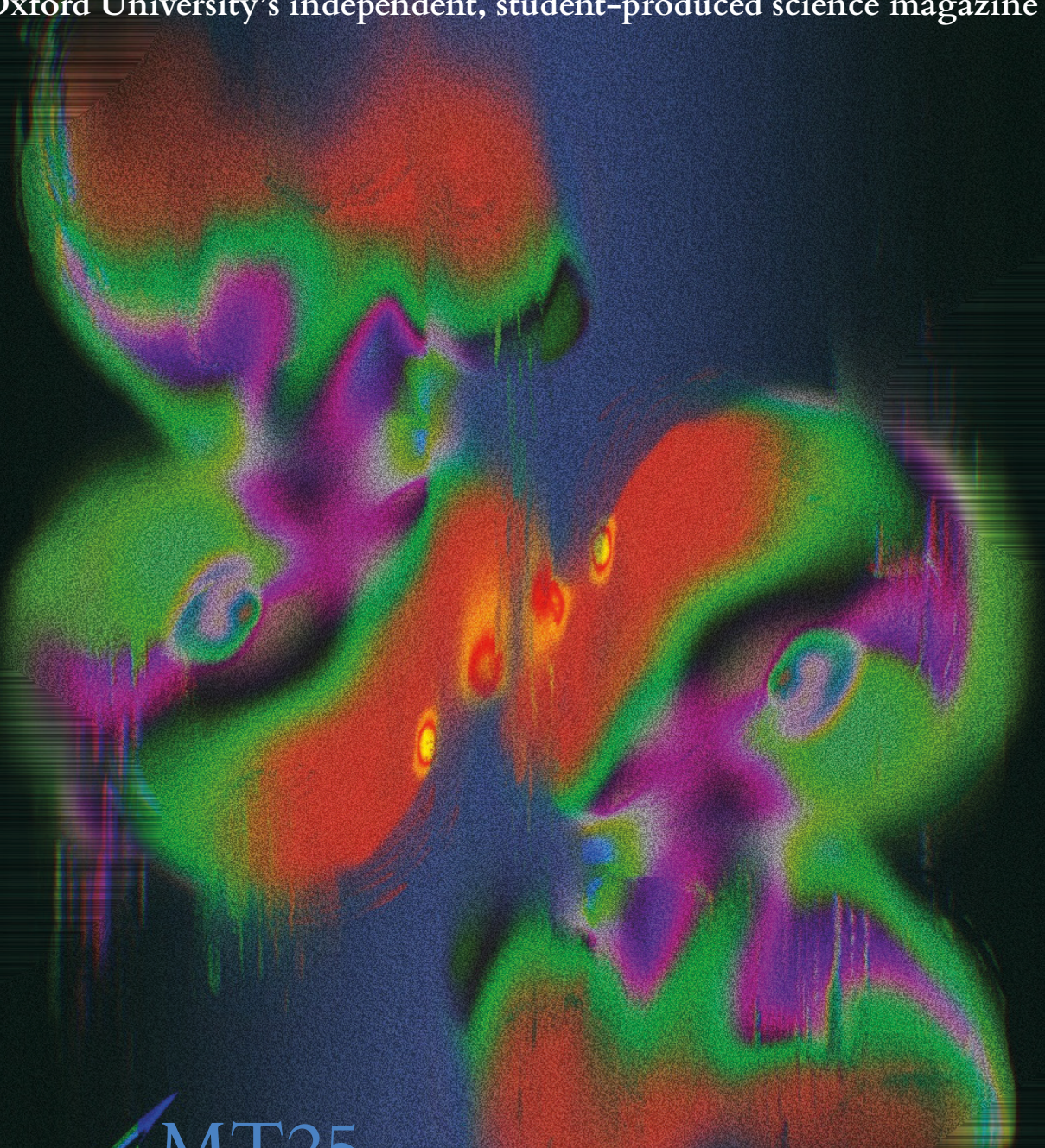


the Oxford Scientist

Oxford University's independent, student-produced science magazine



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Katee Li

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Editors' letters

Hello,

My journey with The Oxford Scientist began two short years ago, and it is truly a delight to now be sharing with you, as Co-Editor-in-Chief, our print edition for Michaelmas 2025.

