each student moving ahead into the future on a path not necessarily dictated by standard practices and procedures. Technology enables today's learners to think and inquire, to take risks and find solutions to problems rather than be mere participants in a static system that wants to cater to the 'average'.”

Ms Manika Sharma
Director, The Sri Ram Schools, New Delhi



“We're seeing more young minds become creators and entrepreneurs than ever before”

“The brain is now being hardwired for speed and surface knowledge, not deep thinking”

“It's not just genetics, but also our thoughts, experiences and our responses that shape and evolve our brains, including the overexposure to the world of technology. The human brain is wired differently today, and is under threat in the modern world. There's no doubt technology has made lessons more stimulating, interesting and fast paced, but kids are losing out on sensory and motor skills. While tactile stimulation (touching, hugging, etc) and motor coordination is under-stimulated in their growing years, there is an overload of visual and auditory systems.

“The constant exposure to multimedia has improved children's visual-spatial capabilities and the ability to hunt for and scan information in a jiffy, but it has also resulted in information overload, distraction, a dip in thinking, and a weaker imagination. Even memory, reasoning and problem solving have, unfortunately, taken a back seat.

“This imbalance is redesigning the neurological development in the brain's anatomy. The neuron pathways are becoming permanently damaged. The brain is now being hardwired for speed and surface knowledge, not deep thinking. This is a wake-up call for all stakeholders.”

Ms Mrinalini Kaura

Director & Founder Principal, Venkateshwar International School, New Delhi



“Lethargy of mind has crept in...”

“Nothing is more dynamic than the human mind. From the Stone Age, we have transformed ourselves into a civilization that is deeply impacted by gadgets, smart devices and computers, all of which make life effective and efficient. Credit goes to the human brain that could imagine, learn, observe, and create.

“But, while arduous chores have vanished, giving us more time, relaxation and ease, we can't deny the lethargy of mind that has crept in.

“The increased dependence on Google, GPS, calendar alerts, smart phones, and calculators have left the human brain delible. One can discern a radical change in our capabilities of retaining, remembering and, thus, sorting information. I remember my grandfather savouring the lyrics of classic poems and having the lexicon at his fingertips, metaphorically. He was from the generation that was blessed with the 'pre-internet brain'.

“From ignorance of our surroundings and absent-mindedness to the hovering dangers of critical forgetfulness or early Alzheimer's, the human brain is gradually losing its intrinsic abilities. 'Use it or lose it' stands apt for human brain. In a world engulfed by technology, the human brain is suffering from sleep disorders, attention and concentration issues, and deteriorating problem-solving skills.

“The current horrifying news from across the globe of youngsters losing their lives while posing for selfies is an indication that technology is also gravely impacting individual identities as more and more of us are displacing the 'true self' with an exaggerated, ideal self.

“Technology, implicitly, has transformed the human brain into a shallow thinker, losing its connect with nature, tradition and self.”

Ms Suruchi Gandhi

Principal, Bal Bharati Public School, New Delhi

“This is our opportunity as educators to embrace the positive aspects of change”

“Yes, technology is rewiring young (and not-so-young) brains. This is not a new phenomenon; technology has always profoundly impacted thinking. The difference today is the sheer pace of change. Student brains are currently being challenged to respond to more and more stimuli, at ever-increasing rates, and there is little doubt that our students think and learn in profoundly different ways than we did in school. Our opportunity as educators is to recognise the trends, embrace the positive aspects of change, and prioritise for our students the skills and dispositions that might otherwise be lost amid this reshaping process: authentic social engagement, creativity and passion, attention to detail, an aptitude for reflection and the capacity for joy and wonder.”

Mr Corey Stixrud

Principal, Kodaikanal International School, Kodaikanal



PORTFOLIO

early days

The first few weeks of an animal's life are fraught with danger so, as **Suzi Eszterhas**'s intimate pictures show, parental protection is vital to the newborns' survival

Words by Mike Unwin



A bat-eared fox in Kenya's Maasai Mara Reserve watches over her 13-day-old kit, newly emerged from the den. She will continue to suckle her litter for 14–15 weeks but thereafter, in a reversal of the usual roles among canids, the male assumes most of the parenting duties, grooming, feeding and defending his progeny, and transporting them between den sites.



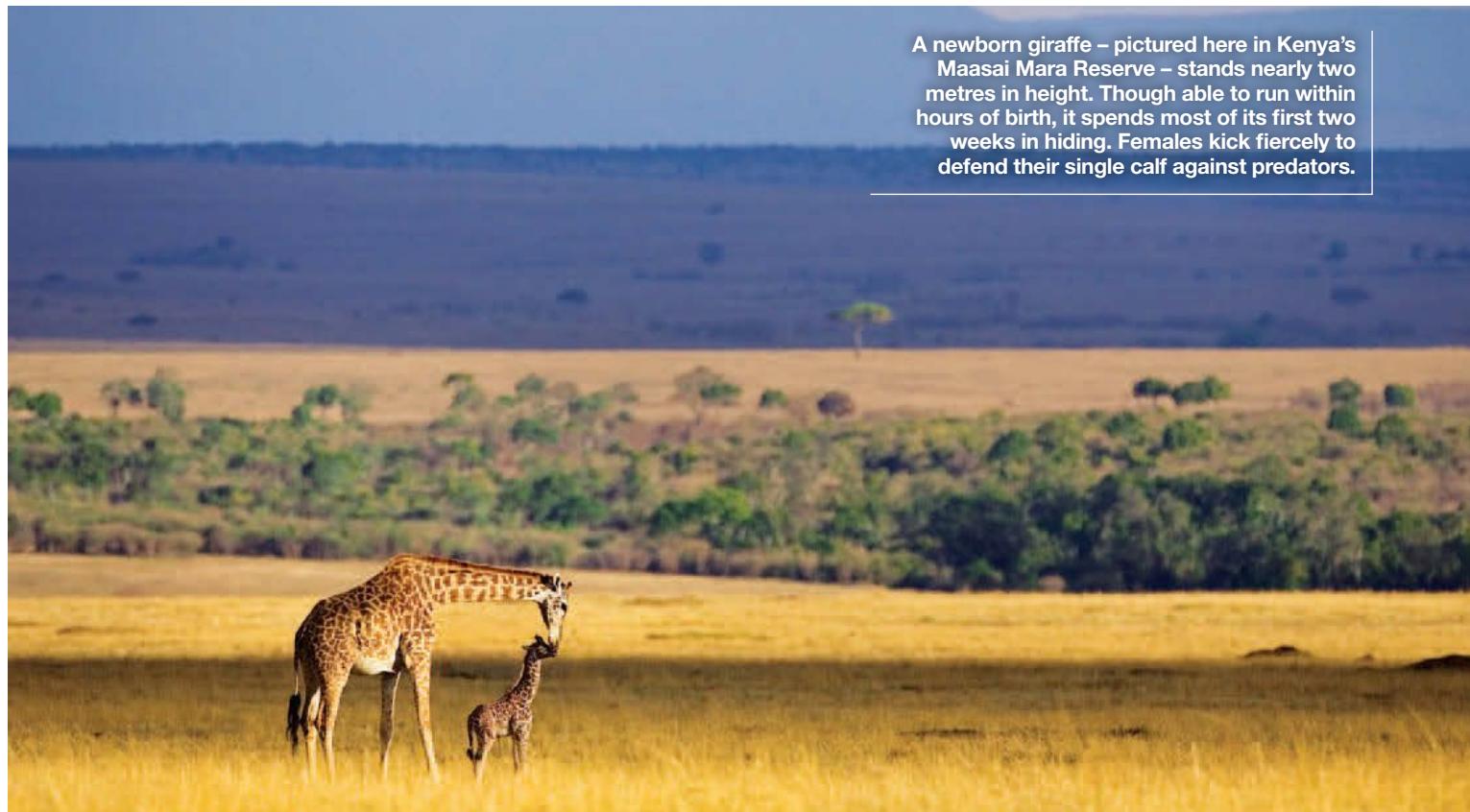
An eight-week-old cheetah cub plays with its mother in Kenya's Maasai Mara Reserve. Some scientists have suggested that the silvery mantle of young cheetahs – shed as they grow older – offers them some protection by mimicking the appearance of the notoriously aggressive honey badger.



A young Hoffmann's two-toed sloth at the Aviarios Sloth Sanctuary, Costa Rica, settles into the hammock of its mother's underside, a position it has instinctively adopted since birth. At two months old, it now feeds for itself, although it may remain with its mother for up to two years.



In cats, such as the lion (left, Maasai Mara Reserve, Kenya) and the serval (right, Tanzania) the eyes don't generally open until they are around two weeks old.



A newborn giraffe – pictured here in Kenya's Maasai Mara Reserve – stands nearly two metres in height. Though able to run within hours of birth, it spends most of its first two weeks in hiding. Females kick fiercely to defend their single calf against predators.



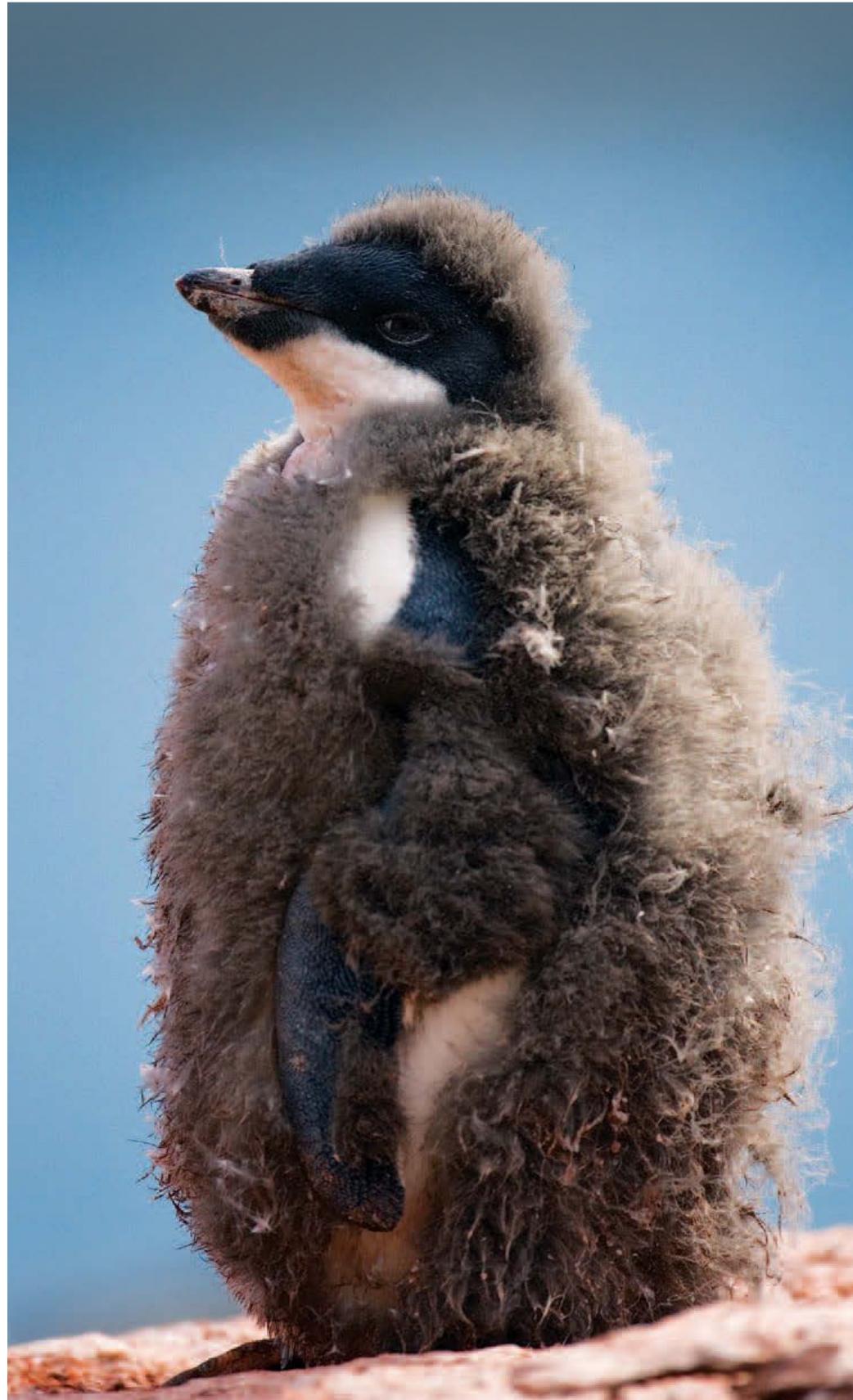
Three brown bear cubs climb on their mother's back as she cools off in a river in Katmai National Park, Alaska. A female bear mates with various males during her two-week oestrus period, so these cubs may have different fathers.



Being fewer than three weeks old, this calf in Kenya's Maasai Mara Reserve doesn't yet have control of its trunk. Full coordination of mouth, trunk and feet takes nine months.

A young ring-tailed lemur in Madagascar's Berenty Reserve holds on while its mother drinks. After spending its first fortnight clinging to her chest, the youngster will thereafter ride on her back.





This young Adélie penguin at Shingle Cove, South Orkney Islands, is shedding its juvenile down. Three weeks after hatching, it joined other chicks in a crèche that provided protection from predators.

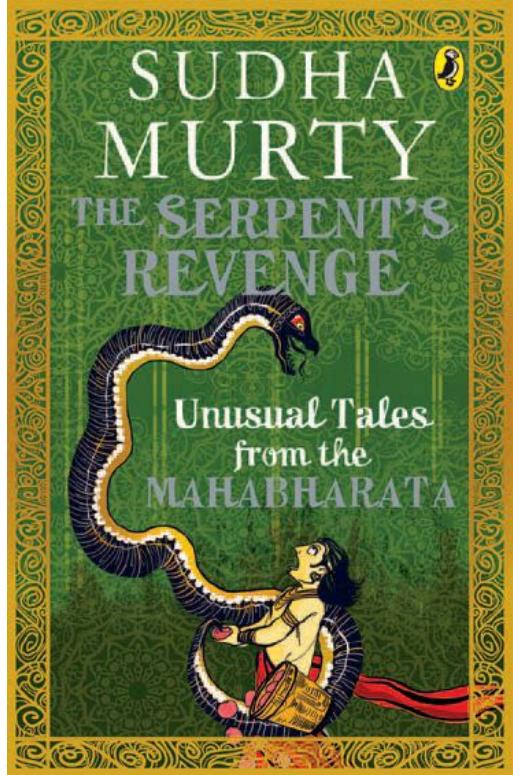
Suzi Eszterhas is an award-winning wildlife photographer based in California. She is well known for documenting family life in the wild (www.suzieszterhas.com).

The IMAGINATION of the STORYTELLER

Sudha Murty's *The Serpent's Revenge: Unusual tales from the Mahabharata* throws new light on the little known aspects of the Kurukshetra War and the characters who peopled it

SUDHA Murty laughs a lot. She laughs without restraint, with spontaneity. Heard over the phone, it's laughter that makes you picture in your mind a person who will make you believe that the world is an interesting place, a place that you can shape, at least to some extent, as you wish.

Hearing that unbridled laughter makes it easy to understand why Sudha Murty is such a great storyteller. A few years ago, she used to read out stories on radio for children, and many of her books – in both English and Kannada – are also perfect for reading aloud. Fittingly, with *The Serpent's Revenge*, she once again takes on the role of storyteller, reintroducing India's greatest epic – the *Mahabharata* – through charming, often extraordinary tales. "I am not the author of these stories," she writes in the introduction, "I am simply a storyteller who has tried to dip into this ocean of ancient, mesmerising tales after referring to multiple sources and removing many illogical details in



an effort to connect to today's readers." The result is a wonderful compilation of riveting stories that will offer new insights into characters we think we know.

EXCERPTS FROM AN INTERVIEW

"Storytelling is a great creativity tool for children."

"Through stories, you can improve children's imaginations. For example, when you show the *Ramayana* on the TV, they get an idea of how Rama looks. Their imagination will not grow. But, when you tell a story, the imagination stretches. The sky is the limit. Children can relate to the story. Being able to listen to stories is better than reading. When you tell a story, children get involved in a way that is not achieved even by reading many books."

