

GM human beings

A moment for reflection

BEIJING

A maverick researcher in China claims to have brought about the birth of genetically modified children

THE SECOND International Summit on Human Genome Editing, held in Hong Kong this week, was supposed to be a forum in which the idea of editing the genomes of human embryos could be discussed calmly and soberly. Fat chance of that. On November 26th, the day before it opened, one of the scheduled speakers, He Jiankui, an expert in DNA sequencing at the Southern University of Science and Technology, in Shenzhen, announced that he had already done it, and that twin girls, named Lulu and Nana, had been born in early October as a result.

The consensus of the first human-genome-editing summit, which was held in 2015, was that researchers should be allowed to edit genes in human embryos subject to regulation, but that no pregnancy should be established before dealing with questions of safety and ethics (for example, addressing the point that changes to an embryo's genome may be passed on to the children of that embryo's adult self). Those questions had become pressing because of the development of a technique called CRISPR-cas9, which makes editing

DNA much easier. So easy, in fact, that there were worries even then that people might start editing it, as it were, in their garages.

And this is more or less what Dr He (pictured above) seems to have done. On November 28th, having disappeared for two days, he explained his version of events to the meeting. Visibly nervous, he outlined his methods and data in a 20-minute talk that was broadcast live on the web.

Interesting times

According to Dr He, seven couples undergoing *in vitro* fertilisation (IVF) participated in the study (an eighth was recruited, but dropped out). One criterion for recruitment was that the putative father was HIV-positive. This seemed connected to the stated purpose of the experiment—to confer immunity to HIV infection on the embryos—even though IVF involving HIV-positive men involves washing the virus out of their semen, and the risk of infecting any resulting embryo is negligible. HIV immunity was to be conferred by disabling both copies of the gene (one inherited from each parent) for a cell-surface protein

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called CCR5, which the virus uses to help it enter and infect a cell. People without a working version of CCR5 are, indeed, immune to HIV infection. But they may also be at greater than average risk of dying of some other infections, including flu.

Dr He says the IVF was carried out at Shenzhen Women and Children's Hospital. In exactly what circumstances is unclear. So far, the twins are the only children said to have been born as a result, but another volunteer mother is pregnant with a supposedly gene-edited embryo.

Reactions, both to the announcement on Monday and to the actual presentation, have been almost universally hostile. David Baltimore, a Nobel prize-winning geneticist who works at the California Institute of Technology, condemned the procedure as irresponsible and a blatant violation of international norms, and also "a failure of self-regulation by the scientific community". And Zhai Xiaomei, the executive director of the Centre for Bioethics at the Chinese Academy of Medical Sciences, says that it is contrary to Chinese law.

As far back as 2003, according to Dr Zhai, the government introduced a regulation prohibiting interventions that could lead to changes in the human genome. Many institutions—including the Chinese Academy of Sciences, the National Health Commission and the Genetic Society of China—have also said that Dr He's work broke the rules. An open letter signed by 122 Chinese scientists denounced it. And, according to their official statements, neither ►►

▶ the university nor the hospital was aware of what was going on. According to Chinese media the hospital has reported the matter to the police as a potential fraud.

Criticism has also come from Feng Zhang of the Broad Institute, in Cambridge, Massachusetts, who is one of the pioneers of CRISPR. He says that the talk was cursory—too thin on the details for him to assess the work properly. Dr Zhang is clear that no aspect of what Dr He did is innovative. “The method used has existed for several years, now,” he says, “and we, as a community, have decided it is still too immature to move to humans. But Dr He pressed ahead anyway and in a way that is totally unnecessary. It’s simply beyond belief.”

Off target?

One concern is that Dr He’s treatment of the embryos may have resulted in mutations in non-target genes and other undesired changes in the DNA of the babies concerned. These could have devastating consequences. Dr He claims he addressed this concern in four ways. Before implantation he sequenced the entire genomes of two cells from each embryo. This showed that both CCR5 copies were disabled in one twin, but only one in the other. He says that the parents were fully aware of that, and decided to implant both embryos anyway. After the implantation, he twice sequenced fetal DNA that had leaked into the mother’s blood, and also DNA from umbilical-cord blood, a fetal tissue. When the babies were born, he also sequenced cells from various of their tissues. He concluded, as a result of all this, that there might be one potential off-target mutation, that no mutation existed in the 609 cancer-associated genes he tested and that no large chunks of DNA were missing.

How accurate his sequencing was is a matter of conjecture. Dr He himself said that in the case of the umbilical-cord blood it covered only about 80% of the genome. That leaves a lot of scope for error. Moreover, scientific matters aside, there are questions about whether informed consent for what happened was properly obtained. It is unclear, for instance, whether those involved in obtaining that consent, including Dr He himself, had received training in the ways of doing so properly.

There is also the question of why anyone thought genetic modification might be of help to the children on whom it was performed. HIV infection is easily avoided and also easily treated (albeit that the treatment is lifelong). The choice of CCR5 as the gene to disable is therefore questionable. And, though the off-target mutations and accidental deletion of sections of DNA that CRISPR can cause may not matter too much if (as is often the case) crops are the recipients, they matter a lot if the recipient is human. In this context, Dr He’s claims about

the tests he carried out are not reassuring.

One of the most bizarre aspects of the story is that Dr He has no official training in reproductive research. After graduating from the University of Science and Technology of China, in Hefei, he obtained a PhD in biophysics from Rice University, in Texas, and then, at Stanford University, became an expert on DNA sequencing. His website lists no papers on matters reproductive, only of a few conference talks on basic and preclinical research.

