

HISTORY

Reimagining the dog

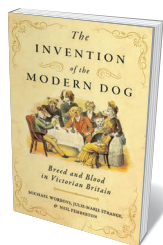
Meg Daley Olmert enjoys a story of the Victorian drive towards unnatural selection.

Charles Darwin, Charles Dickens and P. T. Barnum walk into a pub ... a classic comic set-up that can only lead to one punch line: *The Invention of the Modern Dog*. This chronicle — by science historians Michael Worboys and Neil Pemberton and historian Julie-Marie Strange — charts the confluence of biology, class and popular entertainment that resulted in an unprecedented burst of nineteenth-century canine breeding. That tumult, they argue, stares out at us today from the eyes of our dogs.

Science and engineering were reshaping the British Isles, shrinking distances both geographical and social, even as Darwinian science effectively ‘shrank’ the distance between species. A newly minted middle class donned morning coat and top hat, and strode off to support the making of Empire. Vast numbers of people were ‘improved’ as their hard work finally paid off, and improved people needed improved dogs. Between 1874 and the beginning of the twentieth century, the number of dog breeds recognized in Britain swelled to include foreign breeds, variations of older ones such as the Welsh spaniel and the Skye terrier, and “manufactures”, such as the Yorkshire terrier. These dogs were whipped into must-have status through another Victorian invention: the dog show.

For the lucky and industrious, there was much to celebrate, and the money and time to do it. Over more than 270 pages, the authors document the dog show “mania” that swept across Britain from 1862. It is here that the new, improved dog took centre stage, for better or worse.

The British aristocracy had always been keen on dogs: stud pedigrees remain as closely tracked and controlled as those of their masters. Canine valour was tested in the field and exalted in the arts. Meanwhile, the dog as entertainment had long been the domain of the ‘lower’ classes. Bull and bear baiting, popular in Elizabethan London,



The Invention of the Modern Dog: Breed and Blood in Victorian Britain
MICHAEL WORBOYS,
JULIE-MARIE STRANGE
& NEIL PEMBERTON
Johns Hopkins
University Press (2018)

ended only in 1835, with the first Cruelty to Animals Act. Rat baiting remained a gambling sport in pubs until 1912. Aficionados of these ‘entertainments’ were known as “the Fancy”. Those who bred the fastest, toughest dogs could make a good living on wagers set by the thirsty new army of clerks and mid-level managers. For their wives, the new money bought servants, and empty time and laps were soon filled by miniature dogs such as the King Charles spaniel favoured by Queen Victoria (see *Nature* <http://doi.org/gdthxg>; 2018).

The Fancy scaled up its ‘sporting’ events and toy-dog beauty shows. The gentry, seeing this as entrepreneurial overstep threatening to dilute the purity of the British dogs’ pedigree, created the Kennel Club to set rules for the shows. Yet, despite its claimed dedication to improving breeds, the club never set breeding standards. Those were the preserve of local clubs devoted to a single breed, a newly emerged social stratum spanning the amateur–professional chasm.

Enter Darwin, Dickens and Barnum. Unnatural selection, social pretensions and showbiz set the tone for thousands of dog shows drawing Victorians of all classes (on separate days) to marvel at dogs that were

changing before their eyes. With wolves extinct in Britain, animal baiting banned and game birds bred and delivered within shooting range, dogs no longer needed valour, courage and stamina. Freed to select for conformation alone, each club created an exacting standard for its breed’s appearance and assigned a numerical value to it.

There was little science to guide them. They did have Darwin’s warnings about the evils of inbreeding; and a Lamarckian belief in the heritability of acquired traits still lingered. The well-established practice of outbreeding periodically to improve performance was cast aside in favour of inbreeding to produce physical duplicates of the latest standard. ‘Best of show’ would go only to a black Newfoundland. The pug was shrunk from 14 kilograms to 10. Pointers grew larger. More toxic standards were set for the newly redundant bulldog. Selective breeding and surgical ‘face jobs’ produced extremely flat-faced dogs that were

favoured in the show ring but were reportedly devoid of courage and aggression. George Roper, a leading figure in the Bulldog Club, lamented that the breed was “more liable to deterioration” than others.

The goal was improvement of the dog show, not the dog. Breed standards, based on fashion, were locked into place to make

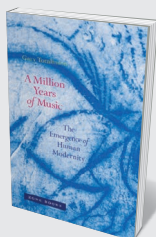
judging easier and competition fairer. The result was dog-as-commodity.

The authors’ exhaustive documentation of these socio-economic forces supports their thesis that today’s dog is a deliberate invention of the Victorians. But, for all the research and reporting, they do not explain the emotional

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NEW IN
PAPERBACK

Highlights of this
season’s releases.



A Million Years of Music

Gary Tomlinson MIT PRESS (2018)

“Musical expression is a universal characteristic of our species.” Musicologist Gary Tomlinson explores the reaches of that idea, and to what extent the traits essential to music-making can be seen as evolutionary behaviours, traceable across human history. Expertly interweaving humanities and science, Tomlinson demonstrates how the answers to philosophical questions surrounding modern music can be discovered in their ancient origins.



drive behind it. Why did the Victorians want this dizzying variety? What did all that messing about with dogs' appearance do to the animals' emotions and behaviour?