"Our children are very smart..."

"If you tell them, 'he did this, or did that,' they will not believe you today. They will Google it, they are knowledge seekers. What adults say is not final for them.

So we use symbolism in stories, and explain what it means. Like, when a person has 10 heads, it means that that person can think in 10 different ways. A person who has four heads can see in all directions. It means he is very knowledgeable and communicative, someone who can understand all that is going on. And someone can look like a serpent, but he is just someone from the Naga tribe. I try to make it as practical as possible so that they can relate. Ultimately, our children

should be able to relate the story to today's scenarios. That is very important. Otherwise the story is a fail."

"I get up early to write."

"It doesn't take me very long to write. Because I've written so many books, I know what I want to write, I don't have to write and rewrite. But I think and research for many years before I write."

"The Serpent's Revenge is the first book of a series."

"There are four books in the series. I would like to release one book each year on Children's Day (November 14)."

"I like the story of Barbarika a lot."

"Barbarika was the son of Ghatotkacha and Maurvi. I like the story because it's really unusual. Barbarika is worshipped in Haryana and Rajasthan as Khatushyam."

I also like *The King of Udupi*.

"It is a simple story, but a nice story (laughs heartily)."

EXCERPT

The King of Udupi



When the war of Kurukshetra took place, even the rulers of other lands ended up choosing sides and were compelled to fight each other.

For instance, King Shalya, the maternal uncle of Nakula and Sahadeva, was tricked into siding with the Kauravas. King Vinda and King Anuvinda, Krishna's brothers-in-law, also fought for the Kauravas. One of the Kauravas, Yuyutsu, was the only one to switch sides and join the Pandavas. Krishna's brother Balarama, upset with the whole affair, went on a pilgrimage instead.

The king of Udupi, unable to choose a side, refused to take a decision. He said, "I will be in charge of the kitchen and feed soldiers from both camps."

The war began.

Each day took the lives of many soldiers. At the end of the day, the remaining fighters from both the camps came to the kitchen and ate together.

There was one strange thing that didn't escape notice – no food was ever left over after everyone had finished their meal in the evening. The king of Udupi

seemed to know exactly how much food had to be made every day, but that also meant that he knew beforehand how many soldiers would not live to see another night.

Curious, the Pandavas asked the king one day, "Please tell us how you know the exact number of soldiers that will make it back alive each day?"

He smiled. "I have a simple technique. I take a bag of peanuts to Krishna at the end of every day and observe him closely. Then I multiply the number of peanuts he eats by one thousand and deduce the number of soldiers that are going to die the next day."

The Pandavas were stunned.

After the war ended, Krishna blessed the king, saying, "You have taken care of all the soldiers who've fought in this battle, without any bias. Your future generations will be famous for making delicious food and serving it efficiently."

People say that this is the reason we see so many Udupi restaurants across India!

EXCERPT

The Yaksha's Quiz

One day, a man approached the Pandavas while they were in exile in the forest. "I need your help, Yudhishtira!" he said, addressing the oldest of the five brothers.

"I had hung some *arani* from a tree branch next to my ashram," he continued. "Suddenly, a deer came and started scratching its back on the tree. In the process, it shook the *arani*, which fell from the branch and got stuck in its horns. Startled, the deer took off at a high speed. I ran behind the deer but couldn't catch up with it. I can't start my *yagna* without the wood. Please, will you help me?"

The Pandavas knew that they could easily get the *arani* wood back for the man. It was their duty to care for their subjects, so they agreed to help him. The five brothers began to look for the deer. Soon, they saw the animal from a distance and tried to surround it, but it sprinted away. They tried again and again to capture the deer, but it proved too fast for them. Tired, the brothers finally sat down under a tree.

Yudhishtira said to his younger brother Nakula, **"Brother, will you fetch some water for all of us?"**

Nakula nodded and climbed up a tree so he could locate the nearest water body. He saw one not too far away from them so he got down and told his brother, "There is a pond nearby. I will bring some water for all of you."

When Nakula reached the pond, he was mesmerised at the fabulous sight in front of him – the crystal-clear water was surrounded by beautiful trees, creepers and flowers. Then he remembered his thirst and stepped into the pond. He wanted to drink a little water before taking it back to his brothers.

Just as he was about to take a sip, there was a loud voice from the skies above. "Don't drink this water, Nakula."

Nakula stopped, stood up straight and looked around. There was nobody in sight.

"I am the owner of this pond," said the voice. "You have to answer my questions before you proceed. You can take the water only if I am happy with your replies."

"Maybe I'm just too tired and that's why I am hearing voices," thought



Nakula. Ignoring the voice, he bent down to drink the water again.

The voice repeated the warning. But by then, Nakula was too thirsty and drank the water. Satisfied, he turned around and started walking away from the pond. Suddenly, he fell to the ground and died.

Meanwhile, Yudhishtira was starting to get worried about Nakula. He said to Sahadeva, "Go and find out what's taking Nakula so long."

The tired and hungry Sahadeva reached the same pond and saw his younger brother lying dead on one side. Shocked and upset, he took a few minutes to calm down and then, unable to take the thirst any more, hurried to the pond to drink some water.

As soon as he touched the water, the voice warned him, "**Be careful, young man.** Stop whatever you are doing and listen to me first. If you don't, you will share the same fate as that man lying there."

Disregarding the warning, Sahadeva drank the water and immediately fell dead.

When Sahadeva also didn't come back, Yudhishtira turned to Arjuna. "Take your bow and arrow and find our brothers," he said to the master archer. "I suspect some danger has befallen Nakula and Sahadeva."

Arjuna saw his dead brothers lying near the pond, and looked around carefully for the hidden foe. Then, overcome by thirst, he, too, bent close to the water.

Right on cue, the voice repeated its warning to Arjuna. "**Show yourself! Come out and talk to me,**" Arjuna roared. "If you don't, I will use my *shabdavedi* arrow and destroy you."

Without waiting for the voice to respond, Arjuna drank the water and dropped dead immediately.

Now, Yudhishtira sent the mighty Bhima, the strongest of the five brothers, to the pond. When Bhima saw Arjuna, Nakula and Sahadeva and heard the voice, he shook in anger, but the same fate befell him as well.

Finally, the weary and thirsty Yudhishtira trudged to the pond himself. When he saw his brothers lying dead on the ground, he rushed to examine them. There were no physical injuries on their bodies. Yudhishtira understood that they had not been in a fight and that some other forces were at play.

Yudhishtira went closer to the pond to have a sip of water. Just as he was about to commit the same mistake as his brothers, the voice spoke yet again.

"My child, stop. I own this pond and you can't drink the water unless I say so. See what happened to your brothers because of their arrogance. I only want to ask you some questions and hear your replies. Then I will

"O Yudhishtira,
I bless you. You are truly
a follower of your path.
I grant back the lives
of all your brothers.
From this day on,
you will also be known
as Dharmaraja
or the king of *dharma*"

decide whether you can drink from the pond or not."

Yudhishtira thought for a while and stepped back.

"Fine," he said. "Ask me your questions. I will try my best to answer them... but, tell me first, who are you?"

Suddenly, Yudhishtira saw a *yaksha* approaching him. The being sat in front of him and began firing questions rapidly at him.

"What is bigger than the Earth?" the *yaksha* asked.

"A mother," replied Yudhishtira.

"What is taller than the sky?"

"A father."

"What is faster than the wind?"

"The mind, of course." Yudhishtira smiled.

"What grows faster than hay?"

"Worry."

"What is the greatest dharma in the world?" queried the *yaksha*.

"Compassion and conscience."

"With whom is friendship never-ending?"

"With good people," responded Yudhishtira patiently.

"What is the secret to never feeling unhappy?"

"If one can control his or her mind, then that person will never feel sad."

The *yaksha* increased his pace now. "What is the greatest kind of wealth?"

"Education."

"What is the greatest kind of profit?"

"Health."

"What is the greatest kind of happiness?"

"Contentment," said Yudhishtira, ever prompt with his replies.

"What is man's worst enemy?"

"Anger."

"What disease will never have a cure?"

"Greed is incurable."

The *yaksha* smiled again. "A last question, my friend. What is life's biggest irony?"

**"It is the desire to live eternally.
Every day, we encounter people dying
but we always think that death will
never come to us."**

"Yudhishtira," said the *yaksha*. "I am pleased with your answers. So I will grant you the life of any one of your brothers."

"I choose Nakula," responded Yudhishtira immediately.

"Yudhishtira, you will need warriors like Arjuna or Bhima in the war that's coming. What makes you choose your stepbrother Nakula instead of your mighty brothers?"

Yudhishtira bowed to the *yaksha*. "My father, Pandu, had two wives, Kunti and Madri," he explained. "While my mother, Kunti, had three sons, mother Madri had twins – Nakula and Sahadeva. If I choose Arjuna or Bhima, it will be unfair to my other mother, Madri, who will be left with no sons of her own. I must be fair and hence I choose one of her sons. That is the call of *dharma* – to live with compassion and conscience, without bias and in peace."

The *yaksha* was delighted. "O Yudhishtira, I bless you. You are truly a follower of your path. I grant back the lives of all your brothers. From this day on, you will also be known as Dharmaraja or the king of *dharma*."

Thus Nakula, Sahadeva, Arjuna and Bhima came back to life and together they knelt down in front of the *yaksha*.

Yudhishtira said, "I am sure that you aren't just a *yaksha*. You killed my four brothers within seconds and you revived them equally quickly. You must be Lord Vishnu or Lord Shiva or someone just as powerful. Will you please reveal your true identity to us?"

The *yaksha* then transformed into Yamaraja, the god of death. "I bless all of you," he said, smiling. "I am the one who went to the poor man in the form of the deer, causing you to come here. I would like to give you a boon. Tell me, what would you like?"

"O Yamaraja, give us a boon that will allow us to live the thirteenth year of our exile in anonymity, as is the condition of the bet that we lost. If we are recognised, then we are bound to repeat the thirteen years of exile again. Please help us disguise ourselves during that year," said Yudhishtira.

"So be it," said Yamaraja. ☺

YOUR DOCTOR WILL SEE YOU NOW

While we know our furry friends are brilliant companions, **Dr John Bradshaw** finds out if they could actually be making us healthier too



Ward K9

Keep you card on you at all times

Keep Card Visible

Administrative Master of Database

Administrative Master of Database

Administrative Master of Database

Dr Jack Russell

Osteology

DOGS: the universal stress-buster. That's the claim increasingly made for 'man's best friend' as dogs find their way into all kinds of unexpected medical situations. Last year, my own institution, the University of Bristol, teamed up with the Guide Dogs charity to offer stressed students a puppy play session. This was by no means the first of its kind: more than a thousand universities have put animal visitation programmes into place to help students. At Bristol University, the 600 slots quickly filled up. Yet the students' enthusiasm is supported by research. In one study, after as little as seven minutes' interaction with a friendly dog, students reported significantly less anxiety and greater feelings of contentment. Viewing a slideshow of the same dog for the same length of time had no effect on their mood. It seems that actually stroking and playing with the dog is crucial. Sorry, YouTube.

As well as stress, dogs are widely touted as a panacea for all kinds of ills such as high blood pressure, loneliness, heart disease and depression, to name but a few. A quick search of the internet will reveal countless articles extolling the health benefits of keeping pets. Some of these claims are supported by science, others remain to be investigated thoroughly, while a few seem to be little more than wishful thinking. So what does canine companionship really offer?

Stressed students clearly value the calming sensation of stroking a dog, and this effect is well supported by

experiments. In this kind of research, a scientist will usually ask a person to read aloud to a stranger (which seems pretty tame compared to the sheer terror of an exam).

Nevertheless, measurable reductions in stress have been recorded just by placing a dog in the same room as the subject. If stroking the dog is allowed, the reduction in stress is even greater. Moreover, it's not simply that the reader reports feeling less stressed, it's actually reflected in their physiology too: their blood pressure falls and their heart beats more slowly and rhythmically.

Different strokes

Long-term stress is a trigger for heart disease, so not surprisingly it's been suggested – and is now widely believed – that the relaxing effect of contact with dogs might benefit cardiovascular health over a lifetime. Early studies supported this idea, showing that dog owners were more likely to recover from heart attacks than people with no pets. However, the act of petting alone is unlikely to have been a major factor, since cat owners seem to be more susceptible to heart disease. Focus therefore shifted to the known benefits of taking regular moderate exercise, which many dog owners do. Not all, of course: a surprising number of pet dogs get their only exercise in their owner's back garden. Moreover, many dog walkers seem more interested in their smartphones than what their dog is up to, and are therefore

Dogs at universities have helped students de-stress



Can we tell when dogs were first domesticated?

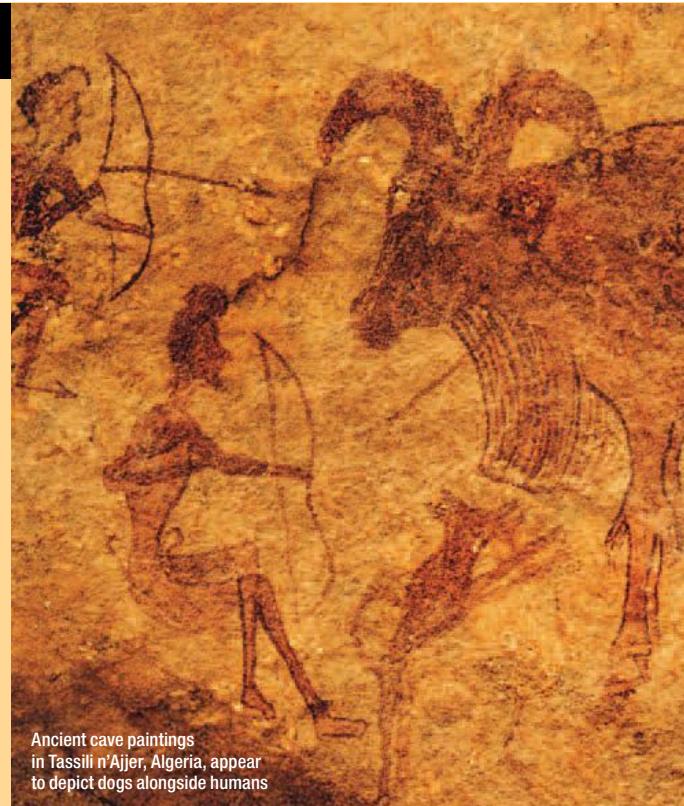
When and where dogs were first domesticated is still hotly debated among scientists. There are a few hard facts that all agree on: dogs were once wolves (and not jackals, as Austrian zoologist Konrad Lorenz once maintained) and they were the first animal to be domesticated, some time in the late Pleistocene before the dawn of agriculture. Beyond that, there is little agreement. The earliest archaeological remains that are unequivocally dogs and not wolves date from 14,000 years ago, but 30,000-year-old skulls have been discovered in France and Belgium that are not pure wolf and may be dogs.

With such baffling archaeological evidence, most scientists have turned to DNA to find out when and where dogs were first domesticated. Tens of thousands of blood samples have been taken from street dogs around the world, for comparison with those of wolves. It's even possible to analyse DNA from ancient bones: minute

samples from the 30,000-year-old skulls mentioned earlier are currently being studied, and it has already been shown that ancient dogs preserved in the Alaskan permafrost were descended from Asian wolves, not American ones.

Indeed, the ancient DNA may turn out to be more informative than the DNA of living dogs. Because dogs have been carried hither and thither around the world, for thousands of years, their current distribution may tell us very little of their origins – hence the competing claims of different groups of scientists that dogs variously originated in eastern Asia, Mongolia, Siberia, Europe or Africa.

But *why* were the animals domesticated in the first place? The most recent theory is that dogs domesticated themselves, initially living as scavengers in and around our villages. Today, this is a way of life still shared by three-quarters of a billion unowned dogs worldwide.