This inexperience has not, apparently, stopped him putting together what is, in effect, a private human-genome-editing project. He says the work was paid for in part by his private resources and in part by a startup fund from his university intended to encourage its scientists to be entrepreneurs—though, to reiterate, the university denies any knowledge or involvement.

Before Dr He’s talk, there was scepticism that he had actually done what he had claimed—and his claims do, indeed, need independent verification. Many people now, though, seem inclined to believe him. The question is how to react to this belief. Dr Zhai warns that China might become a fertile ground for such scandals if its regulatory capacity is not greatly strengthened. As George Church, a geneticist at Harvard University, puts it, “the genie is already out of the bottle.” It needs to be put back. ■

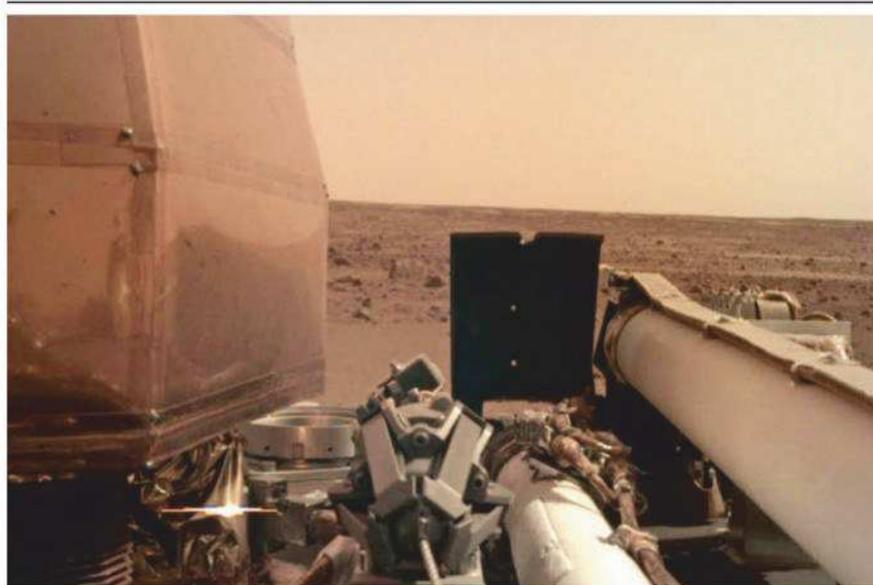
Arachnid parenting

One jump ahead

A spider that suckles its young

SUPERFICIALLY, INDIVIDUALS of a species of jumping spider called *Toxews magnus* look like ants. This protects them from the attentions of spider wasps—a group of insects that catch and paralyse spiders in order to lay their eggs on the arachnids’ bodies, which thus act as a living larder for the wasps’ larvae. Ants are not, however, the only group of unrelated animals that *T. magnus* resembles. They are also quite like mammals. That, at least, is the conclusion of a study just published in *Science* by Quan Ruichang of the Xishuangbanna Tropical Botanical Garden, in Yunnan, China.

Female mammals produce milk to suckle their young. Before modern gene-based phylogeny developed, that was indeed the definition of a mammal. A few other types of animal do something similar. Pigeons, for example, generate a milk-like secretion in their throats, which they feed to their squabs. But until now, only in mammals (or some of them, anyway) was ▶▶



Target in sight

This is the view from the instrument deployment camera of InSight, America’s latest probe to Mars, which landed safely on November 26th. InSight joins one, or possibly two, other missions now operating on the Martian surface (an American rover called Opportunity stopped working six months ago in a dust storm, but may revive if wind blows the dust off its solar panels). Six further craft are making observations from orbit. InSight will investigate the planet’s interior, deploying its instruments (a seismometer to record the echoes of Marsquakes and meteorite impacts, and a probe to measure the planet’s subsurface heat) in two or three months’ time, after its controllers have practised using models, built on Earth, of its surroundings.



A spider that looks like an ant and behaves like a mammal

► lactation thought to be the basis of an extended relationship between parent and offspring. Dr Quan and his colleagues have changed that thinking.

Their study was stimulated by the observation that wild *T. magnus* seem to remain in the maternal nest far longer than most other spider species. They wondered why. They therefore brought some specimens into their laboratory for a closer look. This showed that the mother of a brood exudes fluid from her epigastric furrow, the canal through which she lays her eggs. For the first week of her hatchlings' lives, she deposits this fluid in drops around the nest, from which the young spiders drink. After that, until they are about 40 days old, she suckles the spiderlings directly.

Experiments that measured the growth and survival of young spiders, some of which involved sealing the mother's epigastric furrow using typing-correction fluid, showed that the spiderlings did, indeed, depend on the secretion for nutrition. They relied on it completely until they were 20 days old, at which point they started leaving the nest to hunt on their own account. Even after this, though, the fluid formed an important dietary supplement until they were about 40 days old. And chemical analysis showed that it is a rich source of nutrients. It contains four times as much protein as cow's milk does.

Even when weaned, young spiders, like many young mammals, returned home regularly after they had been out searching for food of their own—and experiments that removed the mother showed she was in some way contributing to their health and survival even then. Young spiders continued to return until they were 60 days old, and thus sexually mature. At that point, the mother started attacking returning sons, thus driving them away—presumably to avoid the risk of them mating with their sisters and producing inbred offspring. Daughters, though, she continued

to tolerate. At what point those daughters, too, left to set up shop by themselves the study did not investigate.

