

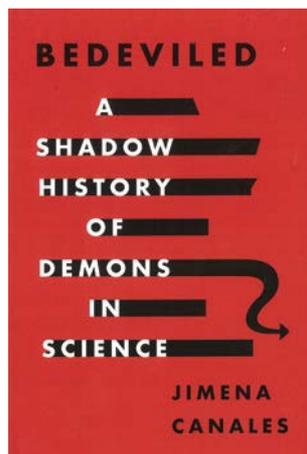
therapies and genome editing techniques would be similar to vaccination, providing prevention which needs only a single administration. Mizuno and Patel (University of Pennsylvania, USA) and Changolkar (University of Michigan Medical School, USA) appraise on the wearable devices used to detect cardiac arrhythmias and monitor pulse, blood pressure, heart and respiratory rates, physical activity and sleep. These devices aid remote patient monitoring, tracking their health behaviours and evaluating strategies to change health behaviours.

The final article is on the well-known antipyretic and non-steroidal anti-inflammatory drug aspirin. Both preclinical and clinical studies indicate that aspirin may decrease the incidence of deaths from sporadic colorectal cancer (CRC) and perhaps other cancers. The evidence for cancer prevention by aspirin is convincing in patients with Lynch syndrome, an inherited disorder resulting from mutations in one of the DNA mismatch repair genes and increases the risk of CRC, endometrial cancer and several other cancers. Rocciotti and Fitz-Gerald (Perelman School of Medicine, Philadelphia, USA) review the results of randomized clinical trials of aspirin in primary prevention of hereditary CRC and conclude that the benefit of aspirin for primary prevention of CRC is unproven as of now. Their article also provides a history of medical use of aspirin, pharmacology and mechanism of action of the drug, and a summary of the results of randomized clinical trials of aspirin in both primary and secondary prevention of cardiovascular diseases. While aspirin has a clear benefit in the secondary prevention of myocardial infarction and stroke, the beneficial effects for primary prevention are counterbalanced by a significant increase in risk for intracranial and gastrointestinal bleeding.

In summary, the book is a good read for medical professionals and biomedical scientists who want to improve their awareness of the frontiers in medicine. The articles in the book also indicate the gaps in the knowledge in several sub-specialities of medicine and are thus useful for the readers to identify topics for their scientific pursuits.

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**Bedeviled: A Shadow History of Demons in Science.** Jimena Canales. Princeton University Press, Princeton, USA. 2020. x + 398 pages. Price: US\$ 29.95. ISBN: 978-0-691-17532-4.

This detailed and insightful book traces the history of the conceptual demons that the modern sciences have invented even as they exorcised spirits from the domain of scientific investigation. It simultaneously chronicles the role these demons have played in advance of the sciences. But while science has been successful in exorcising demons, spirits and superstition, the march of science, as the title of the book suggests, is shadowed by demons of another kind. The demons that scientists invoke in their theories and experiments travesty the provisional rules and principles of the sciences and manifest themselves in scenarios and theories that escape the prevailing imagination of science. Over 10 chapters, an introduction, conclusion and postscript, the author takes us through a journey spanning more than three centuries. The first part of the book covers the demons encountered in physics, and then discusses demons in cybernetics, the computer and biological sciences and finally, the economy itself.

While the book begins more or less with the emergence of modern science in the 17th century, it must be noted that the demons discussed are modern ones. The term 'demon' is employed as an analogy to make an important point about the nature of the scientific quest. Consequently, the analogy is not to be taken literally but understood in the nuanced way that the author elaborates. The irony here is that while the faculty of reason, in tandem with experiments, exorcised premodern demons, scientists introduced imaginary creatures or beings in thought experiments in the scientific realm.

These creatures as devices were helpful not just in exploring the physical realm, but led to breakthroughs at the frontiers of science.