Ancient cave paintings in Tassili n'Ajjer, Algeria, appear to depict dogs alongside humans

A 20-YEAR-OLD MAN WAS MORE SUCCESSFUL IN OBTAINING YOUNG WOMEN'S PHONE NUMBERS IF HE HAD A DOG AT HIS SIDE

unlikely to walk sufficiently fast to enhance their cardiovascular health.

It's been claimed that dog owners get more exercise walking their pet than someone who takes out a gym membership. But perhaps that's not much of a claim, since over half of people who take out an annual gym subscription in January have stopped going by April. And, even though some dog owners undoubtedly do take more moderate exercise than people with no dog to walk, this doesn't seem to translate into their living any longer. Perhaps dog ownership, compared with a brief encounter with a dog cared for by someone else, is stress-neutral: the daily routine of exercising the dog may be relaxing, but owning an animal can be stressful, particularly if it is disobedient or prone to illness.

Recently, the American Heart Association has stated that dog ownership is "probably associated" with a reduced risk of heart disease. Since this doesn't seem to translate into dog owners living longer, there may be another explanation. It could be that it works the other way around: people with poor health think twice before embarking on the responsibility of caring for a dog for the next 15 or so years.

Perhaps they get a cat instead, which would account for the generally poorer health of cat owners compared to the rest of the population.

Working dogs

Dogs can do more for their owners than just get them outdoors: they also provide companionship to a degree unmatched by any other animal. Some dog owners even like to take their pets into the office. In fact, campaigns to persuade companies to allow dogs in the workplace have been gathering momentum since the turn of the millennium.

While office workers' stress levels generally increase from the beginning to the end of the working day, studies have shown that, if employees are allowed to bring their dogs in, they actually feel less stressed by the end of the day. It's unclear how co-workers feel about sharing their space with other people's animals, but anecdotally it seems as though a dog can reduce tensions by providing a focus for conversation.

Several studies have confirmed that dogs do indeed bring people together. In one, conducted in France, it was found that a 20-year-old man was far more successful in obtaining young women's phone numbers if he had a dog at his side: fewer than one in 10 complied if he was on his own, one in three if he was with the pooch.

While there are certain drawbacks to bringing dogs to work, including complaints from those with allergies, and conflicts with religious beliefs, they do seem to bring about a general lightening of mood. ►

DOG MYTHS BUSTED**OLD DOGS CAN'T BE TAUGHT NEW TRICKS**

Nonsense. Like all animals, dogs find it easier to learn while they're young, but their brains are still capable of altering established patterns of behaviour, well into middle age.

**DOGS HAVE A BETTER SENSE OF SMELL THAN CATS DO**

Yes and no. If we're talking about the dog's actual nose, then it is 10 to 100 times more sensitive than a cat's. But both cats and dogs have a second 'nose' called the vomeronasal organ, and the cat's is the more sensitive.

**DOGS CAN FEEL GUILTY**

Nope, their emotions are probably restricted to simple 'gut feelings' like joy, anger, fear and anxiety. The clues that owners interpret as a dog's 'guilty look' are actually signs that the dog is anticipating punishment, but doesn't know what it's done wrong.

**DOGS PREFER CANINE COMPANY**

Wrong again. Given the choice, most dogs prefer to spend time with people, and become distressed when their owners leave the house. Therefore, taking dogs to work probably benefits them even more than their owners.

**A HEALTHY DOG ALWAYS HAS A WET NOSE**

Partly true. While a dry nose may be a sign of illness or dehydration, it may also be because the dog has just woken up and not licked its nose yet.

**DOGS NEED TO BE 'KEPT IN THEIR PLACE'**

No. Current scientific thinking on dogs' minds indicates that they are highly unlikely to have any concept of their position within the family hierarchy. Furthermore, although physical punishment used to be a staple technique in dog training, studies have shown that it creates disobedient and anxious dogs.



Forever friends: 12,000-year-old skeletal remains of a human and dog, photographed in Israel

Paws for thought

So, it appears that dogs build bridges between people and make their owners seem more trustworthy. These may be the main benefits that dogs provide for veterans of conflict who suffer from Post Traumatic Stress Disorder (PTSD) and other mental health difficulties. Although it has been suggested that all veterans should have dogs, some find dog ownership too difficult. Trained PTSD dogs will bring the same stress-reducing benefits as any dog, but, to be effective, they also need to be trained to respond to the needs of their owner, whether that's waking them from nightmares, bringing medicines, or leading them to safety when they experience a panic attack.

A dog's capacity to bring people together may also explain their effectiveness in many kinds of therapy, including the benefits that dogs bring to nursing homes, especially to those institutions that care for individuals suffering from dementia. In one recent Italian study, scientists examined the reactions of dog-loving residents to regular half-hour sessions with therapy dogs. Playing with the dogs brought about



THERE IS EVIDENCE THAT SOME CHILDREN WITH AUTISM-SPECTRUM DISORDERS BENEFIT FROM THE COMPANY OF A DOG

a remarkable change in the residents' behaviour. They went from being largely apathetic to become more active and animated, but also more spontaneous with the dogs – for example, throwing a ball for the animals to retrieve. Another notable feature of interaction with dogs is the extent to which elderly residents reach out and touch them, reducing their feelings of emotional isolation. Unfortunately, although claims have been made that contact with dogs might improve mental functioning, no such benefits have been detected.

There is evidence that some children with autism-spectrum disorders benefit from the company of a dog. Some such children form intense relationships with animals, seemingly finding them easier to relate to. One recent study from France indicated that, to be effective, the dog has to be obtained when the child is old enough to interact with it: such children tend to ignore pets that were there when they were a baby.

But dogs really come into their own when they can combine their outgoing natures with their incredible ability

to read our body language – and their ultra-sensitive noses. Seizure Alert Dogs are now being trained to assist people with metabolic conditions such as brittle diabetes and Addison's disease, but the original idea came from the dogs themselves, some of which seem to have taught themselves to alert their owners to an impending attack. It's not known precisely how they do this, but a dog's ability to detect minute changes in the body odour of the subject must play a part.

The relationship between us and dogs has been in existence for over 10,000 years, and shows no signs of weakening. But it *is* changing, as the traditional tasks that dogs performed have been supplemented by new roles. Getting a dog may not automatically make you healthier, but, if you train it well, it will undoubtedly make you happier – and encourage you to make new friends. ☐

Dr John Bradshaw is an anthrozoologist based at the School of Veterinary Sciences at the University of Bristol, the UK.



★★★★★

ARE YOU A GENETIC SUPERHERO?

Recent research has revealed a handful of 'superheroes' walking among us, whose DNA gifts them with resistance against serious diseases. Now, as **Kat Amey** observes, just have to find them...

SUPERHEROES are everywhere right now. Righting wrongs, saving planets and generally punching each other senseless in films, comic books and TV shows. But just as Clark Kent wanders unrecognised through the world, only turning into Superman when his help is needed, there are genetic superheroes dwelling among us, and, in most cases, they're completely unaware of their amazing powers. Only now, by trawling through the DNA of thousands of people, are we discovering their hidden identities.

Gaulty genes

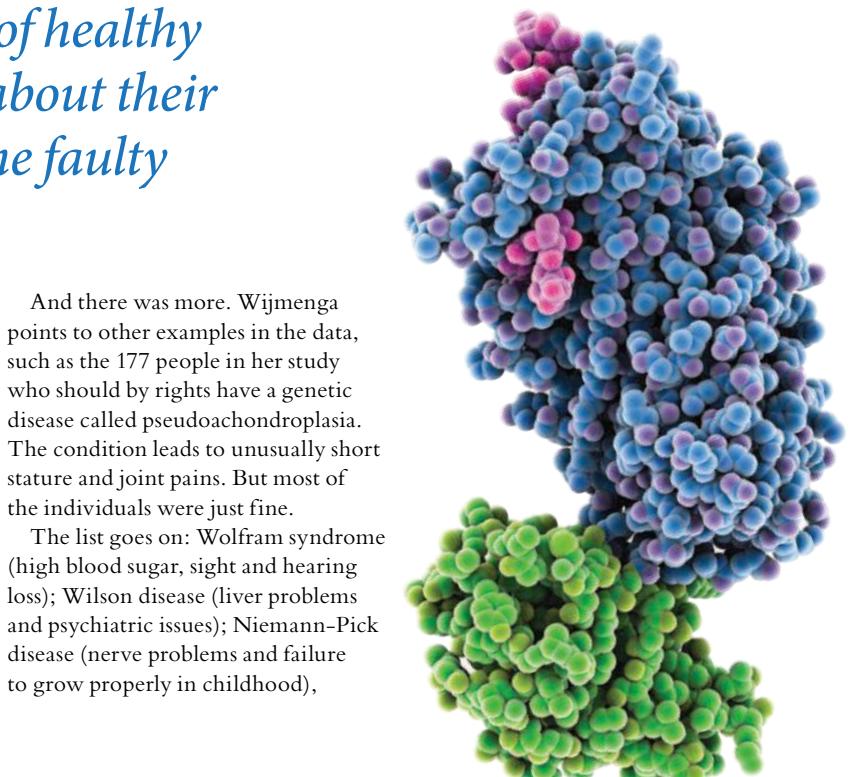
Dr Cisca Wijmenga and her team at the University of Groningen in the Netherlands never set out to find superheroes. Their project was important but unexciting: reading the DNA of 250 Dutch families to establish a baseline for the genetic make-up of the country. Then, as future studies turned up interesting gene variations and faults (mutations) linked to disease, they would be able to tell if they were genuinely responsible for causing illness or just part of the underlying DNA of Dutchness.

Then they found them.

Two unlikely heroes, both in their

There are hundreds of healthy Dutch people going about their daily lives, defying the faulty genes within them

sixties and both carrying two faulty copies of a gene called SERPIN A1 (we usually have two copies of every gene, one from mum and the other from dad). This particular gene normally makes a protein that helps to protect the tubes and air sacs in the lungs. Without it, these delicate structures start to break down, causing serious breathing problems by 30 to 40 years of age. But these two individuals had both made it into their sixties without suffering from any severe lung problems.





Above: The tests by the Dutch team found some surprising genetic mutations among the population.

Left: SERPIN A1 is the gene that provides instructions for making a type of protein (blue) that blocks the activity of certain enzymes (green). When there are faults with SERPIN A1, structures in the body can break down.

and more. There are hundreds of healthy Dutch people going about their daily lives, defying the faulty genes within them.

A similar study by Prof David van Heel and his team at Queen Mary University of London came out in March 2016, looking at the DNA of more than 3,200 British Pakistanis living in east London. It revealed 38 people carrying faulty or missing versions of genes linked to serious diseases. Yet the majority were perfectly healthy. In the close-knit Pakistani community, where there are high levels of marriage between blood relatives, there's an increased chance that people will inherit two dodgy copies of a given gene. And although there are definitely higher levels of genetic diseases in this group, they aren't as high as might be expected.

Similarly, a 2015 study on the genetically reclusive Icelandic

population revealed that nearly 8 per cent of the island's inhabitants carry two copies of 'bad' versions of disease-causing genes, but many of them are perfectly fine.

These findings aren't just limited to humans either. Researchers have discovered dogs carrying a genetic variation that protects them against the doggy version of Duchenne muscular dystrophy.

Real superheroes

Then, in April 2016, came the big one. "Thirteen anonymous genetic superheroes walk among us," proclaimed the headlines, reporting on an impressive analysis of more than half a million people's genetic make-up. A team of US researchers known as the Resilience Project discovered that this lucky handful carry mutations that should leave them with serious illnesses, yet are

somehow perfectly healthy.

Led by Dr Rong Chen at the Icahn School of Medicine at Mount Sinai, New York, along with Dr Eric Schadt and Prof Stephen Friend, the scientists trawled global databases containing information about people's DNA and whether they were affected by any illnesses. The team focused on mutations responsible for childhood genetic diseases, known as highly penetrant Mendelian diseases (see overleaf), where carrying two copies of a faulty gene, or even just one in some cases, is enough to cause severe effects.

To start with, Chen spotted around 15,000 individuals who could be heroes, carrying 'bad' mutations in nearly 200 genes linked to more than 160 severe diseases. Further analysis narrowed this down to 300 people, finally ending up with strong evidence for the existence of just 13 who ►

GENES AND MUTATIONS: A QUICK REFRESHER



What is DNA?

DNA is the genetic instruction manual in our cells. Genes are stretches of DNA that act as 'recipes' for making molecules called proteins, which build our bodies and keep them working.

What is a mutation?

Changes in genes (mutations) can affect the protein they encode, making it more or less active, or causing disease. For example, if you have a mutation in the gene *BRCA2* (pictured), you have a higher risk of breast cancer.

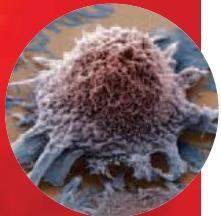


How do mutations happen?

Mutations can be inherited or can occur when eggs and sperm are made, or in the fertilised egg (pictured left).

Can adults get mutations?

Mutations can occur in the DNA within cells in the adult body. While these changes can't be passed on to the next generation, they can lead to diseases. For example, smoking damages DNA, which can cause lung cancer (pictured).



Should I worry?

As well as rare disease-causing mutations, we each have thousands of minor genetic changes – known as variations – that have lesser effects on our bodies, brains and health.

were resilient to a selection of eight genetic conditions.

Three were resistant to cystic fibrosis, a serious disease affecting the lungs and other organs. Another three were unaffected by gene faults that should have caused major bone abnormalities, known as atelosteogenesis. Two were immune to the impact of mutations in a gene called DHCR7, usually responsible for a severe developmental disorder known as Smith-Lemli-Optiz syndrome. Another five had their own unique genetic superpowers against a selection of brain, bone, skin and autoimmune diseases.

Holding out for a hero

Frustratingly, the identities of these masked men and women will remain a mystery. Due to anonymisation and lack of the right consent to re-contact the people in the databases, the Resilience Project wasn't able to track any of them down for further investigation. This problem has led to some criticisms of the study: there's still a chance that there may have been

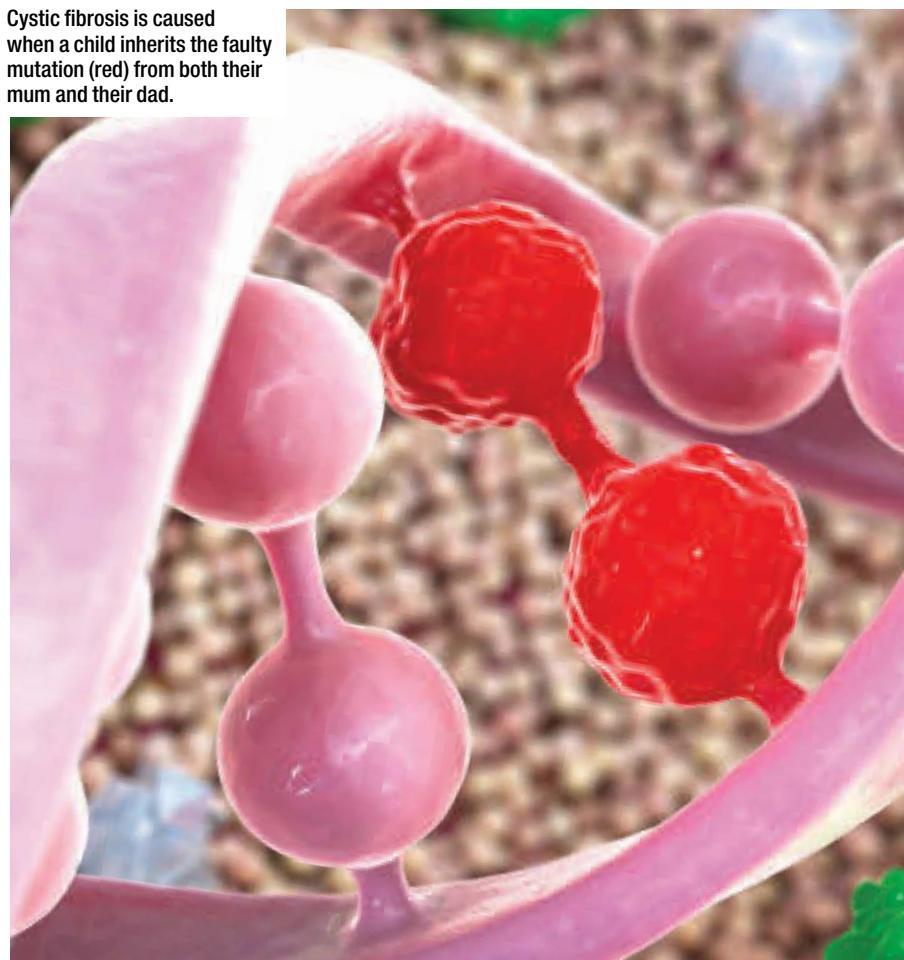
identity mix-ups along the way (not unusual in such large-scale projects) or that they do actually have mild or even more severe forms of the conditions they appear to have evaded.