Whether epigastric lactation and its consequent prolongation of family life is confined to *T. magnus*, or is more widespread among jumping spiders, remains to be looked at. But unless the strategy has evolved very recently it seems likely that at least some of *T. magnus*'s relatives will also employ it. Either way, Dr Quan's discoveries serve as a reminder that if something works well in one part of the animal kingdom, the chances are that it will do so elsewhere, too. ■

Antibiotic resistance

Enlightenment

A novel way to stop the spread of a resistance mechanism

NEW DELHI metallo-beta-lactamase is a bacterial enzyme that poses a serious threat to people. It grants its host resistance to carbapenems and other beta-lactam antibiotics used by doctors around the world as a last line of defence against stubborn infections. And, as if that were not bad enough, it also confers protection against sunlight.

This second protection matters because, in many places, the idea that sunlight is the best disinfectant is no mere metaphor. Part of the treatment of sewage water in sunny climes is often to leave it out in the sun, permitting ultraviolet light to inflict damage to the complex molecules, such as DNA, that sustain bacterial life. Bacteria that survived such assault would be available to cause disease, or to pass their genes on to others that do so.

And, in 2015, one such was found in a treatment plant in Saudi Arabia. This was a strain of *E. coli* (a common bug that lives, usually harmlessly, in human guts) that was, indeed, in possession of New Delhi metallo-beta-lactamase. Peiyong Hong at the King Abdullah University of Science and Technology, in Thuwal, has been working on this bug since its discovery and thinks she may have come up with a way to deal with its resistance to sunlight. As she reports in *Environmental Science and Technology*, she and her colleagues have found that phages (viruses which infect bacteria) sabotage this resistance.

Dr Hong knew from her earlier work that sunlight promotes the activity of some of the bug's genes and suppresses that of others—a process she suspects is mediated by New Delhi metallo-beta-lactamase. In particular, the promoted genes relate to cell-wall synthesis, DNA repair and the production of compounds that mop up harmful oxidising agents produced by sunlight. The suppressed genes (downregulated presumably to avoid competition within a bacterial cell for scarce metabolic resources needed for more immediate tasks) include many related to fending off phages. She therefore speculated that letting phages loose on these now-undefended bacteria might kill them.

She and her colleagues collected naturally occurring phages from Saudi wastewater plants. They found seven types which, when unleashed on the photoresistant strain of *E. coli*, readily destroyed it. Three of the seven, moreover, looked particularly suitable for development as weapons against this strain. When offered various bacteria as potential prey, they attacked only it. And they were also tolerant of sunlight.

Experiment proved this notion correct. When suspensions of the three phages in question were mixed together as a cocktail and added to a suspension of photoresistant *E. coli*, the bacteria began to decay within two hours. In phage-free suspensions, by contrast, they held out for more than four hours.

Using phages to attack bacteria in wastewater plants is not a new idea. There is a long history of their being employed to breach the otherwise-impenetrable biofilms that many species form on bits of equipment used in such plants. Dr Hong's approach, though, is completely novel—and may be of particular value in Saudi Arabia. In such a desert country, water is a precious commodity while sunlight is abundant and free. Wastewater facilities there are already under pressure to release treated water for agricultural and even domestic use. Making sure bugs of this sort are dead before such water is used is of the utmost importance. Using other, even smaller, bugs to do it has elegance. ■

Psychiatric genetics

Attention, please

A vast study seeks to understand the genetic underpinnings of ADHD

TRUE DISORDER or mythical modern ailment? Attention-deficit hyperactivity disorder (ADHD) is one of the most controversial topics in psychiatry. Not for the first time, the internet is brimming with conflicting information. Some deplore a lack of recognition and insufficient diagnoses and treatment. Others denounce overdiagnosis and overtreatment, and argue that the condition is banded about willy-nilly as an excuse for poor parenting.

Identifying the inherited underpinnings of ADHD has proved challenging. Studies of twins with and without its eponymous symptoms suggest that genetic factors bear between 70% and 80% of the blame for causing it. There is not, though—as there is in the case of (say) colour blindness—a clear gene or genes on which that blame can be pinned. Instead, the presumption is that a range of small and hard-to-detect tweaks in the sequence of DNA letters (known as nucleotides) combine to bring about susceptibility to the disorder. Environmental factors such as social deprivation and low birthweight play a greater or lesser role (or sometimes none at all) depending on exactly which genetic tweaks are present.

Now, a dozen of those tweaks have been identified by what is the first large-scale investigation of the matter. An international consortium of more than 200 geneticists and ADHD experts have published, in *Nature Genetics*, what is known as a genome-wide association study (GWAS). The tweaks being sought, called single-nucleotide polymorphisms, or SNPs, are the simplest possible differences between two genomes—namely variations between individuals of single genetic letters in particular spots in the DNA sequence. The researchers looked at SNP patterns in the genomes of 55,000 Europeans, more than 20,000 of whom had been diagnosed with ADHD, seeking SNP variants consistently associated with the condition.

Understanding the roles of the genes these dozen SNPs affect will lead to better understanding of ADHD's causes. Some, for instance, are variations in genes, or the control systems of genes, involved in determining how brains develop in the womb and in early childhood. Others relate to how brain cells communicate with each other. Such understanding may also lead to ideas for new drugs to treat the condition.

Comparing this study with similar ones

on what may be related conditions can also be informative. The SNP pattern found, for instance, overlaps with those discovered in GWAS of insomnia. As Stephen Faraone of Upstate Medical University in Syracuse, New York, one of the ADHD study's leaders, observes, "we've known for years that children with ADHD have sleep problems."

