measures required to keep health systems functional were in many cases severe restrictions of liberties. Thus, in democracies, political leaders had to justify and explain these deprivations to their electorate, while relying on the help of scientists and medical experts to explain the scientific reasoning underlying the measures. Again, this effort has been more successful with some governments, and less so with those of a populist inclination that have been known to have conflicted relations with experts even before the pandemic.

The urgent necessity of clear communications has created new stars of the COVID age, however. In Germany, for instance, the virologist Christian Drosten from the Charité hospital in Berlin, who had been part of the team that discovered the original SARS virus in 2003, became the public face of the pandemic response and was applauded for his clear messaging. However, he has also faced attacks from those who considered the response unnecessary. The chemist and YouTuber Mai Thi Nguyen-Kim also won praise for clear communications to the public.

Science writer Laura Spinney was much in demand as a commentator, as she had written a book about the 1918 flu pandemic published on its centenary, and thus knew better than most people what it is like when a new infectious agent sweeps around the world. Writing about the current pandemic, Spinney also highlighted success stories, such as the Indian state of Kerala, where health minister K.K. Shailaja presided over a remarkable response that limited the number of casualties to double digits (20 by June 15) in a state of 35 million inhabitants.

The sheer amount of information accumulating, which also has to be made accessible to the world population, has been a major challenge. To address this, biologists Virginie Courtier-Orgozozo and Claire Wyart, both based at research institutes in Paris, France, have set up a multi-authored, multi-lingual web resource, en.adios-corona.org. "We deeply believe that it is the role of scientists to inform society and to provide the public with cues and methodology for them to be able to make better choices and to navigate safely in our new environment that we share with the SARS-CoV2 coronavirus," Wyart explains. "We hope to inspire our colleagues around the world to join and help in this fight against both the virus' spread and misinformation for the public good."

Communicators are confronted with a rising tide of misinformation. False information, some of it seeded maliciously with the aim to destabilise democracies, has become a growing problem and contributed to the shift to a 'post-truth world' where even populist leaders take part in the spreading of conspiracy theories and other untruths (Curr. Biol. (2017) *27*, R1–R4).

While these toxic falsehoods can be destabilising at the best of times, undermining the trust in scientific evidence in the event of a pandemic contributes to making things worse. Following swiftly after the wave of infections, the world has witnessed a wave of misinformation, including a rich diversity of implausible conspiracy theories either denying the reality of the disease or attributing it to various non-viral causes from the 5G communications infrastructure to bioweapons research.

The World Health Organisation (WHO) has highlighted the information overload and described it as an infodemic, meaning "an over-abundance of information — some accurate and some not — rendering it difficult to find trustworthy sources of information and reliable guidance."

Researchers are already investigating the infodemic phenomenon, but results published on preprint servers so far are yet to be peer-reviewed. Observers of misinformation problems have already remarked that various interested parties have spotted an opportunity in the crisis and swiftly hitched their hobbyhorses to it.

The most important battle in the fight against misinformation is still to come, however. If and when a vaccine for COVID-19 becomes available, the established networks of hardened vaccine critics may rise to the challenge of undermining its use. In the wealthier countries, where the cost of the vaccination is less of an issue, public trust in it may be the factor deciding its success. In such cases, good science communication can save many lives.

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Book review

What we think about when we think about thinking

John Tuthill

The Idea of the Brain: The Past and Future of Neuroscience
Matthew Cobb
(Basic Books, New York, NY; 2020)
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A few thousand years ago, most people believed that their thoughts and feelings originated within the heart. Gilgamesh, the cocksure protagonist of the world's oldest poem, encourages his timid buddy Enkidu: "if your heart is fearful, throw away fear; if there is terror in it, throw away terror". If this reminds you of a pep talk from a coked-up high-school hockey coach, it is because the heart persists to this day as a metaphorical seat of human emotion. But two thousand years of poking around inside the bodies of animals (including humans) have demonstrated that our thoughts and feelings arise from electrical activity in the brain.

One of the earliest brain pokers was Galen, a 2nd century Roman physician. Galen got his start as a personal doctor to the gladiators, and this position provided him with unusual opportunities to look inside human bodies. On one occasion, Galen observed that a gladiator with a demolished heart remained lucid until the point of death. He was inspired to carry out systematic lesion experiments on basically any animal that he could wangle: goats, bears, lions, cows, monkeys, pigs. He often conducted these ghoulish vivisections as a public spectacle. In Galen's most infamous performance, he demonstrated that squeezing the laryngeal nerve of a squealing pig temporarily eliminated its vocalizations. From these experiments, and others in which he directly lesioned the brain, Galen concluded that the life force ('pneuma') that propels the body originates from the nervous system and not the heart. While Galen's theoretical views of the life force have fallen out of favor, he is remembered as the first

to identify nerves as conduits for the sparks of sensation and action. He also correctly concluded that the brain is the underlying reservoir of thought.