Thanks to Russian geneticists Dimitry Belyaev and Lyudmila Trut (as chronicled in Trut and Lee Dugatkin's 2017 *How to Tame a Fox (and Build a Dog)*), we know that selecting for tame behaviour in wild foxes changes the animals' look. The reverse should also hold: that selecting for coat and eye colour manipulates genes that affect behaviour. If such bundled temperamental effects were mentioned in the vast nineteenth-century breeding literature, it would have been fascinating and important to include them.

Given the profound sense of attachment on which the human–dog bond evolved, I would have expected that this bond — or the lack of it — would be an important factor in the Victorian explosion in breeding. We do

learn that members of the Fancy were said to treat dogs better than their families; that toy dogs were bred to tolerate the excessive fawning of their mistresses; and that the shows' popularity was “driven by the participants' passion for dogs”. The only evidence of passion, however, appears in those (mainly women) who fought to abolish the shows because of abusive conditions (such as long hours, lack of water and worse). They also spoke out against breeding standards that led to gross deformities and diseases still with us. Cruel ear cropping was abolished in Britain in 1895, but the 2007 ban for tail docking still allows exemptions for working breeds such as spaniels, poodles and pointers.

To me, the greatest service offered by *The Invention of the Modern Dog* is to remind us not to breed dogs for conformation alone. We knew that 150 years ago. Take the Dalmatian, which owes its spots

to a gene profile associated with a painful urinary disease. A simple outbreeding to an English pointer in 1973 left the breed with spots and good health. In 2011, 15 generations later, the American Kennel Club finally recognized it as a true Dalmatian.

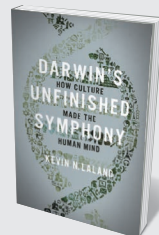
We now have the genetic science and technology to make true improvements to the twenty-first-century dog. We can and we must use this knowledge to re-invent the Victorian canine into an animal bred for good health and temperament. I can't wait to see what that dog looks like. ■

Meg Daley Olmert is the author of *Made For Each Other: The Biology of the Human-Animal Bond* and director of research for *Warrior Canine Connection*, a service-dog training intervention to reduce the symptoms of combat trauma, in Boyds, Maryland. e-mail: meg@warriorcanineconnection.org



How to Tame a Fox (and Build a Dog)

Lee Alan Dugatkin and Lyudmila Trut
UNIV. CHICAGO PRESS (2018)
Biologists Lee Alan Dugatkin and Lyudmila Trut chronicle Trut's extraordinary, long-running research with Dmitri Belyaev on the domestication of silver foxes — work that effectively shrank 15,000 years of evolution to decades.



Darwin's Unfinished Symphony

Kevin N. Laland PRINCETON UNIV. PRESS (2018)
How did the human potential for culture evolve from hominin behaviour and cognition? Evolutionary biologist Kevin Laland navigates the false leads and breakthroughs that led to his theory that culture is both a result of evolution, and a factor that has effectively shaped its progress.

MEDICAL RESEARCH

Riding the global tide of blood

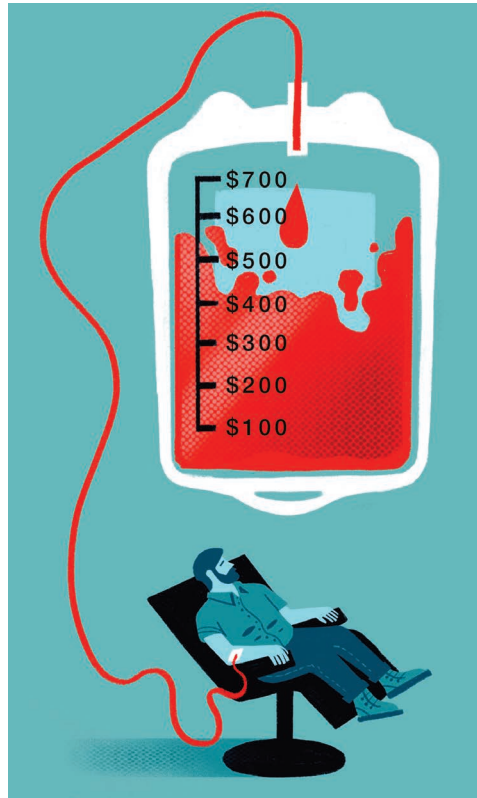
Tilli Tansey enjoys a compelling exploration of the dynamic biological fluid.

Blood is life. Blood is death. Writer Rose George's book ranges extensively and often disturbingly between these contradictory extremes. George examines blood as a life-saving medicine, an infective agent, an easily accessible indicator of disease and injury, a taboo, a weapon and, in all contexts, a commodity to be bought, sold, used, misused or controlled.