More than half the chapters in the book discuss the demons encountered in the realm of physical theory, from Laplace's mechanistic intelligence to Maxwell's demon to those encountered in quantum theory – and 'Bohm's demon' or 'Bohmian demons' is played out in the discussion on hidden variables. We are familiar with the demons evoked by Laplace and Maxwell and, in the latter case, we have a theoretical entity that could, in principle, 'stop entropy, put an end to decay and make the world run in reverse'; the explorations of Einstein, Marie Curie and Planck's reflections on the quantum realm throw fascinating light on the attempts to understand the new realm of physical theory. Thus while the author discusses the imaginary creatures at work in other disciplinary and interdisciplinary endeavours, the demons evoked by physics are widely known and indirectly played a role in the evolution of the scientific understanding of the world. However, these scientific demons did manifest themselves differently in thought experiments and theories. Thus, as the author Canales points out: 'If Laplace's creature was law-abiding and Maxwell's demons were law breakers, quantum demons were law benders.'

In any case, commencing with Descartes' 'evil genius', Canales discusses the philosopher's familiarity with automata and his fixation with one who might create an alternate reality that would mislead our senses, blurring the boundary between the real and spectacle. Descartes must find his way back to reality with the *Cogito ergo sum*. Canales trails how scientists invented several of these now-familiar demons as by products of their theoretical or technological constructions (Laplace's demons and Lovelace's reflections on machines and thinking beings) have enabled the scientists to make important discoveries and invent technological solutions. But the genealogy of these demons unfolds from the precision of Newton's theory to the Laplacian demon, who, given the trajectory and location of a particle as well as the forces acting on it, could compute both its past and future. Every subsequent demon surpassed its predecessor, for example, by sorting out fast from slow-moving gas molecules into separate chambers, one warmer and the other cooler respectively, in violation of one of the fundamental laws of thermodynamics. Each of these, as Canales points

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out, prompted new ideas, inventions and developments in the sciences. The later chapters bring up technological demons of our times, appearing in the work of the mathematician Norbert Wiener, who wondered about the demons that were in fact self-programming electronic circuits, to the demons activated by computer codes facilitating communication between computers, mobiles, digital devices and their users. In addition to the genies haunting powerful computers, there is also a discussion on the invisible hand of the market and the forces driving the global economy.

The author develops a narrative around every golem, imaginary entity, demon mentioned within a wide range of fields down to cybernetic metastable demons and computer demons, to discussing consciousness and Searle's demon that could control neurons in the human brain like a computer program and act as a link between synapses, taking over 'her neurons' and thus manipulating our behaviour, such that we would '...act in exactly the same way as if the neurons had not been intercepted'. Where then is the boundary between artificial intelligence and human intelligence. At the end of this amazing journey through the world of science, one pauses to wonder what motivated the author to write this book.

The concluding chapter and the philosophical postscript offer the reader a clue. At one level within the sciences and the social sciences, the standard narrative of the rise of modern science and the ascent of scientific reason is premised on a fundamental disjuncture – wherein 17th-century science marked a radical break with all that went before. Canales argues that the historians of science as well as of culture have to shoulder the burden of explaining these radical transformations and whether they occurred so rapidly and abruptly. She suggests that: 'There is another answer: a line between modern and premodern ways of thinking is impossible to draw because no such firm line can be found separating knowledge from the imagination – then as now. The persistence of the category of the demon in science is evidence of an interesting anomaly. The term was never dropped from the lexicon of truth-seeking enterprises, even when they became secular and scientific. Instead of a *cordon sanitaire*, modern demons reveal that a *liaison infecté* continues to connect modern culture with past eras in a way that has merged the lessons of old with the lessons of today.'

The deeper point that requires a more detailed discussion, perhaps elsewhere, is that through history, scientists exploring their respective problems not only engage

with real, existing entities, but, more often at any given historical time, work with concepts, categories and beings that escape their empirical net. They are compelled to invent imaginary entities and unknown demons from the premodern or modern worlds. These function as exploratory instruments or devices, as we learn that they remain active long after they have outlived their utility, returning in new forms, orienting research and innovation, prompting fruitful and enriching debates, resulting in a deeper understanding of the world. Maxwell's demon resurfaces today in a new form in research on the thermodynamics of information. If the core of this book is both rich and vast in its coverage of the sciences, the last two chapters leave much to the scientist, and the historian and philosopher of science to ponder over the practice of science and its relation to the past – for the book, it is evident, has much to offer both readerships.

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