This term began with the loss of a true icon of science communication, Jane Goodall. I admired not only her pioneering approach to primatology, but also her ability to reach so far beyond her discipline, to bring out the humanity and curiosity in all of us. It seems fitting, therefore, to have landed on the theme of 'Connections' for this issue. My time at this publication has connected me to so many inspiring scientists and writers, and the topics that are important to them; this issue is no exception, and what a privilege it has been. It is important now more than ever to ask questions about what connects us, as connection and collaboration remain pillars of scientific integrity and progress. I am encouraged to see that the student community here remains committed to just that, and I hope that The Oxford Scientist will continue to provide a platform for everyone to engage in the conversation. I invite you to connect with the diverse themes of this issue, and indeed, to use it to connect with each other.

I am especially proud of the team that has come together in a term that has not been without its challenges. I would like to extend thanks to all who have made this issue possible: particularly to Rayvell and Iulia for their tireless collaboration; to the exceptional Print team; to all of the writers, editors, and artists who have contributed; and to all at OSPL for their consistent support.

Happy reading,
Erin Adlard
Co-Editor-in-Chief, MT25



Dear all,

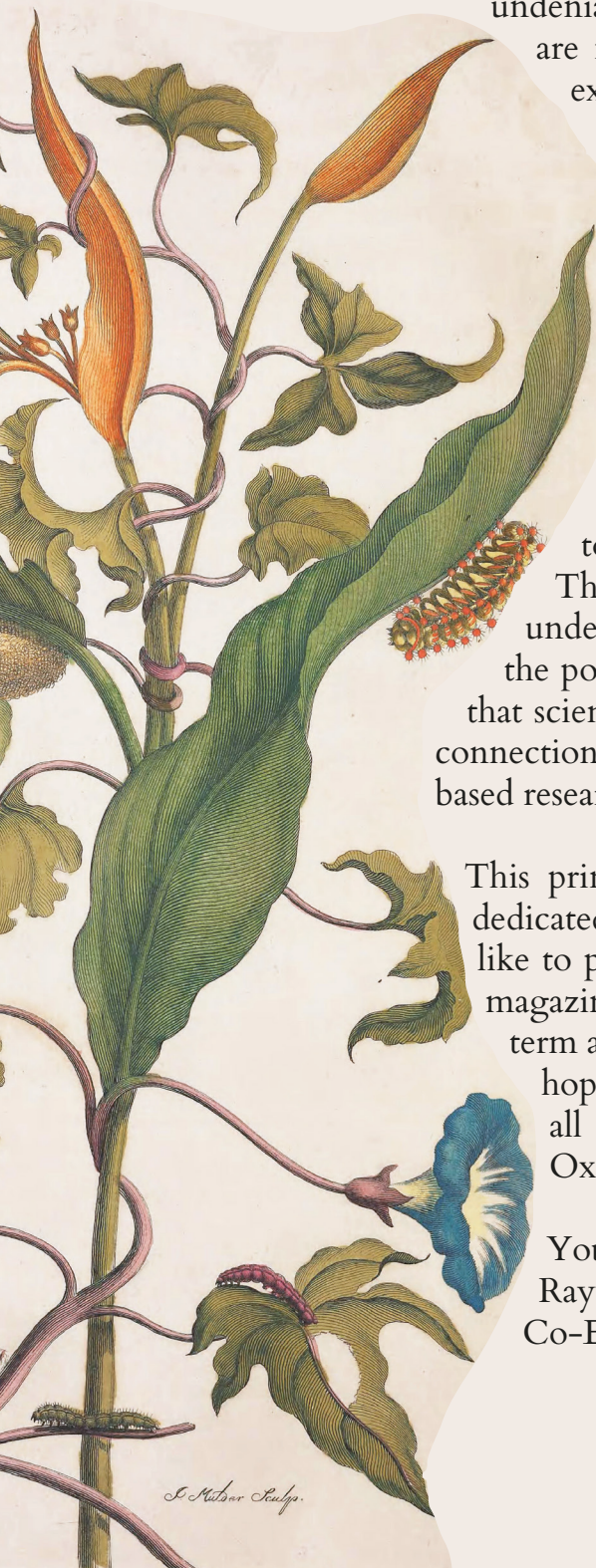
My warmest welcome to everyone at Oxford, especially to those who have just joined us this academic year. As Co-Editor-in-Chief, I am extremely excited to present to you our Michaelmas 2025 print edition, 'Connections'!