George (whose previous books examined shipping and human waste) develops each theme in a series of engaging personal stories and journeys. The "vein to vein" account of blood transfusion starts at St George's Hospital in South London, where George donates 470 millilitres of blood. She then 'follows' it to a National Health Service Blood and Transplant (NHSBT) processing facility in south-west England. There, a single donation can provide a range of products. These include red blood cells, platelets and cryoprecipitate for clotting disorders, as well as whole blood depleted of white blood cells to transfuse into infants with less-developed immune systems, and fresh frozen plasma for transfusion to replace lost blood. We learn that, since 2003, a "male donor preference" has operated in Britain: women's plasma, laden with excess hormones, mainly from contraceptive pills and hormone-replacement therapy, requires considerably more screening and treatment, and is routinely discarded.

George shares some sobering statistics. Every three seconds, someone in the world receives a blood transfusion (this translates to 2.5 million units of blood transfused per year in Britain, and 16 million in the United States). But many nations, including all those in Africa, fail to reach the World Health Organization's target of 1–3% of the population donating. In Sweden, a modest initiative begun in 2012 has increased contributions by simply texting donors to let them know when their blood has been used; Britain has followed suit.

But these life-saving donations can also carry death and disease. The disturbing

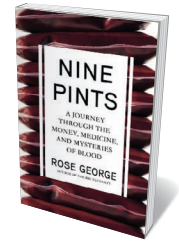


stories of contamination from around the world, especially by HIV and hepatitis C, are now well known. For instance, many people with haemophilia, surgical patients and new mothers who received blood products in the 1970s and early 1980s in Britain also unknowingly received infections, mainly HIV and hepatitis C. Many are still seeking recognition and compensation. The introduction of more-stringent criteria for donors has removed these problems from Britain's blood supply. There are effective measures. One is the rejection of blood donations from people who have recently visited areas where blood-borne diseases such as malaria, West Nile fever or Zika are rife. Another is testing for a wide range of viruses, including hepatitis B

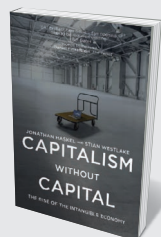
and C, HIV and syphilis. (Ironically, British blood is considered a risk for contamination with the prions causing the neurodegenerative condition Creutzfeldt–Jakob disease, and is not accepted outside the country.) Elsewhere, larger risks remain. HIV infection from a transfusion is 3,000 times more likely in India than in the United States. And, worldwide, as many as 10% of HIV infections have been calculated to come from blood products.

There are further disturbing tales. We sense the terror of 16-year-old Radha in western Nepal: while she is menstruating, she must make her lonely way each evening to a remote hovel to sleep. This practice, *chaupadi*, makes Radha, like thousands of other teenagers, vulnerable to sexual assault by local men. George also recounts stories of poverty-stricken "plassers" in the United States, who legally sell their plasma twice a week (European limits are 24 donations a year) to earn US\$2–3 per day. And there are the rural communities in India where blood is now a kind of cash crop. As George reports, this has led to horrific abuse of migrants, imprisoned as "blood slaves" and bled for cash.

Heroes and heroines, too, abound in *Nine Pints*. Janet Vaughan, considered "too stupid to be educated" by her headmistress, qualified in medicine in the mid-1920s and specialized in blood disorders at the London Hospital. She made crude liver extracts for the treatment of pernicious anaemia, using mincing machines borrowed from friends, including Virginia Woolf (a distant relative). By the late 1930s, war was looming, heralding a need for blood. Knowing of



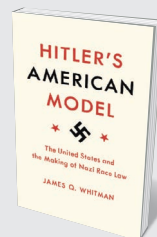
Nine Pints: A Journey through the Money, Medicine, and Mysteries of Blood
ROSE GEORGE
Metropolitan (2018)



Capitalism Without Capital

Jonathan Haskel and Stian Westlake
PRINCETON UNIV. PRESS (2018)

In our new industrial era, business assets are mostly intangible, from software to research. Jonathan Haskel and Stian Westlake offer insight into this mass economic shift, and how to exploit the move towards immaterial capital.



Hitler's American Model

James Q. Whitman PRINCETON UNIV. PRESS (2018)

Early US eugenics policies famously helped to inspire Nazi atrocities. Here, legal historian James Whitman examines how US Jim Crow laws, which enforced racial segregation from the 1880s to the 1960s, became a model for the Reich's egregious anti-Semitic Nuremberg Laws.

advances made in collection and storage during the Spanish Civil War, Vaughan established several effective blood depots — one in a bar in Slough, which always attracted donors. She initiated a mobile service, using ice-cream vans to collect and deliver blood around the country. One contemporary commentator, Major General W. H. Ogilvie, considered the greatest medical advance of the Second World War to be not penicillin, but the blood-transfusion service.

For me, the outstanding hero is Arunachalam Muruganatham, an innovator in sanitary products from southern India. It is an area where menstruation is considered shameful and dirty, many women cannot afford commercially produced pads, and public toilets and running water are rare. The lack of basic hygiene and the use and reuse of inadequate washable rags can lead to girls and women missing out on education and employment, and contracting gynaecological infections.