The dozen identified variants do not, on their own, confer the disorder. The findings will not, therefore, lead directly to genetic tests for ADHD. What they do do, though, is dispel the idea that ADHD is merely bad behaviour, or even a mythical condition. And that, of itself, may help to change attitudes towards children who have it, and towards their parents. ■

Prosthetic limbs

Ghost busters

Experience of phantom limbs lets amputees control real replacements

IN THE EARLY 16th century a knight called Gottfried von Berlichingen spent decades marauding and feuding on behalf of the Holy Roman Empire. He conducted most of his career singlehandedly—the other having been blown off by a cannonball. To replace it he had a metal duplicate made, with spring-loaded fingers that could hold a sword, shield or the reins of his horse. This early prosthetic device gave him the nickname "Götz of the Iron Hand".

Prostheses have come a long way since Götz's day. A technique called targeted muscle re-innervation (TMR) permits surgeons to take the nerves that once controlled a missing limb and attach them to muscles in a patient's chest or back. The re-directed nerves grow into their new muscular homes. These then act as signal amplifiers: a muscle's electrical activity

reflects that of the nerves supplying it, but is far more powerful and therefore easier to detect using external electrodes. That activity, duly interpreted by computer, can be used to drive motors within the prosthesis to make it do what its wearer wants.

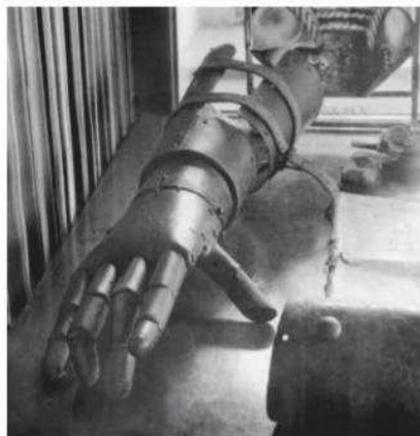
For this to happen, though, the patient must spend weeks, or even months, learning to twitch the re-innervated muscles in particular ways to achieve particular outcomes. That is frustrating and tedious. Nor is the re-innervating surgery itself without risk. A better way to control prosthetic limbs would be welcome. And one may now be on offer.

Some amputees feel the presence of a phantom limb where the real one was. Often, they feel that phantom to be under their control. If it were possible to use these feelings to direct the behaviour of a prosthesis, TMR might be made redundant. Nathanael Jarrassé of the Sorbonne and Jozina de Graaf of Aix Marseille university, both in France, have begun working on how to do this.

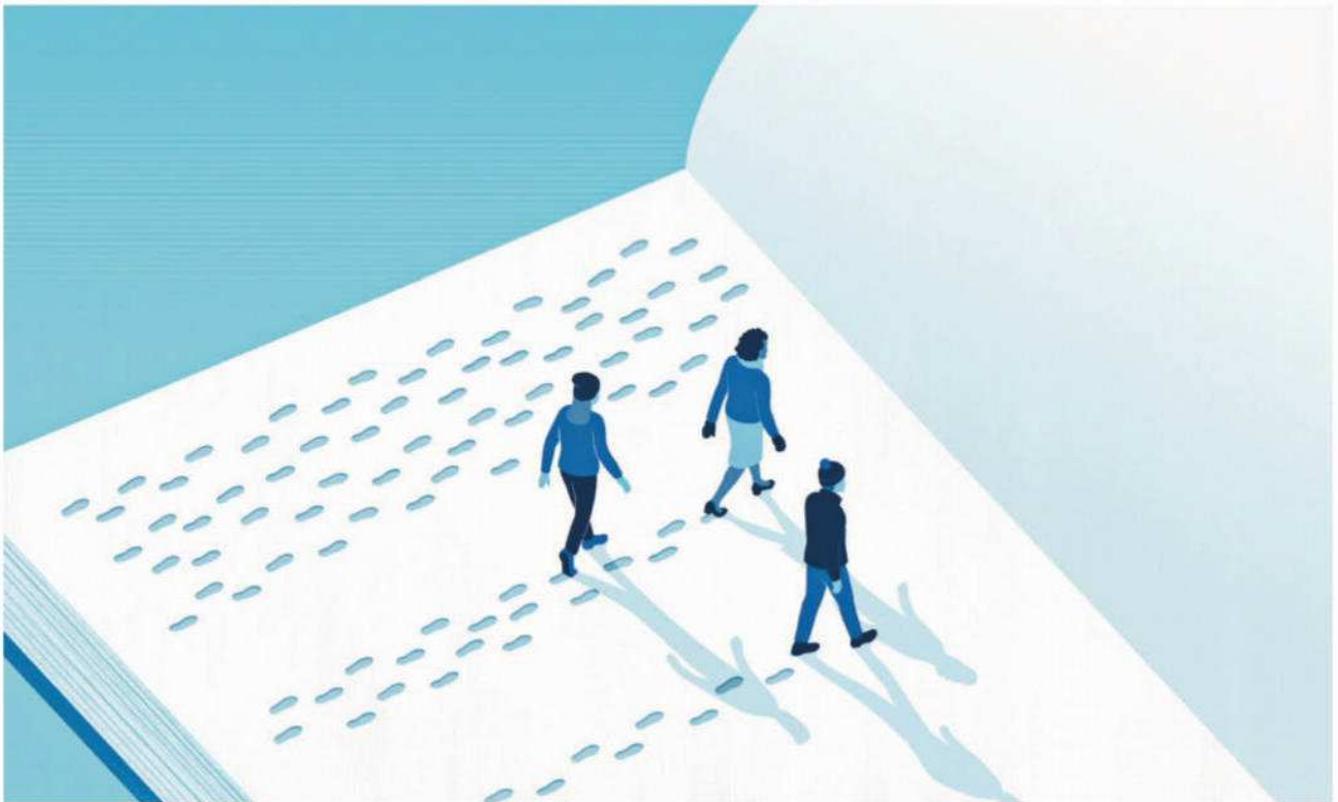
In their latest study, just published in *Frontiers in Bioengineering and Biotechnology*, Dr Jarrassé and Dr Graaf stuck six electrodes onto the arm stumps of two volunteer amputees who had each lost that limb above the elbow. (The loss of the elbow joint as well as the wrist greatly complicates the task of interpreting the signals and controlling the prosthesis.) These half-dozen electrodes read activity coming from the arm's remaining muscles as the volunteer thought about moving the missing limb.