Nothing in science happens in isolation. Its very foundations are built upon the collective work of hundreds of thousands of scientists around the world, past, present and future. While we may bicker about the differences between the physical and life sciences, it is undeniable that, fundamentally, many scientific phenomena are much more intimately connected than you would expect. From atoms to our bodies to the whole universe, every aspect of our lives and the world can influence and be influenced by one another. I am thrilled that our authors this term have taken the opportunity to explore the unique connections that shape the world we live in.

In an age of unlimited access to information, we are increasingly exposed to the ways science interacts with our everyday lives. At the same time, we now live in a world where the people seeking to undermine science have never had more influence. Therefore, it is ever more important that we seek to understand how science has always been connected to the politics and societal issues of the time. I firmly believe that science journalism must be committed to tackling these connections head-on, in addition to communicating evidence-based research faithfully and effectively.

This print edition could not have happened without our dedicated team of writers, editors and artists. Thus, I would like to pay tribute to everyone who has contributed to this magazine, especially to Erin and Iulia for helping to make this term at The Oxford Scientist run as smoothly as possible. I hope you, dear reader, will have as much fun discovering all of life's wonderful connections as we have in The Oxford Scientist team.

Yours truly,
Rayvell Wijaya
Co-Editor-in-Chief, MT25



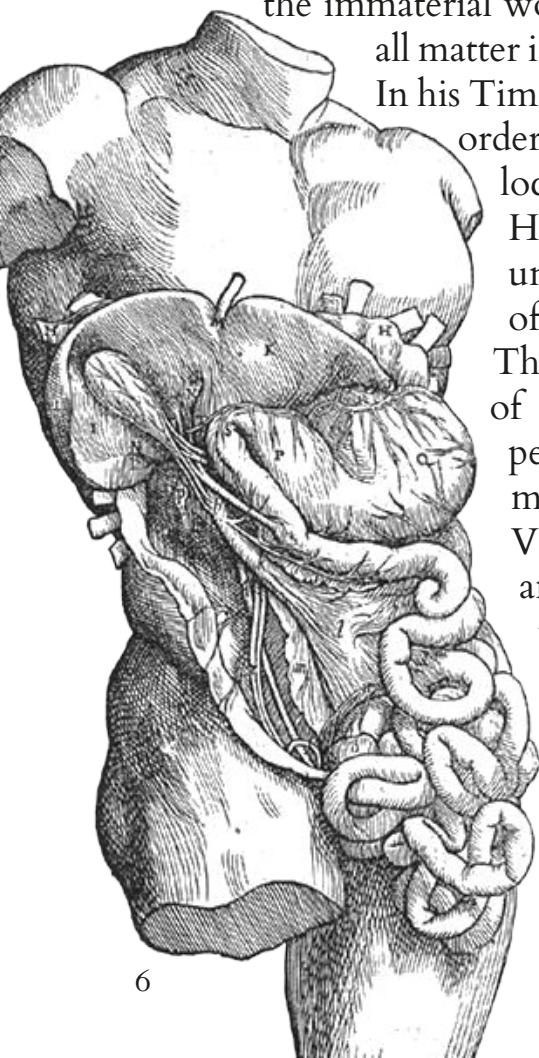
Of Art and Science: An Interconnected History

Angela Bannister

One imagines the artist's studio and scientist's laboratory as antithetical—the artist's mind surrendered to feeling, intuition, expression; the scientist's to fact, logic, and rigour. But history tells another story, one where the same curiosity motivates both individuals. Central to both is the precedence of observation and interpretation, used in a human attempt to understand the world around us.