There may be other issues too. The biggest is the mutation database itself. This is the resource that lists all the genetic faults known to be linked to diseases. This makes Wijmenga sceptical about the powers of many of the individuals she found in her study.

"All of them are disease genes, but some of them are really common in the Dutch population, and that makes you wonder if those are true mutations or they just ended up in the database in the past but don't actually cause disease," she says. "For some of these variants, around 90 per cent of the people have the mutant version, which doesn't make sense if it's a real mutation. These things should be rare. So this tells us that the databases aren't that good."

That said, there's still evidence that some superheroes, at least in the genetic sense, are real. And although the identities of those in the Resilience

Cystic fibrosis is caused when a child inherits the faulty mutation (red) from both their mum and their dad.



Project's first study will never be known, the next phase promises to bring a new generation of heroes into the spotlight. The plan is to recruit up to a million people from the general population, find the superheroes among them, figure out how they got their powers, and work out how to harness them for good.

"At this point, it still sounds rather ambitious and crazy to say things like that," explains Jason Bobe, founding director of Harvard's Personal Genome Project, who's been brought in to head up the search. "It's like claiming that you have a platinum record without first writing a hit song, and the challenges of reaching a large number of people are serious."

He's after three types of people to get involved, signing up through an interactive app that will take them through consent forms and questionnaires – almost like Facebook for genetics – evolving over time into the most ambitious genetic research project ever undertaken. The first group of people who Bobe is keen to hear from is those who have reason

The plan is to recruit up to a million people from the population, find the superheroes among them, and figure out how they got their powers

to believe they are a superhero and are resilient to disease. In some cases, they may have incredibly strong evidence for this.

"For example, we've found a guy who has a really strong family history of early-onset Alzheimer's disease, which is typically fatal within 10 years. He's had a dozen family members die of this disease, which only takes one mutation. He's almost 70 now and figured that he dodged that genetic bullet," explains Bobe. "So he joined a research study and, to his surprise, he discovered that he actually has the very same mutation that killed so many of his family. Then the question becomes

what's so special about this guy? How did he get lucky?"

Bobe is also keen to attract people who have no reason to believe they're superheroes, just regular genetic Joes with no strong family history of disease, but who are interested in finding out more about their genomes and getting involved in research.

Falling into the third category are those people who are affected by a serious Mendelian disease, because they're clearly not resilient.

"If you're actually suffering from the disease, there's still a role for you too," Bobe explains. "We would love to have the participation of people ►

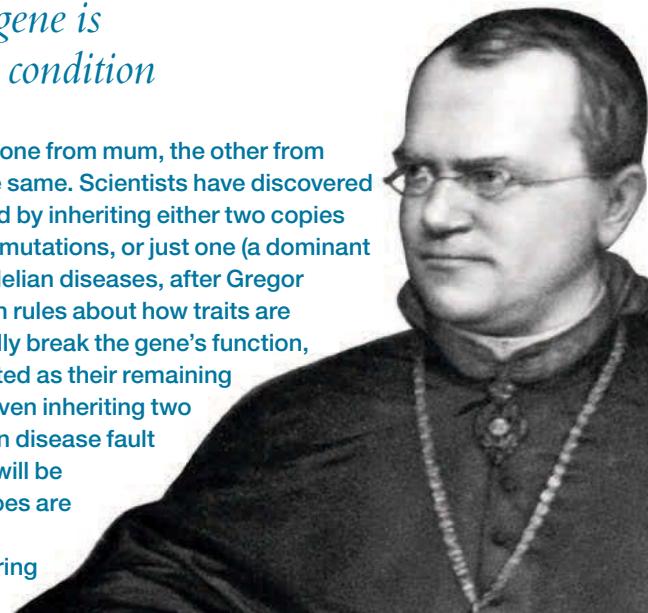
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MENDELIAN DISEASES

ONE GENE, ONE DISEASE?

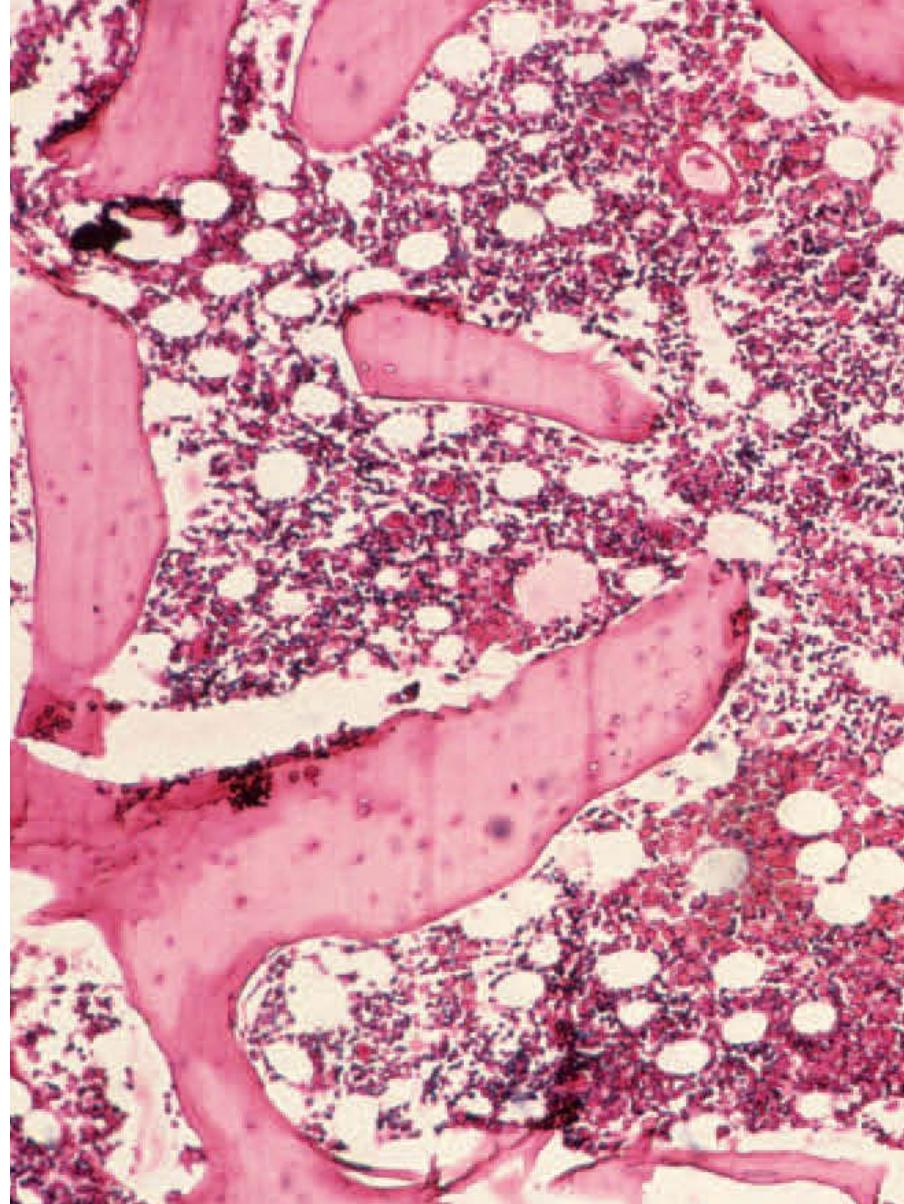
Just one copy of a faulty gene is enough to cause a genetic condition

We inherit two copies of every gene, one from mum, the other from dad, and they are not necessarily the same. Scientists have discovered hundreds of diseases that are caused by inheriting either two copies of a faulty gene, known as recessive mutations, or just one (a dominant mutation). These are known as Mendelian diseases, after Gregor Mendel (pictured) who first laid down rules about how traits are inherited. Recessive mutations usually break the gene's function, so people with one copy are unaffected as their remaining healthy gene can compensate. But even inheriting two recessive or one dominant Mendelian disease fault doesn't necessarily mean someone will be severely affected. Genetic superheroes are at the extreme end of this spectrum, carrying 'bad' gene faults but appearing to be healthy.



Below: Dr Cisca Wijmenga is leading the Dutch study into genetic superheroes.

Bottom: In this digital representation of the human genome, each colour represents one of the four chemical components of DNA.



"In the past, we had this kind of black-and-white idea about genetics but now there are all shades of grey"

dealing with and managing these diseases to serve sort of as a National Guard, so, when we do find somebody who is resilient to cystic fibrosis, we would love to call upon all those individuals with cystic fibrosis to serve as controls in the decoding."

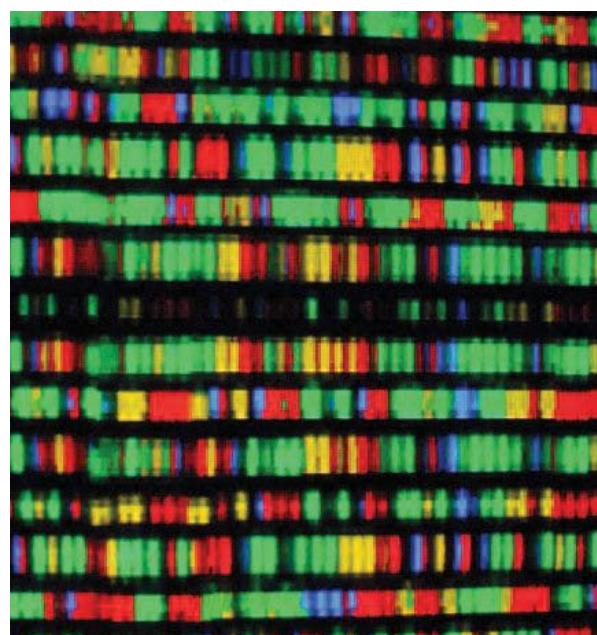
Deciphering the data

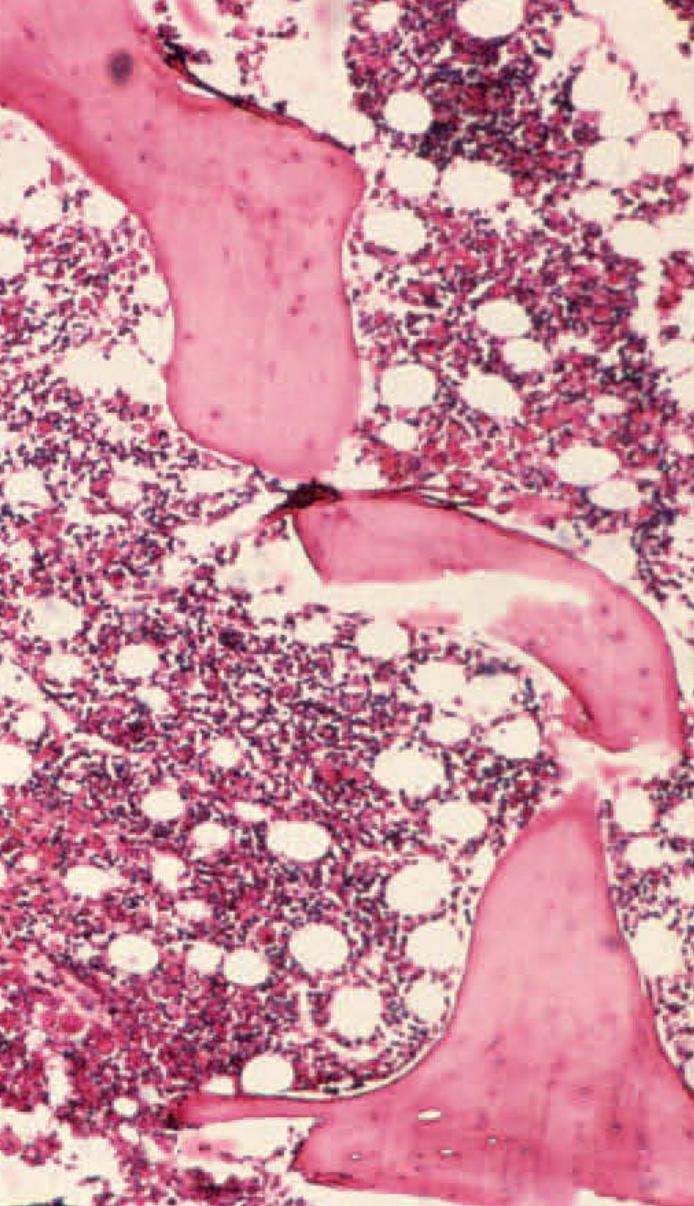
It's this part, the decoding, where things get really hard. As the previous studies have shown, superheroes are out there and are relatively easy to find. But the big challenge is working out

how they're doing it. Take the example of the man who dodged the Alzheimer's bullet.

"It's what I like to call a smoking airbag, the opposite of the smoking gun. This guy has had an airbag in his biology that has gone off and we need to find it, but it's looking for the needle in the haystack.

What other genetic or environmental factors in this guy's life have enabled him to escape this disease, where in every other case that we've seen it's been fatal,"





explains Bobe.

"Now that we have molecular tools like whole genome sequencing, we can generate a lot of data on this one person and try to identify the factor that's providing protection. Because, if we can identify something like a protective mutation that's actually fending off this heritable disease, then we can identify either preventive strategies or maybe develop new therapies."

The environment may also play a role in determining whether someone succumbs to the effects of a mutation or not. That could cover anything from a person's diet and lifestyle to the womb where they grew from a single cell into a baby. It's this aspect, that most excites Wijmenga.

"In the end there are still people

Above: Niemann-Pick disease causes a fatty substance called sphingomyelin to accumulate in the body, as seen in this bone marrow. Some individuals in the Dutch study had the genes for it, but are seemingly healthy.

running around with these mutations but still have no disease," she says.

"I think if we found out that this is environmental, then that's even better. If you can find out what those environmental factors are, you have much better ways to treat people with 'bad' genes. It is much harder to change your genetics than your environment."

Whether it's nature, nurture or a combination of the two, the existence of genetic superheroes tells us that strictly Mendelian ideas about one gene fault always leading to one disease are far too simplistic. Now we're starting to rifle through the genes of the fit and well, we're finding all kinds of surprises. For a start, we need to start viewing people who carry genes for 'pure' Mendelian diseases as existing along a spectrum, ranging from severely affected at one end to superheroes at the other. And, in fact, everyone's a bit mutant, carrying up to 40 'bad' gene faults.

As head of a clinical genetics department, Wijmenga finds this ambiguity challenging. "We're dealing on a daily basis with patients," she says. "We sequence their genome and find a mutation, and we have to predict what we think that means.