The trick was that the learning needed to manipulate the prosthesis was done not long-windedly, as in TMR, by the patient, but rapidly, by a computer algorithm. This recognised within minutes the different patterns of electrical activity that corresponded to different actions of the phantom limb as imagined by the volunteer, such as opening or closing the hand, or moving the wrist. It then directed motors to replicate such actions in the prosthetic arm. Both patients were thus able to use the device intuitively—successfully grasping, placing and releasing objects.

The new system is not perfect. At the moment the algorithm recognises only the type of movements the phantom limb is making in the patient's mind, not their speed or their amplitude. It also takes half a second or so to process the electrodes' signals. This delay between intention and execution means the user does not yet experience the prosthesis as if it were part of the body. These imperfections are, though, things that might be overcome in the future. And if they can be, the phenomenon of phantom limbs will have been turned from something that is often distressing to those experiencing it, into something of great benefit. ■



How they used to do it



Books of the year

The big read

The best books of 2018 were about corruption, blood, slavery, survivalism, espionage and a drifting second-world-war veteran

Politics and current affairs

Moneyland. By Oliver Bullough. *Profile Books*; 298 pages; £20. To be published in America by St Martin's Press in May; \$28.99 Moneyland is the author's term for the virtual country into which the world's mega-rich smuggle their (sometimes ill-gotten) wealth, so insulating it from the attention of tax and other officials. Focused in part on the kleptocrats of the former Soviet Union, the book ranges across the world and a wide cast of lawyers, accountants and mountebanks who see to it that money stolen in poor, ill-run countries can be invested in rich, safe ones. An urgent exposé of a vital subject.

Enlightenment Now: The Case for Reason, Science, Humanism and Progress. By Steven Pinker. *Viking*; 576 pages; \$35. *Allen Lane*; £25 His critics regard him as Panglossian, and suspect he cherry-picks statistics, but the author's case for global optimism is entertaining and well-argued. The Enlight-

enment virtues of reason and education, allied to trade and technology, have made the world richer, safer and even happier, he contends, and the improvements are likely to continue. Populists and demagogues are merely a blip in this consoling counterpoint to the misery of the news.

Fascism: A Warning. By Madeleine Albright. *Harper Collins*; 254 pages; \$27.99 and £16.99 The former secretary of state—and a long-time professor of international relations at Georgetown University—fled both Nazism and communism as a child. She does not deploy the term “fascism” loosely and deplores those who do; instead she coolly analyses the way countries can descend into tyranny. In uncertain times, she observes, many people no longer want to be asked what they think: “We want to be told where to march.”

→ Also in this section

77 Books by our writers

First Raise a Flag: How South Sudan Won the Longest War but Lost the Peace.

By Peter Martell. *Hurst*; 320 pages; £25 A correspondent based in Juba, capital of the new, troubled country of South Sudan, explains its tragic predicament. A history of slave raids, imperialism and brutal rule by Khartoum leads to independence and civil war. The saga is enlivened by interviews with retired spooks and elderly veterans of the colonial administration.

Into the Hands of the Soldiers: Freedom and Chaos in Egypt and the Middle East.

By David Kirkpatrick. *Viking*; 384 pages; \$28. *Bloomsbury Publishing*; £25 In this pellucid chronicle of Egypt's trajectory since the toppling of Hosni Mubarak in 2011, the former Cairo bureau chief of the *New York Times* is almost as scathing about the bungling foreign policy of successive American administrations as he is about Abdel-Fattah al-Sisi, Egypt's strongman president. The country's so-called stability, he suggests, is again breeding misery and extremism. ▶▶

► **Shadows of Empire.** By Michael Kenny and Nick Pearce. *Polity*; 200 pages; \$19.95 and £14.99

The “Anglosphere” is not a term in common parlance. This timely and enlightening book shows that, throughout the 20th century, the idea of a fraternity of English-speaking nations exerted a powerful influence on British politicians, including Churchill and Thatcher. It has resurfaced in Brexiteers’ dreams of invigorated Commonwealth trade.

History

A History of America in 100 Maps. By Susan Schulten. *University of Chicago Press*; 256 pages; \$35. *British Library*; £30

A collection of maps, by turns beautiful and eccentric, which charts the making of America. It shows the role of maps in exploration and conquest and proves that, while some aspects of American political geography are enduring, much in the country’s make-up has, like the banks of the Mississippi, always been in flux.

Pogrom: Kishinev and the Tilt of History. By Steven Zipperstein. *Liveright*; 288 pages; \$27.95 and £20

The pogrom in Kishinev in 1903 became a byword for anti-Semitic violence for Jews everywhere, its victims blamed variously for their passivity and for having resisted their attackers. The event roused Zionists and Jew-haters alike, and was instrumental in both the publication of the “Protocols of the Elders of Zion” and the establishment (in New York) of the NAACP. A gripping, scrupulous history of a seminal but mythologised atrocity.