In pre-modern thought, neither art nor science was a distinct category. Rather, both originated from the representation and interpretation of nature. The ancient Greek *technē* described both knowledge and craft, uniting the pursuit of understanding through making. Plato believed the perceived world was a copy of the immaterial world and 'Forms'—timeless and absolute ideals to which all matter in the physical world participates—structured this reality. In his *Timaeus*, the cosmos is imagined as a work of craftsmanship, ordered according to geometric ratios. Aristotle, his student, located 'Forms' within nature rather than transcendentally. He analysed art, physics, and ethics in parallel, applying universal laws to each to illuminate fundamental principles of the universe.

The Renaissance reimagined the classical interconnectedness of art and science. Brunelleschi's discovery of linear perspective transformed vision into geometry, the first marriage of art, optics, and mathematics. Yet, it was da Vinci who fully realised the synthesis between proportion and mathematical order. To him, observation was central to understanding nature. He left behind, alongside some of the most famous paintings in history, thousands of pages of personal ruminations and documented observations on every inquiring subject. His sketches found comparisons between veins and rivers, muscles and pulleys, demonstrating that in his mind, art and science were inseparable. Similarly, Vesalius transformed medicine in *De Humani Corporis*



Fabrica through his intricate drawings that combined scientific precision and artistry, overturning much of Galen's anatomy, which relied on animal dissection and had predominated from the second century AD.

*'Science arose from
poetry—when times
change,
the two can meet again
on a higher level as
friends.'*
Johann Wolfgang von
Goethe

By the seventeenth century, the methodologies of art and science diverged. The Scientific Revolution sought certainty in measurement and experimentation, institutionalising science. Through telescopic observation, Galileo sketched mountains of the moon and charted Jupiter's satellites to prove the cosmos followed physical law. Descartes separated the thinking mind from the material world, turning nature into a mechanism governed by cause and effect. Later, Newton, in his *Principia*, formulated the laws of motion and universal gravitation, using this to account for planetary movement, tides, and comet trajectories, eradicating doubt about the Solar System's heliocentricity. In doing so, science increasingly excluded the perceptual methods it had shared with art.

Though still institutionally divided, art and science intersected once again in the late nineteenth century. The scientific school of thought relied on hypothesis-based inquiry, while art developed from classical art, inclined to imitate nature, toward branches of impressionism, cubism, and expressionism. Advances in colour theory by Goethe and Chevreul emphasised human perception could differ from physical reality, directly informing impressionist experiments with optical effects. Einstein's Theory of Relativity changed notions of space and time, inspiring Cubists to reimagine perspective. Across the twentieth century, photography and film obscured boundaries between the disciplines even further. C.P. Snow's *The Two Cultures* presents this divide as a persistent intellectual problem, highlighting how scientific and literary cultures often fail to communicate even though their methods and curiosity have always overlapped.

The supposed divide between art and science is less a historical truth than a construct of thought. A convention in philosophy assigns to science the exclusive practice of investigation, and to art, that of production. The scientist takes apart his subject. The artist puts it together. In reality, the scientist engages in both processes, as does the artist; both in the pursuit of understanding. In the age of "two cultures", the question is whether interdisciplinary inquiry between art and science will ever truly return.

Intertwining of the nervous and immune systems

Eva Knightley

Neuroimmunology is the study of the complex interactions between the nervous system and the immune system. You might think that the two systems function independent of each other, which was widely believed until the 1980s when the field was formally established. The two are in fact, highly connected, anatomically and physiologically. Neuroimmunology is now an extremely exciting interdisciplinary field with large amounts of interest, which aims to understand the mechanisms behind the interactions of these systems and how this can then be used to improve diagnosis and treatment of diseases.

The autonomic nervous system, responsible for our unconscious activities, innervates the main immune system components – namely the liver, spleen, bone marrow, thymus, lymph nodes, and skin. Therefore, molecules produced by one system can highly influence the activity of the other.

In diseases such as multiple sclerosis (MS), the immune system works abnormally

and recognises our own cells as “foreign” and attacks them. This feature is common among all autoimmune diseases. MS is characterised by the destruction of the protective myelin sheath around neurones in the central nervous system, disruption of nerve signals, and subsequent problems with vision, balance, and movement. If the immune system does not work like it should, there is a chance the nervous system won’t either.