It's important that we have a much better understanding of our genome and when a mutation matters and when it doesn't. In the past we had this kind of black-and-white idea but now there are all shades of grey. It's an interesting time to be a geneticist, I would say!" ☺

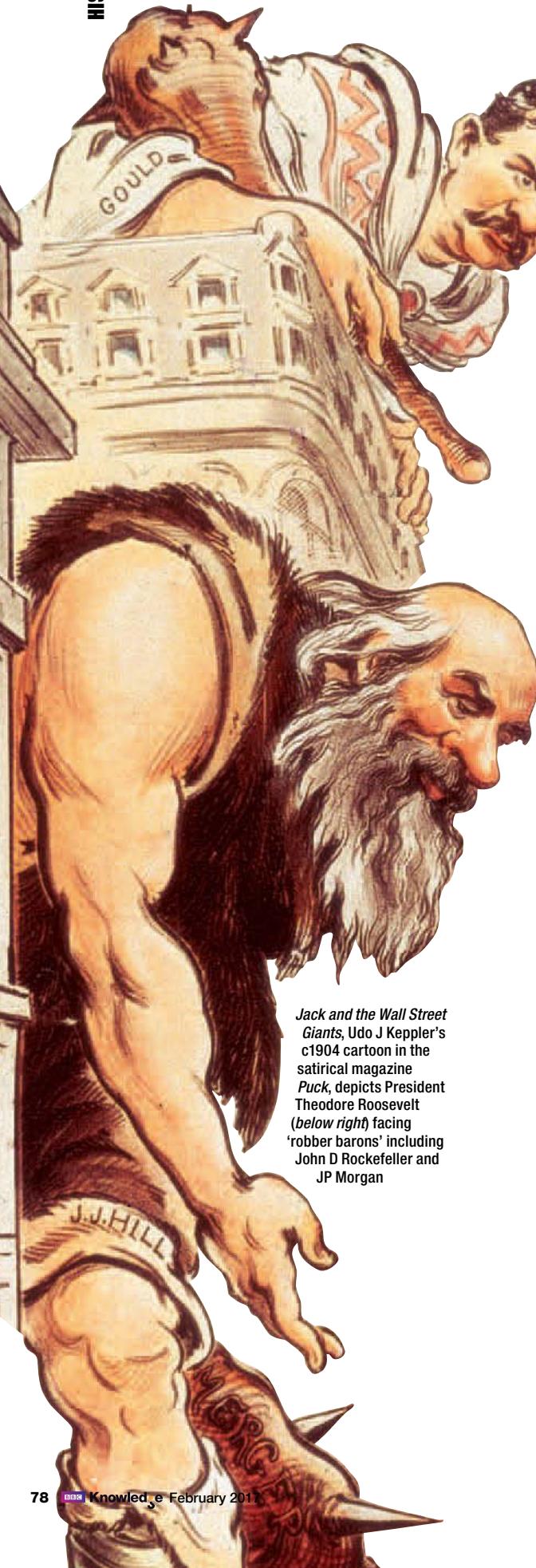
Kat Arney is a London-based science writer and broadcaster. Her first book, *Herding Hemingway's Cats: Understanding How Our Genes Work* (Bloomsbury Sigma) is out now.

HERO HUNT

ARE YOU A GENETIC SUPERHERO?

The Resilience Project was planned to begin its first phase of recruitment in autumn 2016. It will initially launch in the US, before expanding to other countries. It will take people through a short survey to assess their chances of being resilient to genetic diseases. Find out more and sign up for updates at resilienceproject.com





Jack and the Wall Street Giants, Udo J Keppler's c1904 cartoon in the satirical magazine *Puck*, depicts President Theodore Roosevelt (below right) facing 'robber barons' including John D Rockefeller and JP Morgan

Rise of the Robber Barons

Grasping monopolists or American heroes? **Adam IP Smith** tells the story of a new breed of ruthless businessmen who made fortunes from oil, steel and railroads in the second half of the 19th century

RAILWAY bosses were not supposed to order their own freight cars to be burned. But, in 1859, the superintendent of the western division of the Pennsylvania Railroad – a diminutive, barrel-chested 24-year-old Scotsman called Andrew Carnegie – did exactly that. From a business point of view, Carnegie's logic was impeccable, if unconventional: a derailed train was blocking the line, and it would be quicker and cheaper to destroy it than to haul it to the nearest depot. Keeping the network moving, Carnegie realised, was the highest priority.

The metaphor is irresistible: Andrew Carnegie, on his way to becoming one of the richest men the world has ever known, ruthlessly destroying anything that stood in his way.

In February of the same year, *The New York Times* used a sinister simile to attack Cornelius Vanderbilt – a man born in the 18th century, when travel times were limited to the speed of the fastest horse, but who went on to dominate the early development of both steam ships and railroads.

To Carnegie's ambitious generation, the venerable Vanderbilt – or

'the Commodore', as he was known – was the man who showed what could be done if you disregarded old rules and made your own. In the 1850s, Vanderbilt was engaged in fierce competition to control the lucrative sea route to California via Central America. At one stage, his rivals paid him a subsidy in exchange for him suspending his line.

To the *Times*, though, Vanderbilt's behaviour was literally robbery. He resembled "those old German barons who, from their eyries along the Rhine, swooped down upon the commerce of the noble river and wrung tribute from every passenger that floated by." The label 'robber baron' was born in that angry



editorial; 20 years later, it was in wide circulation as withering shorthand for the handful of men who dominated business in what Mark Twain dubbed “the Gilded Age.”

In the wake of the American Civil War, with the nation reunited on the back of the abolition of slavery, these so-called robber barons – generally identified as Vanderbilt, Carnegie, John D Rockefeller and a handful of other hard-nosed and hugely successful businessmen of that era – profited from one of the most profound revolutions in the human experience: the transition from a society in which most people were either self-employed or in some form of unfree labour, to one in which most worked for wages.

Bigger is better

One thing they all had in common was that they made their money from the relentless logic of the economies of scale. By driving out competition, controlling the supply and distribution chains, and keeping wages as low as possible, the robber barons ruthlessly cut costs. They forged their path in the business world at a time when new technologies – steel, oil refining, railroads and steam-powered factory technology – were remaking the material basis of the western world. They were the exploiters, not the inventors: men who took small-scale operations and scaled them up, and then up again.

Size was everything. As John D Rockefeller realised, one big oil refinery was vastly more efficient than 20 small ones. Similarly, as Jay Gould and Leland Stanford were to demonstrate, big railways with no competition could move more freight and charge higher rates than a bunch of small railroads competing for the same traffic.

The robber barons created the world's first large-scale corporations – impersonal organisations that, with the aid of bankers such as JP Morgan, could raise undreamed-of capital from financial markets. When Morgan bought Carnegie's steel business in 1901, he paid the equivalent of US\$370bn in today's money. Rockefeller's Standard Oil totally dominated the world's production, refinement and distribution of oil.

By 1890, railroads employed around three per cent of the entire national workforce, or 800,000 men – many times more than worked for the government or served in the armed forces.

The personification of these otherwise impersonal organisations, the robber barons were, among other things, literally cartoon characters. Their names and faces became familiar to millions through the pages of satirical illustrated magazines such as *Puck* in which the titans of industry were drawn as crooked hucksters carving up the country, or as obscene octopuses strangling the populace. The cartoons fed into a mass movement to defend the principle of government of, for and by the people against the monopolists who had stolen the American dream.

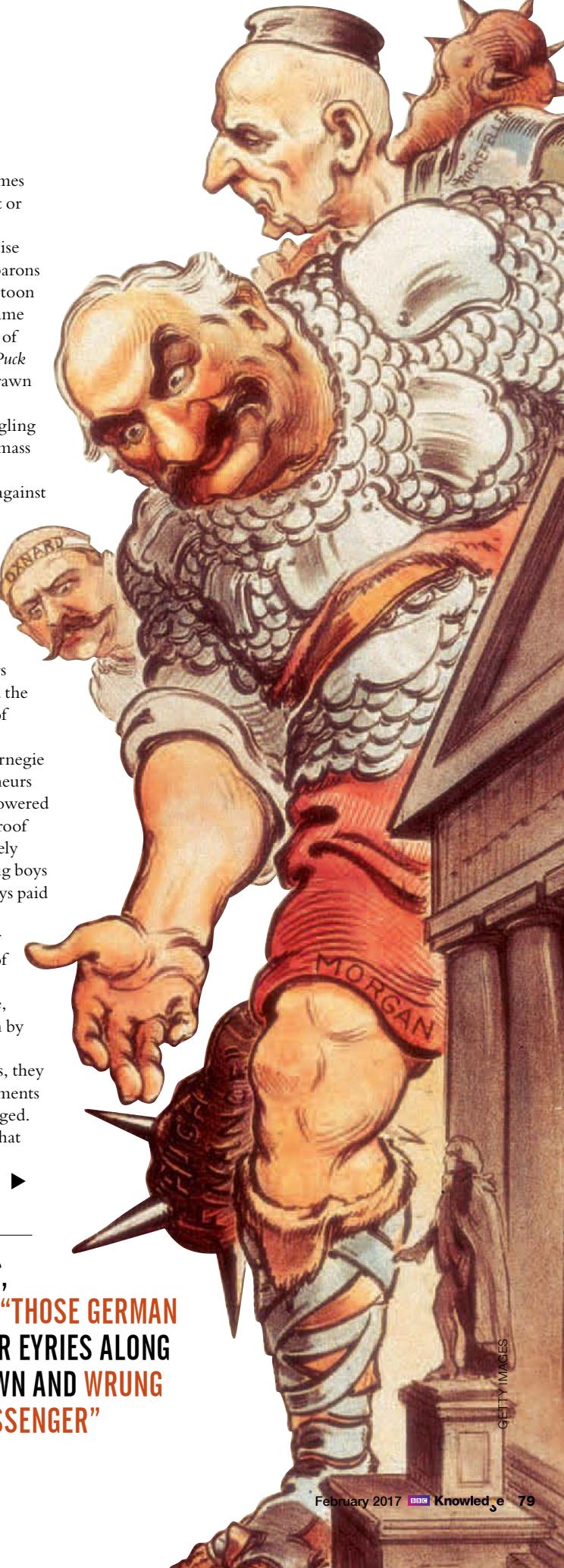
Ida Tarbell, a feisty journalist whose father's oil-producing business in western Pennsylvania had been ruined by Rockefeller, was the most acerbic of the critics. Tarbell and her millions of sympathetic readers were fighting, they thought, to defend the dying ideal of an egalitarian republic of small-scale farmers and artisans.

For others, however, the likes of Carnegie and Rockefeller were heroic entrepreneurs who were making America a steam-powered superpower. They were the real-life proof of the moral wisdom of those immensely popular Horatio Alger stories for young boys in which, in America, hard work always paid off and the poor could rise up.

Critics and fans alike saw the robber barons, for good or ill, as the masters of this new world. But these men did not always see it that way at all. They were, by their own accounts, driven as much by anxiety as optimism. Neither Horatio Alger's heroes nor Ida Tarbell's villains, they saw themselves as the necessary instruments by which the economy could be managed.

Rockefeller and Carnegie claimed that they were motivated not by personal ambition but by public-spiritedness. ►

**ACCORDING TO THE TIMES,
VANDERBILT RESEMBLED “THOSE GERMAN
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THE RHINE, SWOOPED DOWN AND WRUNG
TRIBUTE FROM EVERY PASSENGER”**



Three titans of big business



THE FIRST OF THE BARONS

Cornelius Vanderbilt 1794–1877

Wealth: At his death, Vanderbilt's fortune was estimated to be around US\$100m which, as a share of US GDP at the time, makes him perhaps the second-wealthiest American in history, after only John D Rockefeller.

How he made his money: Shipping, then railroads. Vanderbilt began work as a ferryman in New York City harbour, soon working his way into a partnership with the operator of a state-of-the-art steamboat. By the 1850s, he ran a transatlantic passenger line and was competing hard, using every trick in the book to dominate the lucrative transport route to California. (At that time by far the cheapest and quickest way to the goldfields was to take a ship from New York to Panama or Nicaragua, make an overland crossing from the east coast to the west, then embark again for the sea journey up the North American Pacific coast.) After 1860, Vanderbilt sold his shipping interests and invested in railroads instead. He spent the final 10 years of his life building up the New York Central, the principal route from New York City to Chicago.

How he spent it: Establishing one of his sons as his heir. Not one of the great philanthropists, he nevertheless endowed Vanderbilt University in Tennessee.

Legacy: Vanderbilt was the first of the so-called 'robber barons'.

THE TOUGH PHILANTHROPIST

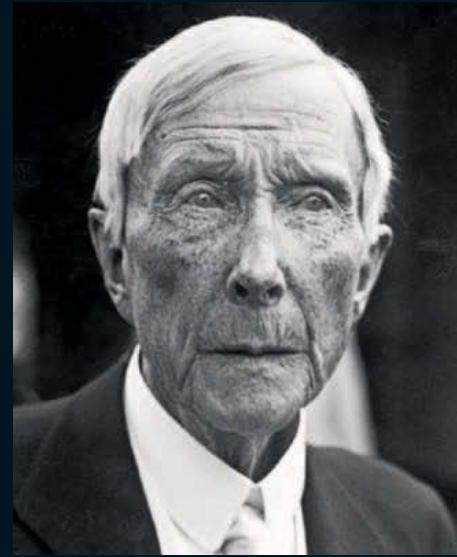
Andrew Carnegie 1835–1919

Wealth: He sold Carnegie Steel for US\$480m – if calculated as a share of GDP today, at least US\$370bn.

How he made his money: Steel. Carnegie was born in Fife into a family of struggling weavers who emigrated to western Pennsylvania in search of a better life when young Andrew was 13. He worked his way up from telegraph messenger boy to a senior position in the Pennsylvania Railroad, thanks to the patronage of railroad president Tom Scott. Avoiding service in the Civil War by paying for a substitute to fight in his place, Carnegie made his mark, and the basis of his fortune, by investing in steel companies. His innovation was to find ways of using new processes and technologies to produce steel more cheaply and in vastly greater quantities than ever before. Driving out competition and buying out all his suppliers, Carnegie's companies provided, among other things, the rails that crisscrossed America in the late 19th century.

How he spent it: He gave away 95 per cent of his fortune in his lifetime, endowing libraries, universities and concert halls, and campaigning for international peace.

Legacy: He was culpable for vicious labour relations, but was also a great philanthropist.



THE OIL BILLIONAIRE

John D Rockefeller 1839–1937

Wealth: The world's first dollar billionaire, his fortune at the time of his death was estimated to be around US\$1.4bn, making him by far the richest man in the country, then or since.

How he made his money: Oil. The son of a bigamist father and a devout mother, from a young age, Rockefeller had a steely determination to make money. Like Carnegie, he avoided military service in the Civil War, going into partnership to build his first oil refinery in 1863. In the 1870s he built a near-monopoly, squeezing out the competition and agreeing exclusive discounts with railroads to transport his products. He was a great practitioner of vertical integration, bringing every element of the supply train, from western Pennsylvania oil drillers to distributors and retailers, into his business empire. His Standard Oil was the first 'trust', a new kind of vast corporate entity that contained, in this case, 41 other corporations. At its height, Standard Oil controlled 95 per cent of the oil business in the US.

How he spent it: Creating foundations supporting education and science.

Legacy: He was an innovator in corporate structure – the great monopolist.

Andrew Carnegie, who latterly gave away some US\$350m of his fortune

The two were hardly soulmates (Carnegie got a kick out of giving an annual Christmas present of fine Scotch whisky to the teetotal Rockefeller) but they each developed a theory of capitalism according to which the vast organisations they built were the necessary means of managing the hellishly disruptive forces unleashed by industrialisation.

Their companies, they argued, reduced inefficiency and wasteful over-production. Where there was chaos, they brought order; where there was strife, they brought harmony. This was a breathtaking inversion of how many saw them, but it was repeated with conviction, and it drew on a coherent and, to them, self-evidently true narrative of their careers.