The China Mission: George Marshall’s Unfinished War, 1945–1947. By Daniel Kurtz-Phelan. *W.W. Norton & Company*; 496 pages; \$28.95

Marshall’s mission to China is much less well-known than his effort to rebuild Europe after the second world war. The former, unlike the latter, failed; China descended into civil war and then a communist dictatorship. This account of the debacle by a former diplomat is both a compelling portrait of a remarkable soldier and statesman and an instructive lesson in the limits of American power, even at its zenith.

Rise and Kill First: The Secret History of Israel’s Targeted Assassinations. By Ronen Bergman. *Random House*; 784 pages; \$35. *John Murray*; £19.99

For this impressive work of reportage, the author not only spoke to hundreds of Israeli spies but also convinced them to hand over a trove of documents. Then he constructed a thrilling narrative of extreme bravery and compromised morality.

Business and economics

We the Corporations: How American Businesses Won Their Civil Rights. By Adam Winkler. *Liveright*; 496 pages; \$28.95

“For most of American history”, the author comments, “the Supreme Court failed to protect the dispossessed and the marginalised, with the justices claiming to be powerless in the face of hostile public sentiment.” Meanwhile “the court has insisted that broad public sentiment favouring business regulation must bend to the demands of the constitution.” A lively survey of a neglected but important feature of American history.

AI Superpowers: China, Silicon Valley and the New World Order. By Kai-Fu Lee.

Houghton Mifflin Harcourt; 272 pages; \$28
A former manager at assorted American tech giants—and now the boss of a Chinese venture-capitalist fund—anticipates the coming contest to dominate artificial intelligence. He thinks China will crush Silicon Valley because it has more data, disdains privacy and competes more ruthlessly. Thought-provoking, if not altogether convincing.

Radical Markets: Uprooting Capitalism and Democracy for a Just Society. By Eric Posner and E. Glen Weyl. *Princeton University Press*; 368 pages; \$29.95 and £24.95

A law professor and an economist argue that the way out of liberalism’s impasse is to expand the role of markets, not to subdue them. Some of their ideas—on property rights, elections, immigration and

much besides—are impractical, and others eccentric; but together they point to a possible response to the challenges of populism and protectionism.

EuroTragedy: A Drama in Nine Acts.

By Ashoka Mody. *Oxford University Press*; 672 pages; \$34.95 and £25.49

A comprehensive and authoritative history of the euro which argues that the project was a predictable error. Written by a former senior official at the IMF, the book laments the intellectual failures present at the foundation of the single-currency area and in the mishandled response to the sovereign-debt crisis after 2010.

Crashed: How a Decade of Financial Crises Changed the World. By Adam Tooze. *Viking*; 720 pages; \$35. *Allen Lane*; £30

This panoramic survey of the aftermath of the financial crash of 2008 has four main themes: the immediate response, in which the banks were rescued; the euro-zone crisis; the shift in the developed world after 2010 to more austere fiscal policies; and the rise of populist politics in Europe and America in the wake of the debacle. The author has little faith in the ability of governments to take decisive action when the next crisis hits.

Biography and memoir

The Wife’s Tale: A Personal History. By Aida Edemariam. *Harper*; 314 pages; \$26.99. *Fourth Estate*; £16.99

The author’s Ethiopian grandmother, Yetemegnu, was married at the age of eight to a religious student more than 20 years her senior. By 14 she was a mother. She fled her husband’s mistreatment, yet when he was arrested she petitioned the emperor on his behalf; on his death she mourned “my husband, who raised me”. The family sought sanctuary in the mountains when the Italians invaded in 1935. This intimate memoir is also an oblique chronicle of Ethiopia’s turbulent history.

Educated. By Tara Westover. *Random House*; 385 pages; \$28. *Hutchinson*; £14.99

A riveting memoir of a brutal upbringing. The author grew up in a normally opaque environment: a Mormon survivalist household in Idaho, where she endured abuse and received no education. Despite not setting foot in a classroom until she was 17, she made it to university and wound up with a PhD from Cambridge.

Barracoon. By Zora Neale Hurston. *Amistad*; 208 pages; \$24.99. *HQ*; £12.99

Zora Neale Hurston’s study of Kossula, later called Cudjo Lewis, one of the last Africans to be kidnapped into slavery in America, has never been commercially published before. Interviewed at his home in Alabama in 1927–28, he vividly recalled



▶ his capture and illegal transportation on the eve of America's civil war: "I think maybe I die in my sleep when I dream about my mama." A devastating book.

Napoleon: A Life. By Adam Zamoyski. *Basic Books*; 784 pages; \$40. *William Collins*; £30
Some of his critics portray him as a monster; enthusiasts have characterised him as a demi-god. In this superlative account, Napoleon is a mortal, with great virtues and equally great flaws, at once dazzling and gauche. "From the sublime to the ridiculous", Napoleon himself said after his disastrous campaign in Russia, "there is but one step."

Churchill: Walking with Destiny.

By Andrew Roberts. *Viking*; 1,152 pages; \$30. *Allen Lane*; £35

Of the many biographies of Winston Churchill, this is the fullest. Acknowledging its subject's flaws and sometimes catastrophic mistakes, it nevertheless makes a compelling case for his greatness, both as a statesman and a writer. More unusually, by evoking his wit, generosity and courage, it also succeeds in making him lovable. "I was not the lion," Churchill said, "but it fell to me to give the lion's roar."