Muruga, as he is known, noticed his wife using newspapers and cloth during menstruation, and decided to experiment with alternatives. He carried a football filled with goat blood under his clothes so that he could release the liquid as he moved, and gain some sense of the practical difficulties. Ridiculed even by his family, he persevered, and designed machines to manufacture affordable pads, encouraging local communes and factories to produce and sell them. Muruganatham's story has featured in a 2013 documentary by Amit Virmani, *Menstrual Man*, and a 2018 Bollywood feature film by R. Balki, *Pad Man* (see S. Priyadarshini *Nature* 555, 27–28; 2018).

Nine Pints is highly readable and informative, but the chatty style grates at times, and there are a few irritating duplications. And the title — a nod to the volume of blood in a human body, which is variable and related to body size — seems strangely static for a dynamic biological fluid with many vibrant contexts. ■

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PHYSICS

Black-hole fever

Richard Panek on two books tackling the counter-intuitive weirdness of these gravitational beasts.

In the late nineteenth century, physicist Ernst Mach wrote that when Isaac Newton published his theory of gravity in his book *Principia* (1687), it disturbed his fellow natural philosophers. The reason? It “was founded on an uncommon unintelligibility”: two objects interacting without physical contact. Mach was trying to show how an affront to common sense gains respectability through familiarity. By his own era, gravity had become “common unintelligibility”.

Black holes — gravitational beasts that warp space and devour light — have undergone a similar trajectory. In the 1980s, they still seemed like science fiction. Since then, advances in technology and theory have transformed them into scientific (near) certainties. Now, two books — *Einstein's Monsters* by astronomer Chris Impey, and science journalist Seth Fletcher's *Einstein's Shadow* — trace that transition without losing sight of how weird their subject is.

In *Einstein's Monsters*, Impey provides a history of black holes and an overview of investigations into their supremely counter-intuitive behaviour. The possibility of their existence arose from the idea that gravitation is a force of attraction between bodies of matter. If light were matter, as British philosopher John Michell and French mathematician Pierre-Simon Laplace argued in the eighteenth century, it would be subject to Newton's laws. And if Newton's laws were correct, an object with sufficient mass could overwhelm light's mass, creating a “dark star”. Laplace even provided a mathematical foundation for such a thing, in 1799. That year, however, polymath Thomas Young demonstrated that light acts as a wave. Laplace dropped his idea.

Albert Einstein's 1905 paper on the photoelectric effect, suggesting that light travels as both waves and packets of matter (photons), might have revived the dark star — had he not, ten years later, rendered obsolete the idea

Einstein's Monsters: The Life and Times of Black Holes

CHRIS IMPEY
W. W. Norton (2018)

Einstein's Shadow: A Black Hole, a Band of Astronomers, and the Quest to See the Unseeable

SETH FLETCHER
Ecco (2018)

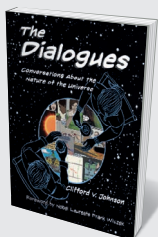
of gravitation as a force mysteriously operating without physical contact. In Einstein's universe, light follows curves in space-time created by the presence of objects with mass. Within months of Einstein's 1915 presentation of his general theory of relativity, astrophysicist Karl Schwarzschild found a solution for Einstein's equations: an object needn't be huge to trap light, as Michell and Laplace had assumed; it just needs to be sufficiently dense.

Impossibly so, thought many physicists, including Einstein. Such an object could result only from mass collapsing into a state of infinite density — a singularity. And infinities don't lend themselves to enthusiastic scientific endorsements. Just because a “monster” is mathematically feasible doesn't mean it exists.

However absurd, the possibility lurked, and some theorists love lurking absurdities. From the 1920s, they had the benefit of quantum mechanics, an understanding of the subatomic Universe in which previously unimaginable density makes sense. Theorists in the 1930s calculated that the mass of a star determines its eventual fate — and that those fates include a neutron star or a dark star.

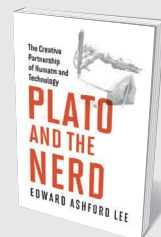
A neutron star was fine: quantum mechanics could account for a creature wherein a few cubic centimetres of matter weighs one billion tonnes, and the nuclei of adjoining atoms abut one another. A dark star was different. The ugly, infinity-dependent singularity at its heart defeated both general relativity and quantum mechanics.

For black holes to become commonly ▶



The Dialogues

Clifford V. Johnson MIT PRESS (2018)
Physicist Clifford Johnson aims to spark curiosity about science through discourse. In this thought-provoking graphic novel, he optimizes the rule of ‘show, don't tell’, encouraging engagement with concepts from the multiverse to immortality in everyday social scenarios.



Plato and the Nerd

Edward Ashford Lee MIT PRESS (2018)
Technology and creativity are irrefutably intertwined. Computer scientist Edward Ashford Lee explores both the potential impact of the digital revolution on human evolution and how technology's “real power comes from partnership with humans”.

► unintelligible, observations had to catch up. From mid-century, astronomers looked at the Universe in electromagnetic wavelengths from radio waves to γ -rays, and identified distant objects that generated geysers of radiation — a match for theoretical black holes. Theorists such as Stephen Hawking tried to divine what happens at the event horizon — the boundary between this Universe and whatever lies beyond the gravitational field.