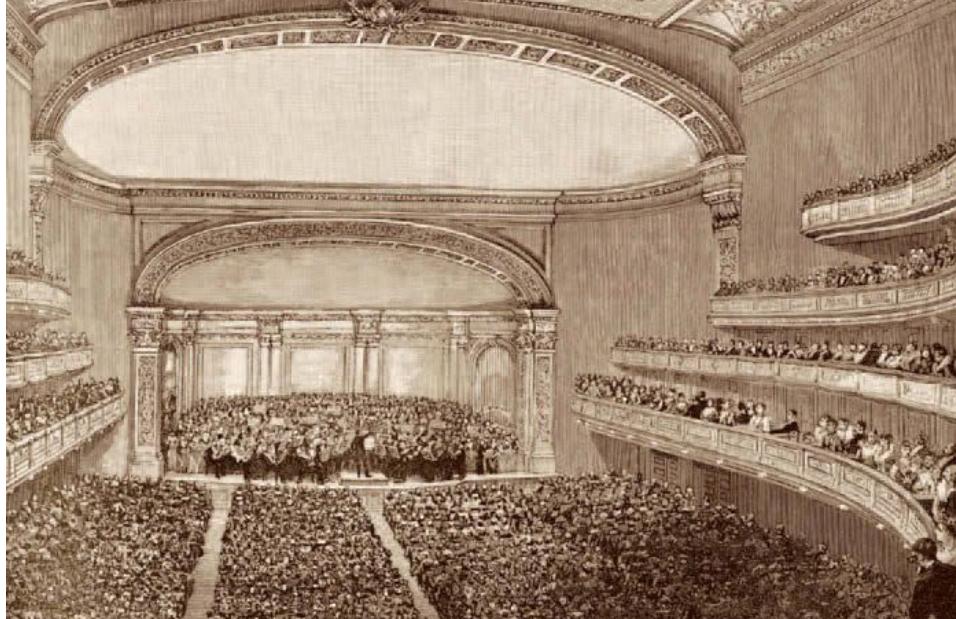
A prime example concerns how Rockefeller understood the crucial turning point in his business career. This occurred in the early 1870s, at a time of falling prices in the nascent oil-refining business, when he leveraged a freight deal with a railroad to compel his competitors in Cleveland to sell out to him. Charged with behaving aggressively and dishonestly, Rockefeller responded that his company was an “angel of mercy.” Standard Oil, he later claimed, was “the Moses who delivered [his benighted competitors] from their folly which had wrought such havoc in their fortunes.”

Carnegie adopted a similar business strategy and, in essence, a similar rationale when he moved from railroads into steel, combining investment in new technologies with using every trick in the book to eliminate rivals.

The curse of bigness

At the heart of the problem – as their critics saw it – was the sheer scale of the robber barons’ enterprises. It was ‘the curse of bigness’ that gave these men the giddy power they had. But the robber barons’ riposte was that the new economy required central planning. “The day of combination is here to stay,” Rockefeller assured an interviewer in the 1920s, as Europe experimented with different types of state planning. “Individualism is gone, never to return.”

It was a sentiment echoed by New Deal planners when, in response to the



New York's Carnegie Hall is packed to the rafters on its opening night in 1891. The world-famous concert hall was funded by the magnate who gave it its name, Andrew Carnegie

CARNEGIE HAD A GREAT DESIRE FOR PUBLIC ADULATION AND A HUGE DETERMINATION TO PRESENT HIMSELF AS ACTING ALWAYS IN THE PUBLIC INTEREST

Great Depression, they abandoned decades of anti-monopoly politics. In its place, they sought ways of centrally managing a capitalist system in which no one imagined a return to 19th-century levels of growth.

Carnegie had a greater desire for public adulation than Rockefeller ever seemed to require, but a similar determination to present himself as acting always in the public interest. After he sold his business, Carnegie moved into a newly-built mansion in Manhattan (complete with an elevator and a prototype air-conditioning system) and wrote tracts in a library with Sunday school-type mottoes painted high on the walls. Gazing up from his desk at the injunction that ‘Thine Own Reproach Alone Do Fear’, Carnegie worried about the contrast between “the palace of the millionaire and the cottage of the laborer.”

To combat the dangers of “rigid castes” living in “mutual ignorance” and “mutual distrust” of each other, he poured millions of dollars into building public libraries – more than 2,500 of them around the world. This munificence was possible because of the vast business he had created and was therefore, to him, evidence that great concentrations of wealth could (at least

in the right hands, such as his own) bring about a great dispersion of public benefit.

A disappearing world

Contrary to the way they are often imagined, the robber barons were, in fact, the champions neither of unfettered free markets nor of unfettered individualism. Paternalists more than libertarians, they saw rational central planning as the antidote to the insecurity and irrationality of market competition. Hailed for their role in the onrush of modernity, they harked back to the virtues of a disappearing world and worried about the spiritual and social consequences of the gulf between rich and poor to which they had contributed so much. Their material success assured, the robber barons sought something more: validation that their work was of public worth.

These larger-than-life industrialists had an all-too-human capacity for self-deception, and it is easy – and not entirely unfair – to charge them with hypocrisy. But that does not mean we should not take seriously their own rationalisations. The words of these robber barons reveal much about how these powerful men made the choices that helped shape our world. ☐

Adam IP Smith is a senior lecturer at University College London in the UK, specialising in American history.





Game of Queens

For more than 100 years from the late 15th century, women held positions of power in Europe. **Sarah Gristwood** traces the intricate network of interrelated queens and regents

ILLUSTRATIONS BY DAVIDE BONAZZI

AFTER her accession ceremony on 13 December, 1474, Isabella of Castile rode through the streets of Segovia – behind a horseman holding a naked sword. Even her husband, Ferdinand of Aragon, was shocked, protesting that he had never before heard of a queen “who usurped this masculine attribute.” But Isabella’s reign ushered in an explosion of female rule, unequalled until our own day. In the 16th century, England, Scotland, France, the Netherlands, Spain, Portugal and Hungary all came at one time or another to be controlled by a woman, whether as regent or queen regnant.

These rulers were linked by a complex web of mothers and daughters, mentors and

protégés. Lessons were passed from Isabella of Castile to her daughter Catherine of Aragon and thence Mary I, and from the French regent Anne de Beaujeu to Louise of Savoy, through Louise’s daughter Marguerite of Navarre to her daughter Jeanne d’Albret, to Marguerite’s admirer Anne Boleyn and thus to Elizabeth I.

Their experiences are echoed today. Headlines about Angela Merkel, Theresa May, Nicola Sturgeon and Hillary Clinton emphasise a powerful woman’s looks and likeability; the problem of gendered abuse, of seeming tough enough for high office without being dubbed unfeminine; the question of whether female leaders will relate to each other, and exercise

their power, in a specifically female way.

The age of queens did not outlast the 16th century. Women had found themselves at the forefront of the great religious divides that tore Europe apart, but those divisions meant that, though Anne Boleyn could be educated in two foreign countries, her daughter Elizabeth never set foot out of her own land.

Overleaf we introduce 10 key female figures who dominated 16th-century Europe, and explore the relationships that linked them. ►

Sarah Gristwood is the author of *Game of Queens: The Women Who Made Sixteenth-Century Europe* (Oneworld, 2016).

The power grid

A web of family and influence linked top noblewomen

Isabella I of Castile (1451–1504)

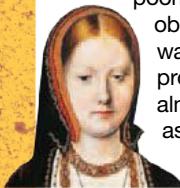
Before she even took the throne, Isabella broke with tradition by arranging her own **marriage to Ferdinand of Aragon, uniting the two main Spanish kingdoms**. They ruled together as the mighty Catholic Monarchs, famous for their expulsion of the Moors and Jews, for establishing the Inquisition in Spain, and for their sponsorship of Christopher Columbus. Ferdinand and Isabella produced only one short-lived son but several influential daughters – among them Catherine of Aragon who, in 1509, married England's king Henry VIII.



DAUGHTER-IN-LAW

Catherine of Aragon (1485 – 1536)

Catherine was defined by Spanish heritage. **Henry VII of England sought the valuable Spanish alliance** by wedding her to his eldest son, Arthur; after Arthur's early death, she married his younger brother, Henry VIII. As regent in 1513, "in imitation of her mother Isabella", she rallied English troops to resist a Scottish assault. But, as daughter to a successful queen regnant, she was poorly placed to understand her husband's obsessive desire for a son. When her marriage was rent by Henry's infatuation with her former protégé Anne Boleyn, Catherine still, after almost 30 years in England, described herself as a stranger in the land, appealing for help to her former sister-in-law Margaret of Austria.



DAUGHTER

SISTERS-IN-LAW

PROTÉGÉ

Mary I (1516 – 58)

Catherine of Aragon inculcated in her daughter Mary her own belief in the validity of her marriage to Henry VIII, and her own resolute Catholicism. "We never come unto the kingdom of Heaven but by troubles," she assured her daughter. **Mary's determined resistance to her father's religious reforms** was attributed to her "unbridled Spanish blood." She endured years of real hardship before, in 1553, the death of her younger brother Edward (and a passage of armed resistance reminiscent of her female forebears) brought her to the throne. Once on it, as observers noted, she always favoured Spain and promoted her mother's religion. She married Philip of Spain and her efforts to restore the Catholic faith, involving the persecution of Protestants, earned her the sobriquet 'Bloody Mary'.

STEPDAUGHTER

HALF-SISTERS

Margaret of Austria (1480 – 1530)

The child of Mary of Burgundy (ruling duchess of what would later be known as the Netherlands) and future Holy Roman Emperor Maximilian, Margaret was, while still a toddler, contracted to the French king-to-be Charles VIII. When that alliance fell through, she married Juan, heir of Isabella and Ferdinand, and then, after his early death, the Duke of Savoy. After he died she returned to the Netherlands where, for many years **she ruled as regent on behalf of her nephew, the future emperor Charles V**. She raised four of his sisters, all of whom became queens consort – of France, Portugal, Denmark and Hungary. Mary of Hungary succeeded her aunt as regent of the Netherlands and raised another generation of influential nieces. Though Margaret of Austria never bore a living child, she has been called the *Grand Mère* – 'Great Mother' – of Europe.



PROTÉGÉ

Anne Boleyn (c1501 – 36)

In 1513, Anne came to the court of Margaret of Austria as one of her maids, before spending seven years at the French court. **This continental education gave her a glamour that made her a star when she returned to England**. But it also gave her the opportunity to witness the religious reforms promoted by Marguerite of Navarre, and to see women exercising power in a way still unfamiliar in England. Before her marriage to Henry, Anne – as an active promoter of French interests – was seen as a useful alternative to the Habsburg Catherine. But, a few years later, when a Habsburg alliance was desirable, that French identification contributed to her fall.



DAUGHTER



PROTEGE

Anne de Beaujeu (aka Anne of France, 1461 – 1522)

Eldest daughter of the French king Louis XI, Anne was widely noted as a woman of great ability. The Salic Law, however, prohibited her from acceding to the throne. Instead, on Louis's death she acted as regent in all but name during the minority of her younger brother Charles VIII. Anne wrote an advice manual for noblewomen, *Enseignements [Lessons for my Daughter]* that has been compared to Machiavelli's *The Prince*. "When it comes to the government of their lands and affairs, [widows] must depend only on themselves; when it comes to sovereignty, they must not cede power to anyone," was one of her maxims. Anne was in charge of the upbringings of Margaret of Austria during her marriage to Charles VIII, and of Louise of Savoy.

CHILDHOOD FRIENDS

PROTÉGÉ

Louise of Savoy (1476–1531)

Louise's status rose steadily as several French kings in succession died without heir until the closest in line to the throne was François, her son by the Count d'Angoulême. After François I became king in 1515, Louise was widely regarded as the power behind his throne. In 1529, she sat down with Margaret of Austria (her childhood playmate when they were both raised in Anne de Beaujeu's care) to negotiate the so-called 'Ladies' Peace' of Cambrai. Neither Louise's son François nor Margaret's nephew Charles could compromise their dignity by being the first to talk of reconciliation, but, Margaret wrote: "How easy for ladies... to concur in some endeavours for warding off the general ruin of Christendom, and to make the first advance in such an undertaking!"

DAUGHTER

PROTÉGÉ

Elizabeth I (1533–1603)

Thanks in part to her long reign, Anne Boleyn's daughter is remembered by many as England's greatest monarch. She represents the apogee of an age of queens – which, however, was perhaps already waning before her death. Elizabeth might be seen as exemplifying many of the maxims laid down for powerful women at the beginning of the 16th century by the French regent Anne de Beaujeu (above). Elizabeth's motto was *Video et taceo* – I see but say nothing. "Have eyes to

notice everything yet to see nothing, ears to hear everything yet to know nothing," Anne de Beaujeu had urged.

Elizabeth corresponded with Jeanne d'Albret, Catherine de Medici and the influential Ottoman consort Safiye. But the religious divisions of the Reformation denied her the easy contact with other women across the continent that had been enjoyed by earlier generations, and fostered her long rivalry with her Catholic kinswoman Mary, Queen of Scots.



Marguerite of Navarre (aka Marguerite d'Angoulême, 1492 – 1549)

Louise of Savoy's daughter Marguerite was also in Cambrai when the 'Ladies' Peace' was negotiated. Louise, François and Marguerite were so close that they were known as 'the trinity'; neither of Marguerite's two marriages (to the Duc d'Alençon and to Henri II of Navarre) impeded her devotion to her brother, nor her sway over his court. Author of the book of short stories known as the

Heptaméron, Marguerite was an intellectual leader among the great ladies who sought to reform the Catholic church. The number of ideas, books and contacts they had in common suggests that Marguerite became a role model for Anne Boleyn during the latter's years in France. Anne would later send word to Marguerite that her "greatest wish, next to having a son, was to see you again."



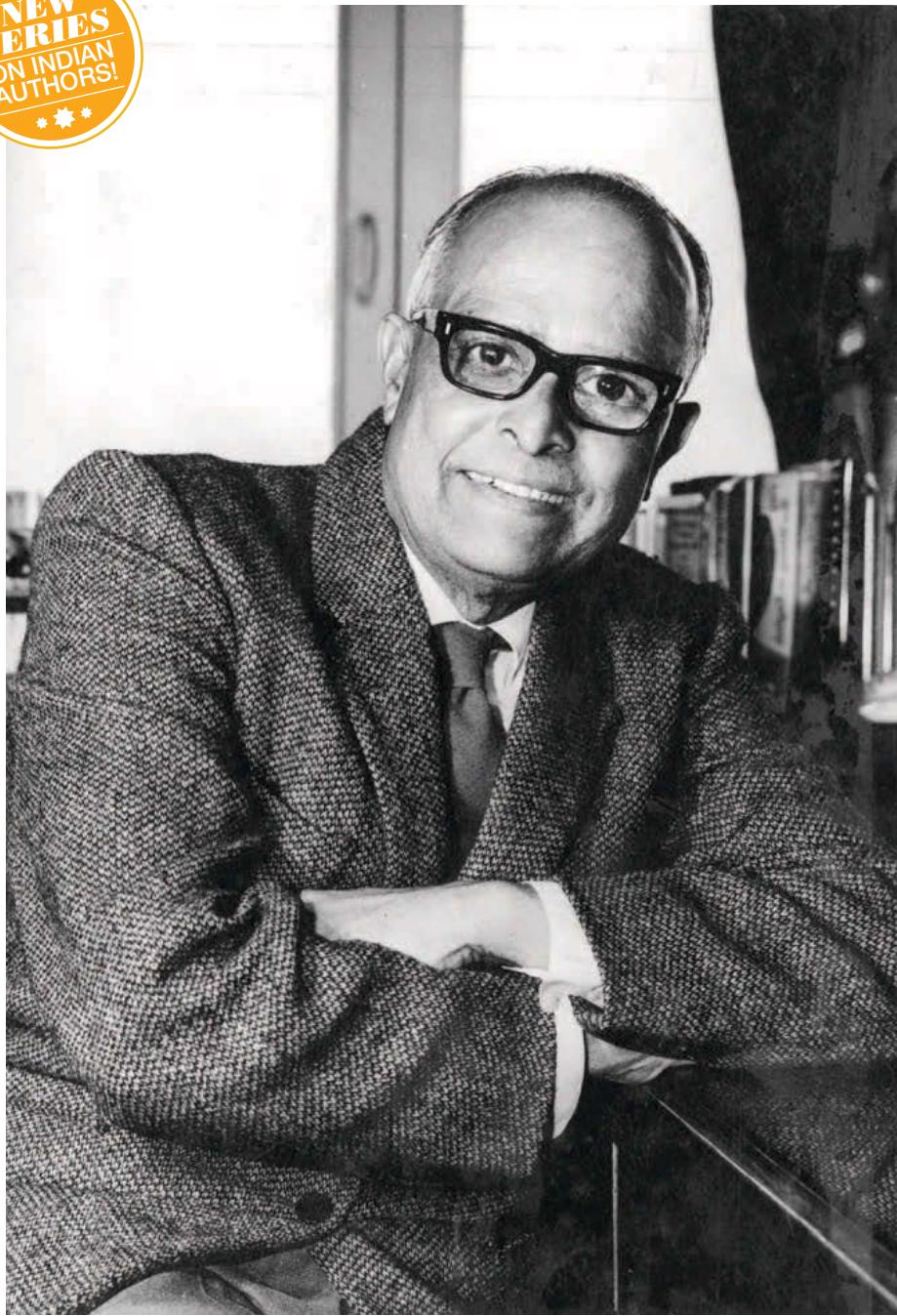
Jeanne d'Albret (1528 – 72)

In 1555, Marguerite's daughter Jeanne inherited her father's Navarrese kingdom. Reared in her mother's reforming tradition, in 1560, she publicly converted to the Protestant faith, joining France's Huguenot rebels inside the besieged fortress of La Rochelle, she became a heroine of the Reformation.

