

Books & arts

and Rhodri, a researcher in science, technology and innovation studies, bring together insights from a range of fields that analyse the workings of science. They explore from a philosophical perspective how scientists weigh forms of evidence. They use scientific studies to understand why researchers lack incentives to replicate findings. And they turn a scientometric lens on features of the literature such as public bias, selection bias and confirmation bias.

Drawing on – mostly male – theorists including Karl Popper, Thomas Kuhn and Bruno Latour, the Lengs show that, far from being engaged in a disinterested activity, scientists are in the business of persuasion. They write narratives to convince colleagues of their claims, or to overthrow conventional wisdom. Evidence becomes a rhetorical device: scientists might torture their data to say the right things, fail to mention evidence that contradicts their claims or add circuitous arguments that spin their evidence. Put more positively, evidence is credible only when embedded in a persuasive story. It does not speak for itself.

The authors dive into one of Gareth Leng's research interests – the hormone oxytocin – to lay bare the mechanisms of discovery. In a delightful historical chapter, they show how oxytocin's perceived role shifted from chemical promoting quick birth to 'love hormone' of maternal care, to 'cuddle hormone' of partner bonding, to 'trust hormone' influencing social behaviour. The substance first described by Henry Dale in 1906 bears little resemblance to our current understanding; all its roles are entwined with conventions and interpretation.

Disruptive culture

Another section starts as a fairly composed description of the emergence of scientific journals. It quickly turns into a passionate reproach to the commercialization of publishing and its disruptive effect on science. Corrupt journals and oligarchic publishers appear as villains, and disparaging scientists as their victims. The impact factor, once an innocent tool for librarians, is now a distorting measure that can make or break careers. On the basis of purely anecdotal material, the authors deconstruct how the culture of journal publishing is affecting science on the ground.

They describe a well-researched phenomenon that I have elsewhere called "thinking with indicators". This is what happens when scientists design and adjust their research to ensure a good score, or pick research questions to improve their chances of getting tenure. It is problematic when other criteria of quality – originality, long-term progress, broader relevance – become 'unthinkable'. The Lengs correctly implicate the publishing industry. But publishers are part of a complex web that also includes funders, institutions, evaluation systems and broader political and

social structures. This systems perspective is sometimes lacking in *The Matter of Facts*.

That aside, the book spotlights major flaws in science, including various forms of bias, lack of transparency and rigour, excessive competition, commercialization and vanity publishing. These pre-date COVID-19. The crisis has exacerbated some; others have evaporated as scientists rush to solve life-or-death problems.

This moment calls for a global collective vision of the structure of science. It is unclear who will articulate such a vision. The Lengs

help us to understand why: the value ascribed to discovery is determined by a cocktail of reason, rhetoric, conviction and power. Evidence has little purchase when denial is what wins votes. Perhaps field hospitals in parks, prisoners digging mass graves and the collapse of global supply chains will change the calculus?

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THE SIMONS FOUNDATION

Maryam Mirzakhani made breakthroughs in fields such as dynamics.

Mathematical hero: the movie

Documentary celebrates the first woman to win a Fields Medal. **By Davide Castelvecchi**

Maryam Mirzakhani broke into the exclusive club of top mathematics prizewinners in 2014. It was a momentous occasion: whether because of committee biases or the gauntlet of systemic obstacles and social pressures, no woman had previously won the discipline's most coveted award, the Fields Medal, established in 1936. Now, it seemed

Secrets of the Surface

Director: George Csicsery

Zala Films (2020)

<http://www.zalafilms.com/secrets>

that the pipeline of female talent was finally beginning to deliver.

George Csicsery's *Secrets of the Surface* is the first feature-length film on Mirzakhani.



Iranian girls were inspired to take up mathematics as a result of Maryam Mirzakhani's success.

It celebrates how she broke multiple glass ceilings – she was also the first Iranian to win the prize. And it strikes a satisfying balance between her magnificent mathematics and her human story, including her untimely death from cancer in 2017, at the age of 40.

The film traces Mirzakhani's roots and legacy, interviewing current students and teachers at the school for intellectually gifted girls she attended in Tehran. She did not show a particular interest in maths early on. Instead, she devoured books, dreaming of becoming a writer. But her aptitude for numbers showed: classmates joked that when presented with a problem in a maths lesson, she took pleasure in solving it four different ways.

Inspirational performance

In 1994, Mirzakhani and her best friend, Roya Beheshti – now a mathematician at Washington University in St. Louis, Missouri – became the first women in the Iranian delegation to the International Mathematical Olympiad. Mirzakhani returned the next year, and gained a perfect score. Her exceptional performance made her a national celebrity, and inspired other Iranian girls to study mathematics.

Graduating from Sharif University of Technology in Tehran, she went on to study for a PhD at Harvard University in Cambridge, Massachusetts. (A move that would these days be extremely difficult, given US President Donald Trump's restrictions on travel to the

“Her collaborators and peers describe a problem solver with the indomitable spirit of a marathon runner.”

United States from Iran and other countries.) In her thesis, Mirzakhani solved a central problem about curves on Riemann surfaces, a subject with a 150-year pedigree. To describe this and other achievements, the documentary switches from biographical to educational mode, with elegant animations.

Billiard-ball breakthrough

Soon after her earning her PhD, Mirzakhani became a faculty member at Stanford University in California, where she made several other breakthroughs with various

collaborators. In one major result, she and Alex Eskin of the University of Chicago in Illinois studied the chaotic dynamics of billiard balls.

In the film, many collaborators and peers describe a problem solver with the indomitable spirit of a marathon runner. Some fight back tears as they recall working alongside her. Their accounts are greatly enriched by interviews and other footage of Mirzakhani shot for a series of videos on the four winners of the 2014 Fields Medals.

Csicsery has carved a niche as a maker of compelling films about mathematicians, starting with the brilliant 1993 *N is a Number*, on Paul Erdős, the most productive mathematician of the modern era and a perennial couchsurfer. Csicsery's latest work celebrates the importance of female role models by showing the impact of Mirzakhani's short but extraordinary life on today's young women. But it never directly addresses the big question: why has no other woman ever won a Fields Medal (and only one, Karen Uhlenbeck in 2019, has received the Abel Prize), and what can be done to change this?

Davide Castelvecchi is a senior reporter for *Nature* in London.