Further advances, such as the Hubble Space Telescope, made the evidence overwhelming. Supermassive black holes probably occupy the centre of every galaxy and determine galactic growth. Over about 50 years, black-hole studies have gone from obscurity to a thriving industry. Theorists, Impey writes, are “in a golden age”, and observers “are harvesting massive black holes on an industrial scale”.

The harvest of two black holes is the subject of Fletcher’s book. One lies in the relatively nearby Virgo A galaxy. The other, the supermassive candidate Sagittarius A*, is at our Galaxy’s heart. Observations of black holes have generally relied on indirect evidence, given the constraints of attempting to ‘see’ a black object on a black background at distances of up to several billion parsecs.

The evidence for Sagittarius A* includes numerous studies over the past 20 years, revealing the zigging and zagging of nearby stars and gas under its apparent influence. But the Event Horizon Telescope (EHT) has tried to observe it directly.

Fletcher, chief features editor at *Scientific American* (which shares a publisher with *Nature*), tells this story. To bring such an observation into the realm of the possible, a telescope would need an aperture the diameter of Earth. By using very-long-baseline interferometry — combining observations from multiple, far-flung radio telescopes — the EHT team conceived an apparatus effectively covering the Western Hemisphere. For one week in April 2017, that network focused on the centre of the Milky Way to extract images such as the blazing radiation that should be generated by matter heating up to billions of degrees as it orbits the black hole at velocities approaching the speed of light.

Fletcher secured close access to the EHT collaboration, particularly director Sheperd Doeleman. Its results aren’t public yet, leaving a hole at the heart of Fletcher’s narrative. He compensates with a compelling behind-the-scenes story of scientists struggling as much

with funding and competition as with the challenges of seeing Sagittarius A*.

Both books address the seeming absurdities of their subject with authority and wit. Fletcher characterizes the EHT as a “distributed Babel, constructed on as many as a dozen high perches”. And after describing a death spiral between two black holes, each 10 million times the mass of Earth and hurtling around each other at half the speed of light, less than 200 kilometres apart, Impey concludes: “This isn’t an orbit, it’s insanity”.

Maybe. But if history is any guide, it won’t seem so for long. Improvements to gravitational-wave detectors such as the Laser Interferometer Gravitational-Wave Observatory should make the detection of black-hole collisions routine, inspiring a new generation of theorists to address the incompatibility of general relativity and quantum mechanics. As these two books make clear, the study of black holes has progressed rapidly from “No way!” to “Oh, wow.” The next step is: “What now?” ■

Richard Panek is the author of *The 4% Universe* and the forthcoming *The Trouble With Gravity*.
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NEUROIMAGING

The brain decoders

Chris Baker enjoys a clear-eyed account of the promise and pitfalls of brain imaging.

Since the advent of neuroimaging in the 1980s with positron emission tomography (PET), the sight of a living human brain in action has captivated scientists and the public. The emergence of functional magnetic resonance imaging (fMRI) in the early 1990s was a watershed. MRI scanners were already common in hospitals and, unlike PET, fMRI does not expose people to radioactivity. By measuring activity in the brain at the scale of a few millimetres, these scans seem to promise profound insight into the workings of the brain. That has led to wild claims that the technique could enable mind reading — actually knowing a person’s precise thoughts.

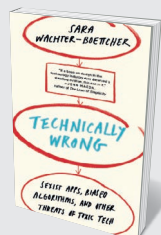
Russell Poldrack tackles these claims head on in *The New Mind Readers: What Neuroimaging Can and Cannot Reveal about Our Thoughts*. RUSSELL A. POLDRACK Princeton University Press (2018)

Experimental psychologist and neuroimaging pioneer takes readers through three decades of fMRI, its promise and limitations. From the race between groups in Minnesota, Massachusetts and Wisconsin in 1991 to show that MRI measures of blood oxygenation can reflect functional brain activity, to the development of techniques for decoding what

someone is looking at, Poldrack surveys the history and biological basis of the technique and its potential application in areas as diverse as law and psychiatry.

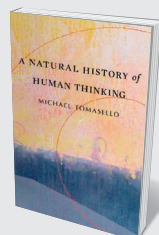
Poldrack is an ideal guide. As director of the Stanford Center for Reproducible Neuroscience in California, he actively advances fMRI methods. His enthusiasm for them is clear, as is his frustration at how their data have been misinterpreted and abused.

The technique has revolutionized neuroscience. Thousands of fMRI studies are published each year on topics ranging from perception to decision-making. For example, we now know that the pattern of blood flow



Technically Wrong

Sara Wachter-Boettcher W. W. NORTON (2018)
Technology permeates life, from grocery shopping to dating apps. Yet we rarely question its design or aims. Web consultant Sara Wachter-Boettcher proffers a damning critique of the ethical dilemmas it poses, and why we need to demand more accountability from tech creators.



A Natural History of Human Thinking

Michael Tomasello HARVARD UNIV. PRESS (2018)
Drawing on 20 years of comparative studies on humans and great apes, psychologist Michael Tomasello theorizes that human cognition arose from social cooperation. Language and culture, he posits, also grew from our ancestors’ need to work collaboratively.



to the fusiform face area in the temporal lobe can indicate that a person is looking at a face instead of a ball; and that imagining playing tennis or walking around your house, say, elicits activations in different brain regions. That is a major advance for neuroscientists and physicians who work with people in apparently non-responsive states after brain injury. It means they can identify patients with conscious awareness simply by asking them to engage their imaginations.