When summoned to appear before the Inquisition, Jeanne was saved by the intervention of Catherine de Medici, even though the latter was on the other side of the religious divide. Catherine tried to promote religious tolerance, but the marriage of her daughter Marguerite to Jeanne's son Henri in 1572 provoked the slaughter of Huguenots known as the Bartholomew's Day Massacre (pictured below). "You cannot govern too wisely with kindness and diffidence," Anne de Beaujeu had said – the final bitter 'Lesson' with which her daughters were to end the century. ☺



R. K. NARAYAN



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**Author and historian
Urvashi Butalia
tells of the life
and words of one
of India's most-
beloved writers**

RASIPURAM Krishnaswami Iyer Narayanswami is not a name that is particularly well known in the literary world. Yet it belongs to one of India's best known writers, more commonly known as R.K. Narayan, the creator of Malgudi, a fictional South Indian town that has endeared itself to thousands of readers across the world. In Malgudi, the stories are simple: children play, they go to school, marriages are arranged, there's a boy called Swami, there are man-eating tigers and much more. But the simplicity, a mark of all major writers, is deceptive, for Malgudi is a mirror of life, its little stories filled with wisdom, compassion and humour.

Narayan is best known for the creation of Malgudi, which featured in many of his writings, and although his *oeuvre* of novels, short stories, essays and more was quite formidable, somehow Malgudi and its characters were so precious to young and old alike that the stories continue to be read and reread.

The son of a school headmaster in Chennai (then Madras), Narayan studied for some years at his father's school. Because his father had to travel for his job, it was Narayan's grandmother who looked after him. At her home, he made friends with a peacock and a monkey! From his grandmother, the young Narayan learned Sanskrit and music, as also arithmetic and mythology.

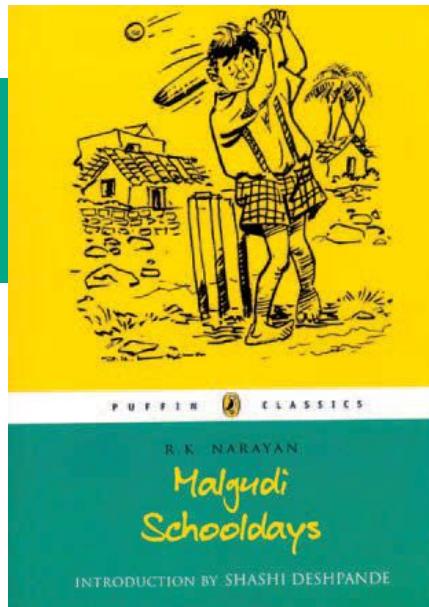
As a young man, he loved to read,

devouring the books he found at home and, later, when the family moved to Mysore, accessing the extensive library in the Maharajah's College High School where he studied. Soon, he began to write – initially short journalistic pieces, mostly for English papers and magazines. Interestingly, after he finished at school, Narayan did not succeed in making it through the university entrance examination and decided to stay at home for a year to read and write. His family supported his decision, and it was during this time that Narayan began the process of turning into the writer he eventually became.

Later, after once again attempting the university examination, and clearing it this time round, he joined university, although he took four years to complete his courses, rather than the usual three. Over a period of time, his conviction that writing was the career he wanted to pursue became stronger and, with his family's support, he began to move in that direction. In the first year of his writing, he earned a sum of nine rupees and 12 annas!

His first book, *Swami and Friends* (later to become a classic) was rejected by many publishers – an experience that is not uncommon for new writers. This book, and two subsequent ones, are said to be quite autobiographical, but Swami's singular contribution to the world of literature was the creation of Malgudi, which was to form the core of so many of his other works.

It was *Swami and Friends* also that was to introduce Narayan to Graham Greene, the master storyteller. The story goes that a friend of Narayan's sent the manuscript of *Swami and Friends* to Graham Greene, and Greene was so impressed with the book that he suggested it to his own publisher and the book was then published in 1935. Greene continued to help Narayan with his books, finding him publishers in England who took them up and, in this way, encouraged him to write. It was also Greene who is believed to have suggested that



Narayan shorten his name to become more accessible to English readers, particularly those in England.

In 1933, Narayan went to Coimbatore to visit his sister and for a short vacation. There, he met a young woman called Rajam, and fell in love with her. Rajam was only 15, but Narayan managed to secure her father's permission and married her. The marriage was short-lived, though; a mere six years later, in 1939, Rajam died of typhoid, leaving Narayan devastated and deeply depressed. His books written at the time – in particular *The English Teacher* but also *The Bachelor of Arts* – are quite autobiographical and reflect what he was going through as a result of his wife's death.

Even as he wrote novels, Narayan's journalistic career continued alongside. Shortly after he married Rajam, he took up a job as a reporter for a Madras-based paper called *The Justice*, which brought him in contact with a wide range of people. Later, he also worked for the Government of Mysore and also tried to set up a journal, which he gave up very soon as it became clear that it was not going to work.

Literary success did not come easily. While Narayan's books were appreciated, they did not make waves and he did not make much money. *Malgudi Days*, his first collection of short stories, was published in 1942. Over time, with Greene's help in getting publishers abroad, Narayan began to become known internationally and to gradually acquire an international readership. The war impacted his life as

it did that of many writers and, during that time, he lost the connection with England. At home, he started his own publishing company, Indian Thought Publications, which became well known. Once money began to come in, Narayan was able to build himself a house in Mysore.

Away from the autobiographical

The same year that he built the house, 1953, his books were published in the United States. He now also began to travel to promote his books, to write journalistic pieces and it was during one of his trips to the United States that he began to write a book, *Guide*, that was to become a sort of classic and was later made into a film starring Dev Anand and Waheeda Rehman. The story of love between a guide and a lonely and unhappily married woman tourist touched the hearts of thousands of people and the book acquired, as books often do, a new life through the film.

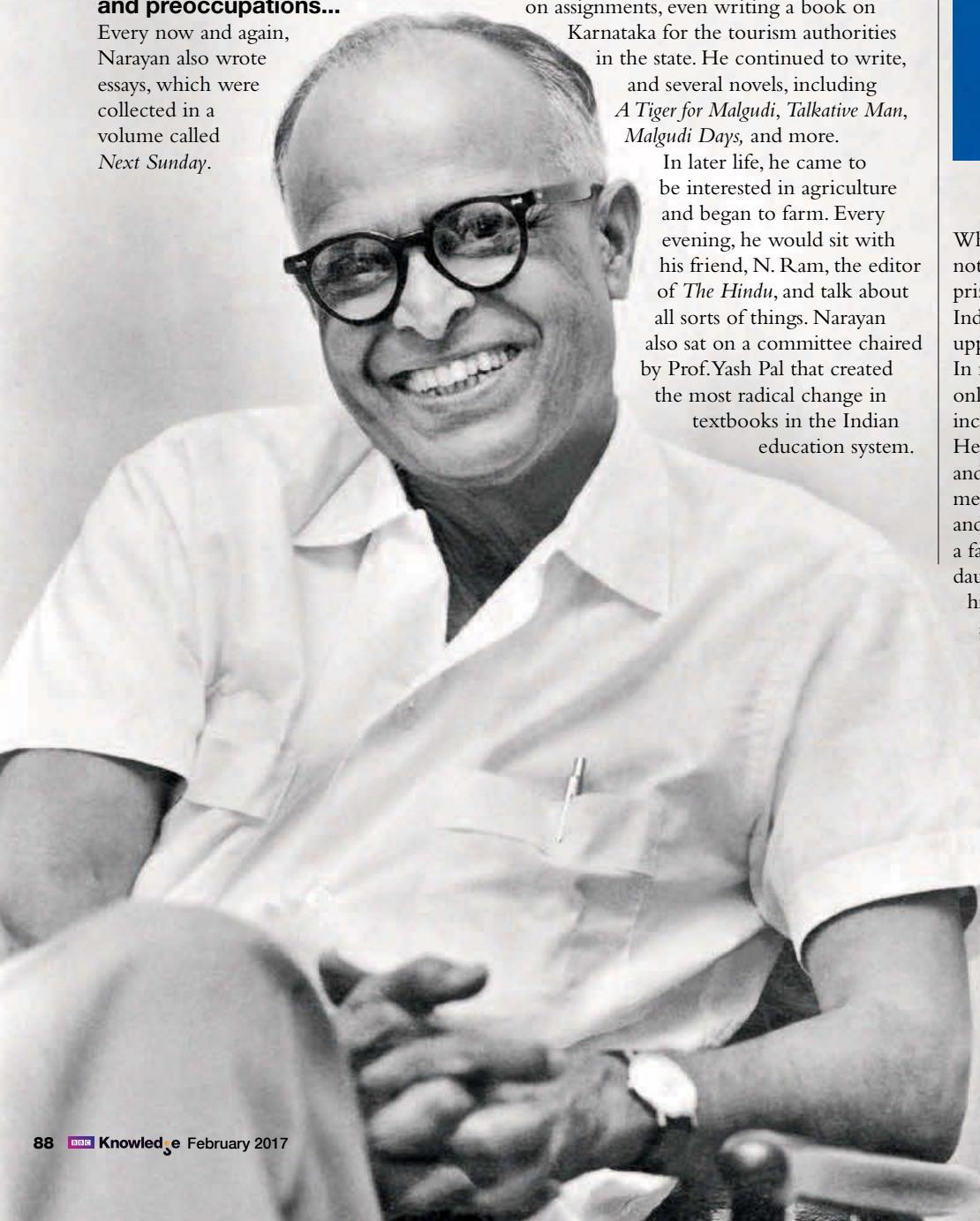
It was at this point in his life that Narayan began to move away from the autobiographical and wrote some books that focused on human relationships, in particular, on domestic discord within marriage, but his canvas also grew wider, with politics and political figures entering his work. *Waiting for the Mahatma*, for example, ►

*"His first book, *Swami and Friends* (later to become a classic) was rejected by many publishers – an experience that is not uncommon for new writers"*

bases itself on an imagined visit to Malgudi by Gandhi. A fairly traditional man himself (his daughter had a marriage arranged by him, and his own marriage, though a love marriage, was complete with all the rites and rituals of a traditional ceremony), he wrote about the horoscope matching that happens in Hindu marriages. *The Financial Export*, considered one of his best works, focuses on the life of Margayya, a real-life character who was supposed to be a financial expert. Yet, although his works began to focus on wider social realities, their focus still remains small and individual, something that increasingly became Narayan's strength.

And on to other writings and preoccupations...

Every now and again, Narayan also wrote essays, which were collected in a volume called *Next Sunday*.

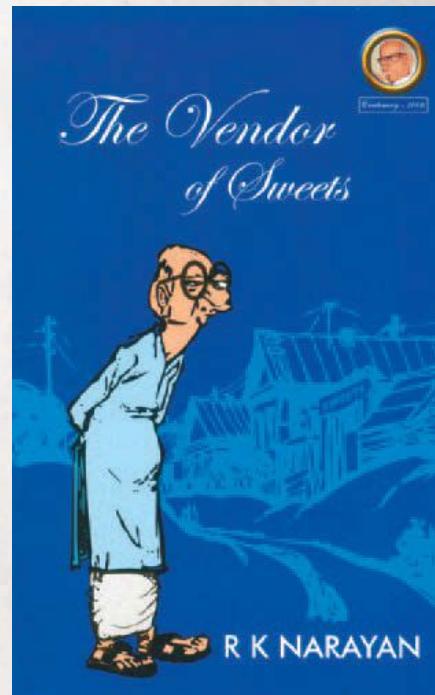


Around the 1960s, he began once again to travel, and went to the USA and Australia where he lectured on Indian literature. And he expanded his body of writing, doing long pieces also for *The Hindu* and literary magazines overseas. The early teachings on mythology, given by his grandmother, stood him in good stead when he published *Gods, Demons and Others*, a collection of stories on the Hindu epics.

Narayan had an equally famous brother, R.K. Laxman, the cartoonist. The two often worked together with one illustrating the other's work. Other novels came – *The Vendor of Sweets*, *The Painter of Signs*, and translations of the *Kamba Ramayana* and, later, the *Mahabharata*. He continued to take on assignments, even writing a book on

Karnataka for the tourism authorities in the state. He continued to write, and several novels, including *A Tiger for Malgudi*, *Talkative Man*, *Malgudi Days*, and more.

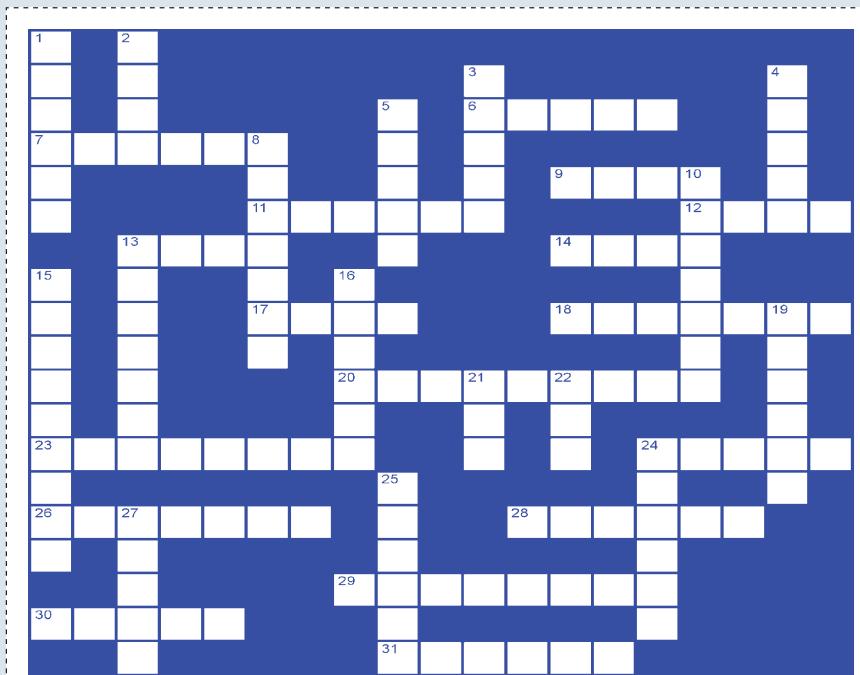
In later life, he came to be interested in agriculture and began to farm. Every evening, he would sit with his friend, N. Ram, the editor of *The Hindu*, and talk about all sorts of things. Narayan also sat on a committee chaired by Prof. Yash Pal that created the most radical change in textbooks in the Indian education system.



When the honours began coming, they did not stop. He received honorary degrees, prizes for his work, recognition from the Indian government, a nomination to the upper house of Parliament, the Rajya Sabha. In many ways, Narayan endeared himself not only to his readers, but to a range of people including politicians, editors, journalists. He was reclusive, living in his large house and writing there, he did not appear in the media much, nor attend literature festivals and other book events. Narayan was also a family man, and his daughter and grand daughter were important to him. It was his grand daughter, Minnie, who looked after him when he was ill. When he died on 13 May 2001, the sense of loss and tragedy was not limited to Mysore and Coimbatore but spread across the world. India had lost one of its most important writers, but Narayan's death was much more than a loss to India, it was a loss to the world. ☐

Urvashi Butalia is the director and co-founder of Kali Women, India's first feminist publishing house. A recipient of the Padma Shri award, she is a historian whose research focuses on the Partition and oral histories. Her book, *The Other Side of Silence*, collates the tales of the survivors of the Partition.