Immune cells in the brain can also secrete several mediators which act as substances known as neurotransmitters. Examples include acetylcholine, dopamine and adrenaline. These are chemical messengers that allow the nervous system to control functions like movement, cognition, mood, and heart rate.

Pain is an interesting sensation that can be regulated by mediators. Macrophages, a type of immune cell which can digest pathogens, can enhance pain by secreting a type of pro-inflammatory mediator called

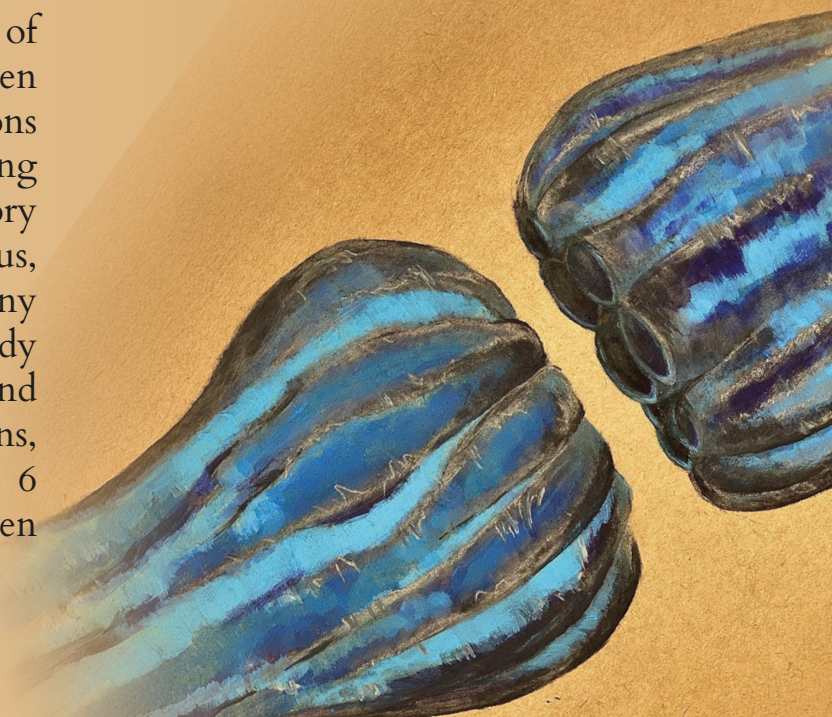
cytokines. This explains why we often feel deep aches and enhanced pain to stimuli that wouldn't usually be painful to us when we are unwell. The cytokines released bind to specific receptors on pain-sensing neurones and communicate with the brain and spinal cord to sensitise these.

On the contrary, various parts of the brain can each modulate the activity of different immune cells and consequently influence the outcome of our immune responses. Neurotransmitters like adrenaline and substance P control the movement of immune cells in a variety of tissues. The vagus nerve is part of the inflammatory reflex regulation, which reduces inflammation when stimulated, and as a consequence its manipulation is being considered as a possible way to treat inflammatory disorders.

Stimuli such as overeating, sleep, and stress can influence immune responses, which is why you often hear the importance of sleeping well and reducing stress in maintaining good physical health. The awful feeling of sleepiness and lack of appetite when you have a fever is due to connections between the two systems. The feeling is partly caused by proinflammatory mediators acting on the hypothalamus, a part of the brain that regulates many essential body functions like body temperature, sleep, heart rate, and emotional regulation. In humans, the administration of interleukin 6 (a specific type of cytokine) has been shown to increase slow-wave sleep.