But some claims for fMRI are exaggerated. In 2007, *The New York Times* published an article based on fMRI data collected while people viewed images of candidates in US presidential primary elections, such as Barack Obama and John McCain. A group of neuroscientists at the University of California, Los Angeles, and political scientists had interpreted the results, alleging that they revealed how swing voters felt about the candidates.

As Poldrack explains, the trouble is that activations of particular brain regions — such as the amygdala and the insula, which have been associated with fear and disgust, respectively — are not uniquely associated with particular mental states. One region, the anterior cingulate cortex, was found to be active in about one-quarter of thousands

THE POTENTIAL FOR OUTLANDISH CLAIMS IS HIGH.

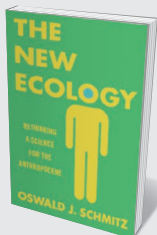
of studies that Poldrack and his colleagues examined, including those involving pain, short-term memory and cognitive control. So, ‘reverse inference’ of thoughts from brain-activation patterns can be very misleading. The potential for outlandish claims is high, Poldrack shows, when scientific data are used to support political and commercial interests — for example, when companies promote the ability to detect lies or to evaluate how viewers respond to advertising without sufficient scientific rigour. *The New Mind Readers* is a valuable example of how science can be discussed clearly and evenhandedly, without sensationalism.

One of Poldrack’s key themes is that interpreting fMRI findings demands an understanding of the underlying data and how they

were produced. These scans do not measure neural activity directly. They rely on changes in the magnetic properties of haemoglobin (depending on levels of oxygen), to reveal local differences in blood flow. These reflect neural activity and are associated with different mental states, such as increases in the activity of motor cortex while tapping the fingers. When a technique involves hundreds of thousands of measurements across the brain, it is challenging to distinguish between a real change and a chance observation. Concerns over reproducibility are prominent. Moreover, many experiments use only a small sample, of fewer than 20 participants, often university students, in a laboratory setting.

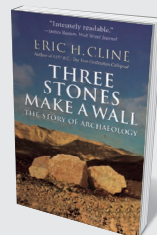
Caution is needed about generalizing to more complex, real-world situations. These include driving a car down a busy motorway, or moving from average activation patterns to single brains in a much more diverse general population, ignoring the importance of the individual variability that is part of being human.

The New Mind Readers is personal and selective. Poldrack gives short shrift to some methods, including brain stimulation, in which magnetic pulses are used to alter brain function directly to probe the ▶



The New Ecology

Oswald J. Schmitz PRINCETON UNIV. PRESS (2018)
As we strive for sustainability amid unprecedented global transition, ecology is evolving to encompass the interdependence of human agency and nature. Ecologist Oswald Schmitz calls for careful stewardship and conservation of biodiversity to foster ecosystem resilience.



Three Stones Make A Wall

Eric H. Cline PRINCETON UNIV. PRESS (2018)
Archaeologist Eric Cline walks us through the fascinating history of his discipline, traversing civilizations and the globe. From the discovery of Tutankhamun’s tomb in Egypt to the future of excavation as technology advances, this is an engaging introduction to a gripping field.

► specific role of the region targeted. He also skimps on neuroimaging techniques such as magnetoencephalography, which directly measures changes in magnetic fields produced by electrical signals in the brain. This is not an exhaustive account, and Poldrack focuses only on key developments and pioneers close to his own work. Yet his idiosyncratic approach is deeply engaging.

I was fascinated by Poldrack's description of why he decided to scan himself more than 100 times over 18 months to investigate how the brain changes over time — despite enduring a panic attack the first time he went into an MRI scanner. This intensive study uncovered much about the stability of brain function and the factors that affect it (including caffeine, food and mood). Yet Poldrack reveals that he learned “depressingly little” about himself during the experiment, highlighting the challenges of using fMRI for personalized medicine.

At times, Poldrack loses focus. His brief forays into topics such as the nature of mental illness are unsatisfying: they are too brief and lack the clarity of the rest of the book. Nevertheless, this is a compelling introduction that lucidly spells out the risks of taking media reports at face value, and urges readers to dig into the details. fMRI is evolving rapidly and researchers are just starting to map brain activity at sub-millimetre resolution, revealing activity — both in different regions and in different layers of cortex within a region.

Happily, despite the book's title, Poldrack makes it clear throughout that ‘mind reading’ as most people would imagine it remains in the realm of science fiction. What is much more exciting is the potential of fMRI for providing insight into brain function that will ultimately lead to clinical applications. ■

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The views expressed do not necessarily represent those of the US National Institutes of Health, the Department of Health and Human Services or the US Government.

ATOMIC PHYSICS

Secret histories of the bomb

Sarah Robey examines two books that together trace the birth and evolution of the nuclear age.

The secretive twentieth-century history of nuclear weapons is an evergreen subject. Writers have mined it for stories of breakneck innovation, wrenching controversy, unimaginable violence, espionage and larger-than-life personalities. Two new books — *Fallout* from historian Peter Watson and *Burning the Sky* by science writer Mark Wolverton — continue this trend, recalling two instructive episodes in our collective nuclear past.