Galen's pioneering work helps to set the scene in Matthew Cobb's pleasurable new book, *The Idea of the Brain*. The field of neuroscience has lacked an approachable narrative history and Cobb's book capably fills this gap. It is divided into three sections: 'Past', 'Present', and 'Future'. In the first section, Cobb skillfully waltzes readers through two thousand years of investigation into the biological basis of thought and behavior. Although some of this history is familiar, Cobb spruces up the memory palace by introducing a number of obscure and colorful characters. We meet Julien Offray de La Mettrie, an 18th century French thinker who published a snarky manifesto in which he presciently argued that humans are biological machines and that human cognition is no different from that of other animals. While La Mettrie's ideas were largely ignored by the scientific community, Cobb speculates that they may have influenced Enlightenment-era pornography, which portrayed sex between humans and machines. Tragically, La Mettrie died young, felled by a whopping bout of indigestion after consuming too much pâté made from eagle livers and 'bad lard'.

Not all of this history is fanciful. Many of the key insights in neuroscience were acquired at a shameful cost: brutal experimentation on vulnerable humans and other animals. Although Cobb points out some of these atrocities, one senses that much of our dark past remains to be excavated and confronted. By comparison, several recent books have investigated the sinister relationship between the field of genetics and the racist ideology of the eugenics movement. Genomic analysis eventually exposed the concept of race as a social construct. It remains to be seen whether insights from neuroscience will re-define concepts of human identity. An optimistic view is that unmasking the ghost in the machine will expose the frailty of human intelligence and reveal our close kinship with other species. But optimism is scarce these days, and Cobb is not especially rosy about the present and future of neuroscience.

At the beginning of the second section ('Present'), Cobb lays out his thesis that "no major conceptual innovation has been made in our overall understanding of how the brain works for over half a century". The legitimacy of this statement leans heavily on the definition of 'conceptual', but the basic point is that our framework for understanding neural computation was established in the first part of the 20th century: neurons are connected into networks that encode symbolic representations of the external world, and somehow these representations are transformed and processed to produce behavior. Cobb claims that, for the past 70 years, we have mainly been discovering new factoids to fit within this framework. Fortunately, this episode of handwringing is brief, and it is followed by a masterful tour through many of the major advances in brain science over the last century. The thematic organization of each chapter — memory, computers, chemistry, consciousness — allows the author to clearly explain key concepts while avoiding chronological singsong. (Regrettably, this section is also peppered with cheeky parentheticals and waggish footnotes, as if the need for authorial introspection has scaled in tandem with the number of neurons we can record from simultaneously.)

A thread in Matthew Cobb's recent work is the role of metaphor in catalyzing scientific insight. In his previous book, *Life's Greatest Secret*, he argued that developments in cybernetics helped spawn the field of genetics by framing issues of heredity in terms of information transmission. In this new book, he again highlights how apt metaphor has allowed scientists and thinkers to conceptualize the function of brains. Descartes compared the nerves of the body to the pipes of hydraulic automata found in fancy French gardens. Helmholtz analogized the conduction of electrical activity in nerves to telegraph wires. Adrian used Morse code to explain how action potentials may represent a neural code. McCulloch and Pitts considered brains as computing machines in which neurons implement logical functions.

In the final section ('Futures'), Cobb worries that we are running out of new technological metaphors for brain function or that the metaphors that we have may be losing their explanatory power. I am all for innovative analogy, but is the scarcity of appropriate metaphors actually a significant barrier to scientific progress? It may be fun to argue about whether or not brains are computers or blockchain tacos, but what do we learn from this debate? Here, I worry that Cobb has confused the practice of science with the communication of science. Then again, one cannot exist without the other, so maybe he is right. Either way, fretting about a lack of appropriate metaphors is like worrying that aliens have more delicious flavors of ice cream than we do.

A valuable lesson from the history of neuroscience is that confident assertion does not equal truth. More often than not, it is actually counterproductive. Lounging in his comfy Greek recliner, Aristotle announced, "and of course, the brain is not responsible for any of the sensations at all. The correct view is that the seat and source of sensation is the region of the heart." In our current pandemic, unqualified armchair declarations of scientific certainty seem to have come back in style. Aristotle was born 50 years after the Great Plague of Athens, but if he were alive he almost certainly would have expressed his asinine views through a series of long-winded Medium posts. A good reason to read history at this moment is to find solace in the knowledge that our predecessors also had to contend with both pandemic viruses and smug blowhards.

The mysteries of the mind have long attracted individuals predisposed to grandiosity. *The Idea of the Brain* makes it clear that neuroscience is still a jungle gym for lofty minds. The book will provide an accessible starting point for budding enthusiasts and students who are curious about the field's traditions and vital questions. Its loving erudition will also satisfy old crusty electrophysiologists seeking a hit of nostalgia. Matthew Cobb has captured a well-framed snapshot of a moment in time at which many of the questions are clear but the hard work of answering them is just getting started.

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