There is a large therapeutic potential underlying the study of these connections, since targeting the neuroimmune crossovers could lead to new ways of managing inflammatory disorders, autoimmune diseases, and chronic pain. It is already proving to be useful in practice, with some MS medications such as ocrelizumab and ofatumumab reducing B-cell numbers, a type of immune cell which is responsible for attacking the neurones in MS. There is an exciting future ahead in the work of neuroimmunology, with the potential to achieve the optimal balance of activity between the two systems.

art by Anna Mathew



Wired Together: How Psychedelics Rebuild Connections

Emily Macrae

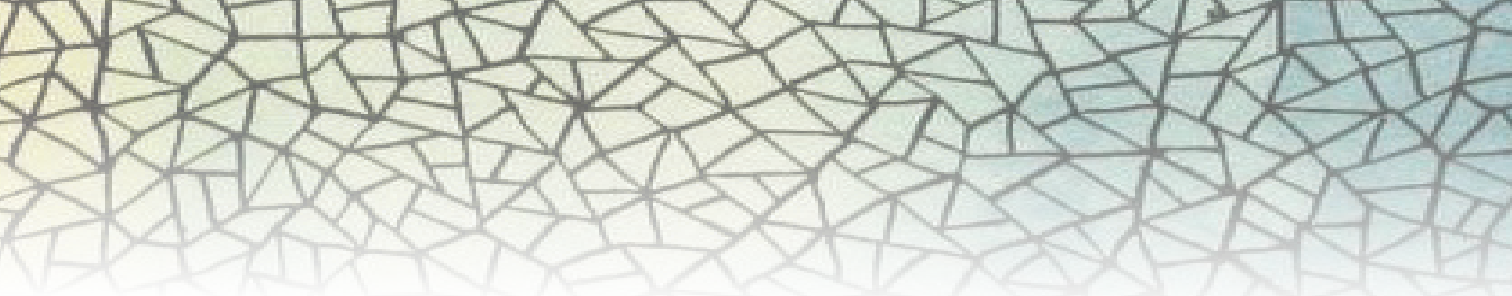
'we are all interconnected, it's like a miracle!'

Despite having been widely considered dangerous and psychomimetic for much of the last 50 years, research since the 2010s has consistently demonstrated the therapeutic benefits of psychedelics in various patient groups. The exact mechanisms that underlie these changes are unclear, but interviews with patients have identified feelings of letting go of resistance, truly experiencing previously suppressed emotions, and feeling more strongly connected to the self and others. This review argues that the reported psychological experiences are vital to achieving therapeutic effects and that it is by increasing connectedness at every level of analysis that psychedelics enable profound change.

Functional connectivity describes the correlations between spatially remote neurophysiological events in the brain. Functional neuroimaging has established the brain as a set of large-scale, interacting networks made up of resting-state systems, such as the Default Mode Network (DMN), and task-positive task-positive networks that guide cognitive processes like memory. Aberrant coupling within and between these networks

is implicated across psychiatric diagnoses, with dysfunction of the Default Mode Network (DMN) specifically being common to many. The DMN's core nodes include the medial prefrontal cortex (mPFC), the posterior cingulate cortex (PCC), the precuneus and the subgenual cingulate. Abnormally high subgenual cingulate connectivity between the subgenual cingulate cortex and with the rest of the DMN has been identified in patients with Major Depressive Disorder (MDD) and positively correlates with depressive episode length and symptom severity.

Psychedelics act primarily as agonists at the serotonin 2A receptor (5-HT_{2A}R), which means they activate receptors usually stimulated by serotonin. These receptors are densely expressed across the cortical regions that participate in the DMN. Psychedelics increase plasticity in preclinical and in vitro models (using cells in the lab, outside of live animals), but evidence of structural rewiring in humans, remains indirect. The increased plasticity may arise from through their action of psychedelics at 5-HT_{2A}R, making them well-placed to reshape DMN connectivity.