Fallout synthesizes the history of the race to create an atomic bomb in Germany, the United Kingdom and the United States from the 1930s to the end of the Second World War — a story of duplicitous players, sinister decisions and regrettable outcomes. In a twist of historical fate, Adolf Hitler's rise coincided with major breakthroughs in particle physics, including the theorization of nuclear fission by Lise Meitner and Otto Frisch in December 1938. By the time war broke out, many prominent scientists had fled the Reich, and the Allies assumed that any physicists remaining in Germany, including Werner Heisenberg, were working to harness fission to produce a bomb (see A. Finkbeiner *Nature* **503**, 466–467; 2013). This was the main reason that Britain and the United States sought to beat Hitler to the punch.

But, as Watson uncovers, British intelligence showed that Germany's atomic programme had stalled by 1942. Why, then, did the joint UK–US atomic programme move forward, despite incredible cost and danger? Watson painstakingly outlines a complex web of who knew what, and when, to show how a series of opportunities to stop what became the Manhattan Project arose, then passed. In 1942, without access to full

Fallout: Conspiracy, Cover-Up, and the Deceitful Case for the Atom Bomb

PETER WATSON
PublicAffairs (2018)

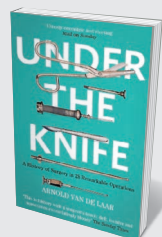
Burning the Sky: Operation Argus and the Untold Story of the Cold War Nuclear Tests in Outer Space

MARK WOLVERTON
Overlook (2018)

British intelligence, the US government actually ramped up its project, assuming that Germany was advancing rapidly. As Watson puts it, “a series of momentous mistakes were made, and lies told” by French, German, British and US officials. Thus “the world stumbled, even blundered, unnecessarily into the nuclear age”. In his view, today's extraordinary nuclear challenges — deteriorating arsenals, ongoing proliferation and the rebirth of sabre-rattling nuclear diplomacy — were preventable.

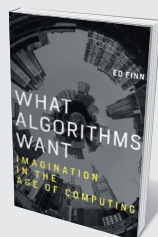
Watson's meticulous attention to this chronology is one of the book's strengths. He details wartime research on both sides of the Atlantic, from Copenhagen to New Mexico, and delves into the motivations and actions of the Allied leadership. Also interesting are his findings on the public availability of nuclear research in contemporary press reports and scientific journals, including *Nature*. Managing these threads is no small authorial feat — of research, especially. Watson also weaves together the insights of previous nuclear historians, such as Richard Rhodes, Martin Sherwin and David Holloway.

In what could have been a volume in its own right, the narrative is bookended by the overlapping wartime sagas of Niels Bohr and Klaus Fuchs. Fuchs, the infamous German



Under the Knife

Arnold van de Laar JOHN MURRAY (2018)
In this witty chronicle, surgeon Arnold van de Laar dissects thousands of years' worth of remarkably gruesome stories. From anaesthetic-free amputations and bloodletting to Albert Einstein's aneurysm, these are key insights into the cut and thrust of medicine.



What Algorithms Want

Ed Finn MIT PRESS (2018)
Algorithms saturate the digital universe, from Amazon book recommendations to Uber. Ed Finn will make you reassess how you think about these formulae: not as mere components of code and computations, but shaped by a philosophy, and shaping culture in their turn.

spy who passed secrets from the Manhattan Project to the Soviet Union, and the towering physicist Bohr serve as foils to the main plot. During the war, each had a longer-term vision of what nuclear weapons would mean to the post-war order. Bohr suspected that the Western Allies' relationship with the Soviets would be damaged; Fuchs, by delivering crucial technical information to the Soviets, helped to ensure that it was.

The aftermath of that era comes to life in Wolverton's gripping *Burning the Sky*, the first book-length treatment of a remarkable series of nuclear tests in outer space, code-named Operation Argus. After the Soviet Union launched its satellite Sputnik-1 in 1957, US agencies realized that they were lagging behind in missile technology. The cold war arms race took on new urgency. When, in early 1958, the US government finally succeeded in launching its Explorer 1 satellite — the first of more than 90 in the series — the achievement did more than calm US anxieties. Experiments on board Explorers 1 and 3 led to the discovery of the Van Allen belts, concentrated bands of radiation that circle the planet along the contours of its magnetic fields.

At a time of international tensions and ample defence dollars, however, scientific discovery was rarely separate from weapons considerations. At Livermore Radiation Laboratory in California, physicist Nicholas Christofilos believed that the belts could be harnessed as part of US defence. He theorized that high-altitude nuclear detonations would create a "shell of radiation" that could destroy missiles and warheads. Convinced, the US government under President Dwight Eisenhower embarked on Operation Argus, and later Operation Fishbowl, to test the theory.

The tests were logistical nightmares. Argus was conducted in the remote South Atlantic amid treacherous weather and technical problems. Only the last of its three 1.5-kiloton weapons detonated at the projected altitude, 794 kilometres above Earth's surface, in September 1958.