Gandhi: The Years That Changed the World 1914-1948. By Ramachandra Guha. *Knopf*; 1,104 pages; \$40. *Allen Lane*; £40

At a time of rising Hindu nationalism, the Mahatma's values and example are as relevant as ever in his homeland. This second volume of a magisterial biography begins in 1914, when Gandhi returned to India from South Africa. It conveys his charisma, his intellect and the evolution of his political beliefs, including his advocacy of Hindu-Muslim reconciliation.

The Spy and the Traitor: The Greatest Espionage Story of the Cold War. By Ben Macintyre. *Crown*; 368 pages; \$28. *Viking*; £25
Oleg Gordievsky, a vital Western asset inside the KGB, was smuggled across the Soviet Union's border with Finland in the boot of a car. The story of Mr Gordievsky's life, and that of Aldrich Ames, the renegade CIA officer who outed him, is told with the gusto of a thriller. A fitting tribute to a brave but lonely man.

Culture

The Personality Brokers. By Merve Emre. *Doubleday*; 336 pages; \$27.95. *Published in Britain by William Collins as "What's Your Type?"*; £20

The Myers-Briggs Type Indicator, the best-known personality test, is the focus of an entertaining cultural history of the personality-assessment industry. It was invented by a mother-and-daughter team, under the influence of Carl Jung. Its enduring popularity ought not to be surprising:



after all, it offers both the "rush of self-discovery" and "the comfort of solidarity" with others of the same type.

The Prodigal Tongue. By Lynne Murphy. *Penguin Books*; 368 pages; \$17. *Oneworld*; £16.99

The first and perhaps only book on the relative merits of American and British English that is dominated by facts and analysis rather than nationalistic prejudice. For all its scholarship, this is also a funny and rollicking read.

Space Odyssey: Stanley Kubrick, Arthur C. Clarke and the Making of a Masterpiece.

By Michael Benson. *Simon & Schuster*; 512 pages; \$30 and £25
An illuminating account of a collaboration that resulted in a landmark film. The author's scientific background helps him to explain its pathbreaking visual effects. The making of a great work of art has rarely been anatomised so thoroughly.

Astounding: John W. Campbell, Isaac Asimov, Robert A. Heinlein, L. Ron Hubbard and the Golden Age of Science Fiction.

By Alec Nevala-Lee. *Dey Street Books*; 544 pages; \$28.99. *To be released in Britain in August*; £10.99
An indispensable book for anyone trying to understand the birth and meaning of modern science fiction in America from the 1930s to the 1950s—a genre that reshaped how people think about the future, for good and ill.

Boom Town. By Sam Anderson. *Crown*; 448 pages; \$28

The fortunes of the Thunder, Oklahoma City's basketball team, become a metaphor for the city's own history in a hymn to an unsung metropolis. In this colourful compendium of heroism, skulduggery, land-grabs, oil and violence, its subject emerges as equal parts Wild West and Oz.

Fryderyk Chopin: A Life and Times. By Alan Walker. *Farrar, Straus and Giroux*; 768 pages; \$40. *Faber & Faber*; £30

Chopin's romantic life—he was a child prodigy who ran off with George Sand before dying at 39—has had many chroniclers. This definitive account draws on new sources to shed light on his career and volatile times. The man behind the myth emerges as an amiable perfectionist.

Fiction

The Long Take. By Robin Robertson. *Knopf*; 256 pages; \$27. *Picador*; £14.99

The wondrous story of a Canadian veteran of the second world war who washes up in New York and then Los Angeles—told mostly in verse. Walker, the protagonist, is haunted by his experiences in combat and by memories of his youth, and pained by the neglect of the homeless in California. Probably the best novel of the year.

The Silence of the Girls. By Pat Barker.

Doubleday; 304 pages; \$27.95. *Hamish Hamilton*; £18.99
The "Iliad" reimagined from the perspective of Briseis, the captured slave-girl who is the cause of the quarrel between Achilles and Agamemnon that animates Homer's epic—and in the original is almost silent. The technicolour horrors of war are accompanied by similes of almost Homeric brilliance.

Washington Black. By Esi Edugyan. *Knopf*; 352 pages; \$26.95. *Serpent's Tail*; £14.99

The title character of this poignant saga is born into slavery on a sugar plantation in Barbados; he escapes in the company of an eccentric inventor, a slave-catcher on his trail, before wandering across several continents. An original and compulsive exploration of a tragic subject. ▶▶

► **Milkman.** By Anna Burns. *Graywolf Press*; 360 pages; \$16. *Faber & Faber*; £8.99

The winner of this year's Man Booker prize is set during the Troubles in Northern Ireland in an unnamed city that looks like Belfast. "Middle sister", the protagonist (nobody in the book has a conventional name), is stalked by a paramilitary. A haunting depiction of the impact of violence on ordinary lives.

Love is Blind. By William Boyd. *Knopf*; 384 pages; \$26.95. *Viking*; £18.99

The tale of a Scottish piano-tuner infatuated with a Russian opera singer gallops across fin-de-siècle Europe, from Paris to St Petersburg to Trieste, then onwards to the Andaman Islands. A treat for the author's many fans and a masterclass in old-fashioned storytelling.

Normal People. By Sally Rooney. *Faber & Faber*; 266 pages; £14.99. *To be published in America by Hogarth in April*; \$26

A beautiful portrait of an on-off relationship between two Irish youngsters, at school and university. The scrutiny of their self-deceptions is at once unforgiving and tender. The tango of power is masterfully conveyed in their dialogue.