PUZZLE PIT



YOUR DETAILS

NAME:

AGE:

ADDRESS:

PINGORE

TCI

SCHOOL /INSTITUTION/OCCUPATION:

EMAIL:

MOBILE

How to enter for the crossword: Post your en-

CROSSWORD: Post your entries to BBC Knowledge Editorial, Crossword No.36 Worldwide Media, The Times of India Bldg, 4th floor, Dr Dadabhai Naoroji Road, Mumbai 400001 or email bbcknowledge@www.co.in by **10 February 2016**.

Entrants must supply their name, address and phone number.

How it's done: The puzzle already, will be familiar to crossword enthusiasts although the British style may be unusual as crossword grids vary in appearance from

country to country. Novices should note that the idea is to fill the white squares with letters to make words determined by the sometimes cryptic clues to the right. The numbers after each clue tell you how many letters are in the answer. All spellings are UK English. **Good luck!**

Terms and conditions: Only residents of India are eligible to participate. Employees of Bennett Coleman & Co. Ltd. are not eligible to participate. The winners will be selected in a lucky draw. The decision of the judges will be final.

CROSSWORD NO. 36

ACROSS

- 6** Popular open source operating system (5)

7 Software ___ : using unauthorized or illegal programs on your computer (6)

9 T in hard drive capacity unit TB (4)

11 The N in Android N (6)

12 iOS' major domo (4)

13 An online journal (4)

14 Google's social network (4)

17 High definition motion picture format (4)

18 The not so well known Steve of Apple (7)

20 City which plans to test Self-driven taxis in March 2017 (9)

23 Social network for people in professional occupations (8)

24 Country which recently started streaming court trials (5)

26 Microsoft's email client (7)

28 DVD successor (3-3)

29 Google's Virtual Reality platform (8)

30 One of the world's largest online distributors for PC games (5)

31 Information about you which a website may store on your computer (6)

1 Payment option on many websites (6)

2 Samsung's smartwatch (4)

3 IBM co-founder Charles Ranlett ___ (5)

4 ___ optic: Cable type commonly used in broadband (5)

5 Farmville developers (5)

8 First ever Tibetan search engine (7)

10 Julian ___ : Wikileaks founder (7)

13 Online currency introduced in 2008 (7)

15 High speed transportation system developed by SpaceX (9)

16 IBM's artificially intelligent computer system (6)

19 Online marketplace that enables people to list and rent vacation homes (6)

21 Technology which greatly aids navigation (3)

22 Sony's handheld gaming device which was succeeded by the Playstation Vita (3)

24 Google browser (6)

25 One of the first Windows Web Browsers (6)

27 A Twitter update (5)

WINNERS FOR CROSSWORD NO. 35

Aashka Jain, Mumbai

Sayantika Biswas, Gurgaon

Niraj Mehta, Bharuch

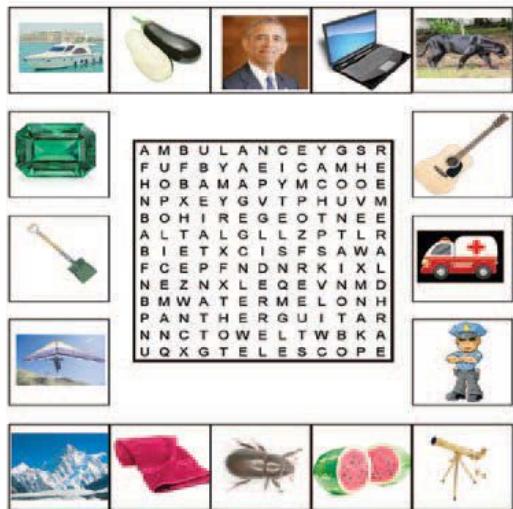
SOLUTION OF CROSSWORD NO. 35



PUZZLE PIT

Q1 PICTURE SEARCH

In the jumble below, the words represented by each of the 16 pictures are hidden either horizontally, vertically or diagonally forward or backwards but always in a straight line. See how many of them you can find? Look out for descriptive names.



A	M	B	U	L	A	N	C	E	Y	G	S	R
F	U	B	Y	A	E	I	C	A	M	H	E	
H	O	B	A	M	P	Y	M	C	O	D	E	
N	P	X	E	Y	G	V	T	P	H	U	V	M
B	O	H	I	R	E	G	O	T	N	E	E	
A	L	T	A	L	G	L	L	Z	P	T	L	R
B	I	E	T	X	C	I	S	F	S	A	W	
F	C	E	P	F	N	D	N	R	K	I	X	
N	E	Z	N	X	L	E	Q	E	V	N	M	D
B	M	W	A	T	E	M	E	L	O	N	H	
P	A	N	T	H	E	R	G	U	T	A	R	
N	N	C	T	O	W	E	L	T	W	B	K	A
U	Q	X	G	T	E	L	E	S	C	O	P	

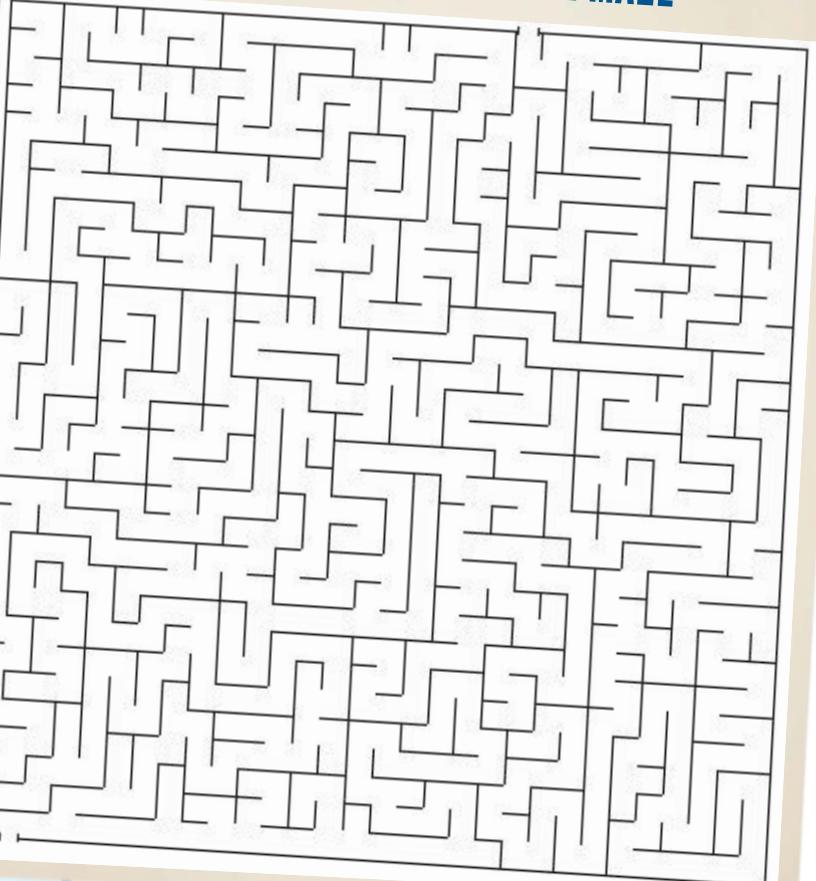
Q2 SCRAMBLE

Solve the four anagrams and move one letter to each square to form four ordinary words. Now arrange the letters marked with an asterisk (*) to form the answer to the riddle or to fill in the missing words as indicated.

LYEER	*	*	*	*	
TVIIS	*	*	*	*	
EILNDN	*	*	*	*	
HIOSDM	*	*	*	*	

Success - keeping your ___ awake and your ___ asleep. - Walter Scott (4,...,6)

FIND YOUR WAY OUT OF THE MAZE



Q3 HEAD AND TAIL

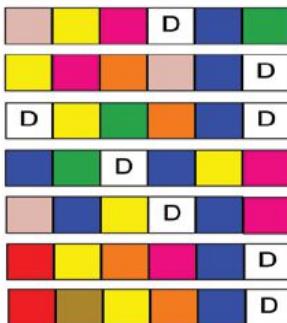
Look at the clue to solve the answer in the form of a compound word. The second part of the answer is the first part of the next answer, etc.

Deprive of by deceit	Short
Reroute	
Student's burden	
Manpower	
Repel	
Tennis stroke	
Auto need	Brake

Q4 ENIGMA CODE

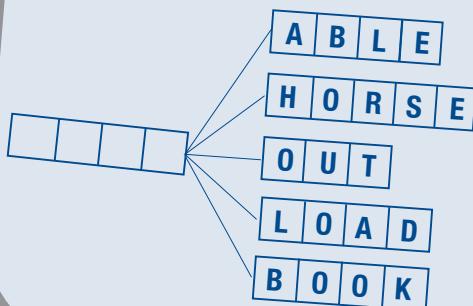
Each colour in our code represents a letter. When you have cracked the code, you will be able to make up seven words. The clue to first word is given to help you get started.

The Clue: *Inure, set*



Q5 DOUBLE BARRELLED

What word can be placed in front of the five words shown to form, in each case, another word?



Q6 BRAIN TEASERS

- 1) I am the only thing that always tells the truth. I show off everything that I see. I come in all shapes and sizes. So tell me what I must be!
- 2) Can you show that four added to six will make eleven?
- 3) What's so peculiar about this sentence?
I do not know where family doctors acquired illegibly perplexing handwriting; nevertheless,

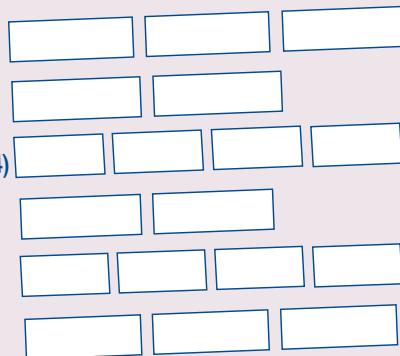
extraordinary pharmaceutical intellectuality, counterbalancing indecipherability, transcendentalizes intercommunications' incomprehensibleness.

- 4) Solve the letter equation given below:
7 S of the W
- 5) What does the following rebus represent?
LAUG SIDE HTER

Q7 PICK AND CHOOSE

Solve the six clues by choosing the right combination of sets of letters given below. Each set of letters can be used only once and only in the order given. The number at the end of the clues specifies how many sets of letters are used in the solution.

1. Triangle type (3)
2. Capital of Austria (2)
3. Successfully carried out (4)
4. Four string guitar (2)
5. Customary (4)
6. Bandage (3)



BBC KNOWLEDGE QUIZ

See how you fare in the general knowledge quiz given below.

Ratings: 1-3 Poor, 4-5 Fair, 6-7 Excellent

- 1) Leicester City won the 2015-16 Premier League title. How many teams have won it so far?
 - a) 5
 - b) 8
 - c) 6
- 2) Where did Alexander the Great die?
 - a) Babylon
 - b) Persia
 - c) India
- 3) What is the SI unit pascal used to measure?
 - a) Force
 - b) Pressure
 - c) Momentum
- 4) Which social network was founded in 2003 is now co-owned by Justin Timberlake?
 - a) Myspace
 - b) Twitter
 - c) Friendster
- 5) Who wrote the Iliad?
 - a) Socrates
 - b) Plato
 - c) Homer
- 6) Which is the world's shallowest sea?
 - a) Dead Sea
 - b) Black Sea
 - c) Sea of Azov
- 7) Who won the 2016 Nobel Prize for Literature?
 - a) Bob Dylan
 - b) Anthony Doerr
 - c) J K Rowling

4 a) Myspace, 5 c) Homer, 6 c) Sea of Azov, 7 a) Bob Dylan

4 b) Twitter, 5 Traditional, 6 Shakespeare, 1 c) Vienna, 2 d) Accomplished,

5 Shakespeare, 6 London, 7 Seas of the World, 4 a) Dead Sea

6 Brain Teasers: 1 A Mirror 2 Add it turned upside down below it and you get XI. 3 Each word in the sentence is "one letter longer" than the word before it. 4 7 Seas of the World,

5 Double-Barrelled: Work

6 Brain Teasers: 1 Add it turned upside down below it and you get XI. 3 Each word in the sentence is "one letter longer" than the word before it. 4 7 Seas of the World,

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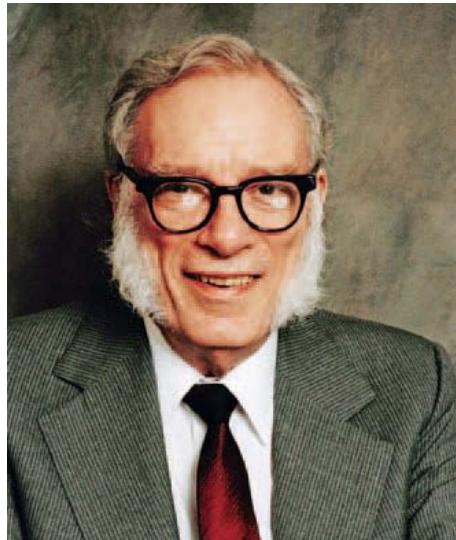
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5 Double-Barrelled: Work

SOLUTIONS:

IN FOCUS



“I DO NOT FEAR COMPUTERS. I FEAR THE LACK OF THEM”

ISAAC ASIMOV (1920 – 1997)

One of the ‘Big Three’ authors of the Golden Age of Science Fiction, Isaac Asimov was also a hugely influential interdisciplinary thinker of his time

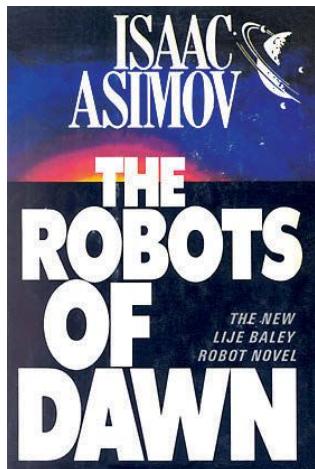
CONSIDERED one of the fathers of the science fiction genre, Isaac Asimov is also one of the most widely read and prolific authors of all time, with more than 500 books to his name. Born between 1919 and 1920 (the exact date is considered unknown, though he celebrated it as January 2, 1920) in the former Soviet Union, Asimov’s family emigrated to the United States of America when he was only three.

His love for reading pulp magazines – his father ran a newspaper and concession stand at which he devoured numerous magazines and newspapers – led him to make the acquaintance of John W. Campbell, editor of *Astounding Science Fiction* magazine, who grew to be both a mentor and a friend. Campbell encouraged the young Asimov to pursue his dream, and, by March 1939, Asimov had his first story published in *Astounding Science Fiction*.

This marked the start of a long, successful tryst with writing. Asimov’s literary output remained steady up until his death, marking a career of over

50 years. Over this illustrious period, Asimov wrote some seminal classics of the science-fiction genre, including the *Foundation* series, the *Galactic Empire* series and the *Robot* series. During his lifetime, he won the Hugo Award, the highest accolade for science fiction and fantasy authors, multiple times. Asimov was also posthumously inducted into the Science Fiction and Fantasy Hall of Fame in 1997.

Asimov’s legacy has endured long after his passing. He was the first person to coin the term ‘robotics’, which has come to be one of the most essential fields in technology today. His Three Laws of Robotics and theory of a positronic brain have had a real world impact, often serving as guidelines for actual robotic experiments. Even in fictional universes, the concepts Asimov explored through his work have become important themes in such popular franchises as *Star Trek: The Next Generation* and *Doctor Who*, and his stories have been adapted for the screen several times, the most recent being the 2004 Will Smith starrer, *I, Robot*.



DID YOU KNOW?

- In 2009, the Asimov Crater on Mars was named in the author’s honour.
- Asimov was such a prolific writer that his books can be found in nine out of the 10 categories in the Dewey Decimal System of library classification.
- In his autobiography, Asimov confessed to a fear of flying; he flew only twice in his life.
- Asimov had a love of small, enclosed spaces, and had stated that his childhood dream was to own a magazine stand in one of New York’s underground subway stations.
- Asimov is credited with introducing three words to the Oxford English Dictionary: Robotics, positronic and psychohistory.



Knowledge