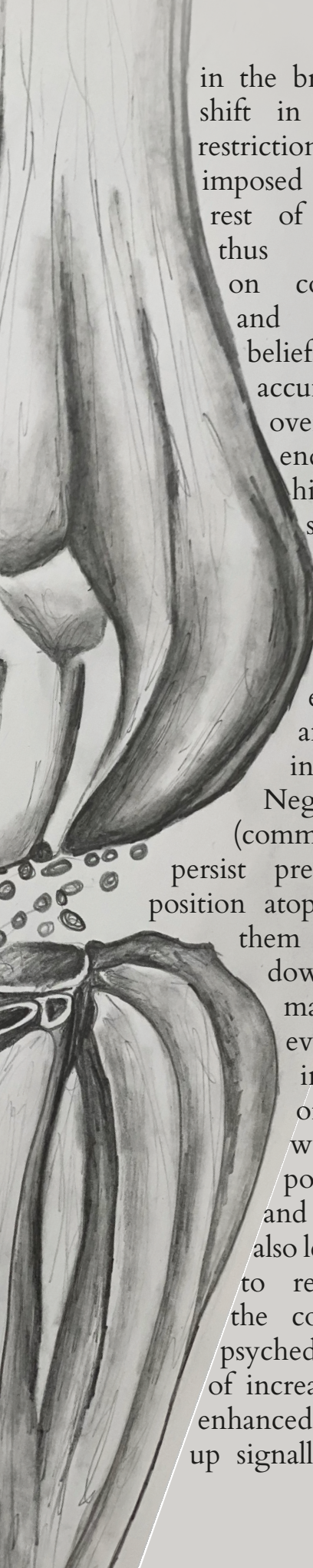


Illustrating this, psilocybin reduced the aberrant connectivity within the DMN in healthy participants, significantly lowering positive coupling of the mPFC and PCC. Several more studies have reported this DMN desynchronisation under psilocybin, although findings can be influenced by analysis choices and haemodynamic confounds (relating to blood flow in the brain). Lasting psilocybin-induced changes have been demonstrated in healthy participants: significant reductions in functional coupling between anterior hippocampus and DMN nodes were observed acutely and three weeks later. This suggests the effects of psychedelics on connectivity can lead to seed longer-term reorganisation.

Beyond altering connection strength, psychedelics appear to change the very nature of these relationships between brain areas. Unlike standard brain imaging techniques, whole-brain modelling enables causal inference of structure and the direction of information flow in the brain by exploiting functional and structural data combined with mathematical models. Processing in the brain can be modelled as a hierarchy of internal generative models, in which higher-order areas generate abstract predictions that propagate down the hierarchy and constrain lower sensory processing.

The influence of any given signal is determined by its estimated precision. Recent wholebrain modelling indicates that psychedelics reduce the directedness of this hierarchy. Strikingly, in a controlled trial of major depressive disorder, psilocybin treatment was associated with reductions in measures of global hierarchy, whereas escitalopram produced the reverse pattern. Responders in both conditions showed greater absolute hierarchical reconfiguration of the precuneus and prefrontal regions but in opposite directions, suggesting distinct mechanistic routes to clinical benefit. Further studies with larger sample sizes are needed to investigate any potential clinical superiority. Similar hierarchical flattening has been reported in smaller studies of other psychedelics such as LSD and DMT, and wholebrain analyses also record an increase in brain entropy: an elevated repertoire of accessible neural states during the acute psychedelic state. While on the face of it this may seem irrelevant to their therapeutic benefits and effects on connectedness, psychedelic-induced increased entropy is predicted by a model of psychedelic effects that bridges phenomenology and neuroscience.

Relaxed Beliefs Under Psychedelics (REBUS) and the Anarchic brain proposes psychedelics reduce the weighting of some high-level predictions



in the brain's hierarchy., This shift in weighting lifts the restrictions that are typically imposed on activity in the rest of the hierarchy, and thus reduces constraints on cognition, perception and affect. Higher-order beliefs are formed via the accumulation of evidence over long timescales, endowing them with high precision and strong influence over the interpretation of other signals in the brain hierarchy. This stability underlies both everyday cognition and cognitive rigidity in mental disorders. Negative self-beliefs (common in depression) persist precisely because their position atop the hierarchy gives them influence over lower down signals, which makes them self-evidencing. Psychedelic-induced low precision of higher-level beliefs widen the repertoire of possible psychological, and hence, neural states. It also leaves beliefs vulnerable to re-evaluation, due to the combined effect of a psychedelic-induced window of increased plasticity, and an enhanced influence of bottom-up signalling. Increased belief-

updating across the hierarchy like contributes to psychedelics' therapeutic effects, but I argue that it is precisely the effects on beliefs at the very top of the hierarchy, that sets psychedelic therapy apart from other treatments.