Fire Sermon. By Jamie Quatro. *Grove Press*; 224 pages; \$24. *Picador*; £14.99

A lyrical, experimental novel about faith and adultery, divine and erotic love, worship and transgression, from an accomplished writer of short stories.

Science and Technology

Beyond Weird. By Philip Ball. *University of Chicago Press*; 384 pages; \$26. *Bodley Head*; £17.99

Most books on quantum mechanics emphasise its weirdness, a built-in excuse for being baffling. Wearing deep learning lightly, this author explains his subject simply and thoughtfully, revealing the theory's true power as a way of knowing what can be said about nature.

Rocket Men. By Robert Kurson. *Random House*; 384 pages; \$28. *Scribe*; £18.99

A gripping account of *Apollo 8*, the first manned space flight around the Moon. The story of the dangerous mission that laid the ground for the Moon landing has not been told in such detail until now.

Nine Pints: A Journey Through the Money, Medicine and Mysteries of Blood. By Rose George. *Metropolitan Books*; 368 pages; \$30. *Portobello Books*; £14.99

This history of blood takes its name from the quantity in a human body. The author visits high-tech facilities, a South African slum and Nepalese villages to convey, scintillatingly, what is known and what remains mysterious about the liquid.

The Economist's journalists unbound

A short history of moonlighting

Here are the books our writers published in 2018

Talk on the Wild Side: The Untameable Nature of Language. By Lane Greene. *Economist Books/Hachette*; 240 pages; \$26. *Profile Books*; £14.99

Our Johnson columnist argues that English is a living organism; language rules are often preferences in disguise. "He is open-minded and discerning," the *Spectator* said; "no zealot and no snob."

Dark Shadows: Inside the Secret World of Kazakhstan. By Joanna Lillis. *I.B. Tauris*; 272 pages; \$25 and £20

A portrait of an enigmatic country by our correspondent there. She traverses deserts, mountains and cities, talking to oilmen, oligarchs and villagers.

All You Need to Know: Sexuality.

By Charlie McCann. *Connell Publishing*; 121 pages; \$14.99 and £9.99

A tour of the meanings of sex in the West—by the deputy digital editor of *1843*—that romps through ancient Greece, medieval Europe, Georgian London, Weimar Berlin and the sexual revolution to the controversies of today.

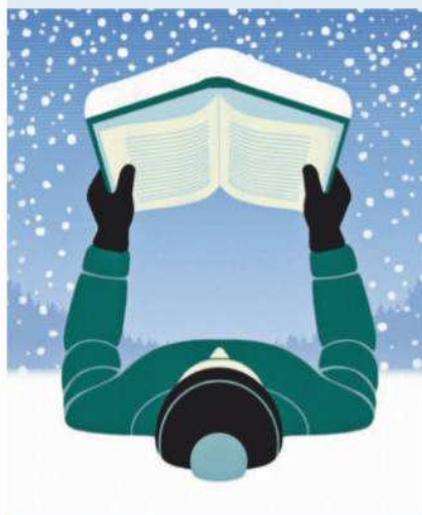
Revolution Française: Emmanuel Macron and the Quest to Reinvent a Nation.

By Sophie Pedder. *Bloomsbury*; 297 pages; \$28 and £25

A close-up biography of an odds-defying president by our Paris bureau chief. "A terrific first draft of a history with significance far beyond the borders of France," said the *Wall Street Journal*.

Bibi: The Turbulent Life and Times of Benjamin Netanyahu. By Anshel Pfeffer.

Basic Books; 432 pages; \$32. *Hurst*; £20



A biography of an embattled, pugnacious prime minister by our Israel correspondent, tracing his rise from MIT student to leader. "Insightful and readable," reckoned the *New York Times*.

The Golden Thread: How Fabric Changed History. By Kassia St Clair. *John Murray*; 368 pages; £20

From Viking sails and ancient Egyptian linen to modern factories, a regular arts writer explains how and why fabric has changed the world. "A charming, absorbing and quietly feminist history," said the *Sunday Times*.

The 100 Best Novels in Translation. By Boyd Tonkin. *Galileo Publishers*; 304 pages; £14.99

Critical essays introducing some of the greatest works of fiction ever translated into English. Our regular reviewer's appreciation "is always fresh, unforced and illuminating," said the *Spectator*.

Picasso and the Painting That Shocked the World. By Miles Unger. *Simon & Schuster*; 480 pages; \$32.50 and £24.99

The story of how a young Spanish painter came to Paris and launched an artistic revolution. The *Washington Post* called our art reviewer's study "a historically and psychologically rich account of the young Picasso."

Capitalism in America: A History. By Adrian Wooldridge and Alan Greenspan. *Penguin Random House*; 496 pages; \$35. *Allen Lane*; £25

Our political editor and his co-author argue that a high tolerance for creative destruction has underpinned America's success. The *Financial Times* said they instilled "a sense of exhilaration that so much of the American experience could be described so vividly and insightfully."

Francis: A Life in Songs. By Ann Wroe. *Jonathan Cape*; 191 pages; £16.99

Our obituaries editor turns to verse for her portrait of St Francis, counterpointing themes in his life with contemporary echoes. The *Spectator* called her "a poet with a distinctive voice, a command of form and a lightness of touch matched by a depth of heart."

Seriously Curious: The Facts and Figures That Turn Your World Upside Down.

Edited by Tom Standage. *Economist Books*; 272 pages; \$9.99 and £8.99
Startling facts and explanations, compiled by our deputy editor. *Booklist* called it "bemusing, informative, provocative—and always interesting".