Half of the Fishbowl tests, in 1962, were aborted or cancelled. As Wolverton shows, it was incredible that there were no serious casualties. Although temporary belts were created, they were much weaker than Christofilos had theorized — capable of damaging satellites and releasing powerful electromagnetic pulses, but not of stopping a missile.

Together, these books highlight the tensions endemic to classified state-sponsored research in democratic society. Watson's subjects, including Manhattan Project heavyweights J. Robert Oppenheimer and Edward

ran counter to the IGY mission. Ultimately, national security lost out to scientific cosmopolitanism.

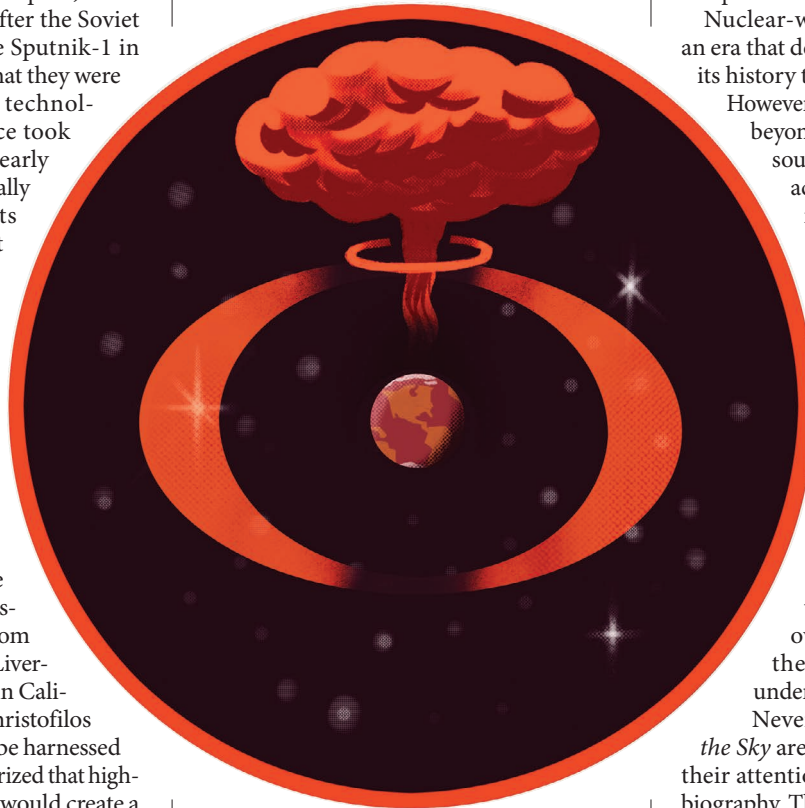
Whereas the Manhattan Project and its vast infrastructure of labs and production sites largely dodged press exposure, Argus officials struggled to contain leaks. By the late 1950s, the public was demanding nuclear transparency, and agencies involved in Argus, such as the Atomic Energy Commission, knew the tests would be controversial. The experiments were finally revealed in 1959 by *The New York Times*, inciting a media frenzy and public debate.

Nuclear-weapons science was born of an era that demanded secrecy. Recounting its history thus demands a sceptical lens.

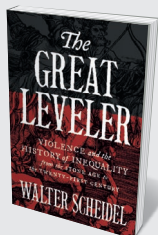
However, problems arise if it is assumed, beyond available evidence, that every source has a secret meaning, every actor an ulterior motive. Watson in particular has a penchant for the conspiratorial, and is eager to expose and blame. That makes for a page-turning read, but can discount the context of war — hot and cold. Both books are populated by egotists and opportunists, the quest for scientific priority, nationalism, ignorance, suspicion and doubts. Ultimately, their stories are all too human. Historians should not absolve their subjects entirely, but we owe it to past individuals, even the most belligerent, to try to understand all the forces at play.

Nevertheless, *Fallout* and *Burning the Sky* are informative and balanced in their attention to diplomacy, science and biography. They also provide much to ponder concerning the state of play now, from the nuclearization of North Korea to the unknown future of the Iran nuclear deal, and the part that the first members of the exclusive nuclear club might have to play in future. ■

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Teller, operated under — and were arguably victims of — extreme compartmentalization of information. Participants had a very limited view of the whole project. Fifteen years later, Wolverton's actors faced secrecy of a new kind. The Explorer missions took place under the auspices of the International Geophysical Year (IGY), the 1957–58 venture in which more than 60 countries shared data and took part in peaceful scientific collaboration. But as classified military studies, Argus



The Great Leveler

Walter Scheidel PRINCETON UNIV. PRESS (2018)
In this monumental, pessimistic study, historian Walter Scheidel examines anew an old social issue: economic inequality. As he reveals, disparities have burgeoned during times of peace, declining only during wars and revolutions. "Inequality never dies peacefully," he notes.



How To Fix The Future

Andrew Keen ATLANTIC (2018)
The Internet has advanced from a communication device to an unstoppable force moulding societies. Andrew Keen, pioneer of the cyber-tsunami, uses lessons from the Industrial Revolution to envision a future relationship with life online that honours human values. **Mary Craig**