Animal models provide mechanistic support for this hypothesis. Rodents exposed to repeated inescapable adverse experiences, such as electric shocks, develop learned helplessness, where they do not attempt to escape future adverse situations regardless of whether they are escapable. This has been used as a model of depression, and the behaviour is considered to reflect the rodents' belief that they lack control over the situation and as such are unable to affect change. Psilocybin administration reverses learned helplessness in rodents, consistent with an ability to alter beliefs about control and agency.

Psychological mechanisms complement this neurobiological story. Experiential avoidance, which refers to the unwillingness to remain in contact with distress and subsequent extreme avoidance of distressing situations, is central to many disorders. While this self-protective mechanism is relatively harmless in the short-term, in the long run it prevents corrective experiences and limits the ability to truly experience the present moment. A recent clinical trial for MDD found that psilocybin significantly reduced experiential avoidance whereas escitalopram did not. These reductions in avoidance

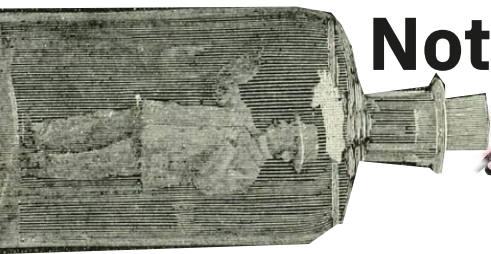
statistically mediated increases in well-being and decreases in clinician-assessed depression severity, suicidal ideation and trait anxiety. Furthermore, reduced experiential avoidance improved four of these five measures via its effects on connectedness. Responders in the psilocybin group also showed significantly larger increases in overall connectedness than participants successfully treated with escitalopram. While psilocybin and escitalopram both increased connectedness with others and the world, psilocybin additionally increased connectedness with the self.

Why might this self-connection matter? Carhart-Harris and colleagues have posited that connection with the self forms a psychological ‘bedrock’. By first forming a stable, compassionate relationship with their own experience, a person can more readily form authentic relationships with others and engage more meaningfully with the world. Psychedelics may accelerate the process of reconnecting with and rebuilding this foundation, by weakening the hold of negative beliefs and providing a window of plasticity that supports learning positive beliefs.

At a practical level, the acute psychedelic experience usually entails intense imagery, emotional upheaval and encounters with autobiographical material. Under these conditions, individuals cannot turn away from the experience; the therapeutic task becomes one of acceptance and experience despite the discomfort. This

moment of experiential acceptance and openness during the window of plasticity may begin to dismantle both the neural and psychological underpinnings of experiential avoidance. After the experience, strengthened internal coherence, or self-connection, stabilises external social bonds and motivates purposeful interaction with the world, which in turn scaffolds ongoing recovery and wellbeing.

Caveats and open questions remain. Much mechanistic evidence derives from preclinical models or correlational human imaging; causal links between synaptic remodelling and long-term clinical outcomes are still being established. The precise roles played by are set, setting and psychotherapy and how they might be optimised for different patients remain undetermined. Nevertheless, converging lines of evidence suggest a parsimonious account: psychedelics temporarily destabilise rigid neural and psychological patterns while enhancing plasticity. Once the altered state of consciousness that follows has begun, it cannot be avoided or ignored: it demands to be experienced. In doing so, regardless of the sensations, content or memories it stirs, individuals can reach a place of calmness, acceptance and connection. By rebuilding connections between synapses, across systems, and within the self, psychedelic therapy interventions may offer a principled route to lasting change.



Notes of musk and romance:

smell in romantic and
platonic relationships

Sophie Lyne

‘Pheromone perfumes’ are social media’s newest solution to your dating disasters. Pheromones are scents naturally produced in bodily fluids like sweat, which trigger responses in other members of a species, including sexual attraction. Brands have developed perfumes that ‘enhance your natural pheromone production’ to make you smell more alluring. The evidence for them is anecdotal, and the videos singing their praises are usually advertisements. Nevertheless, a small body of research does suggest that the role of the olfactory (smell) system in relationships should not be dismissed.

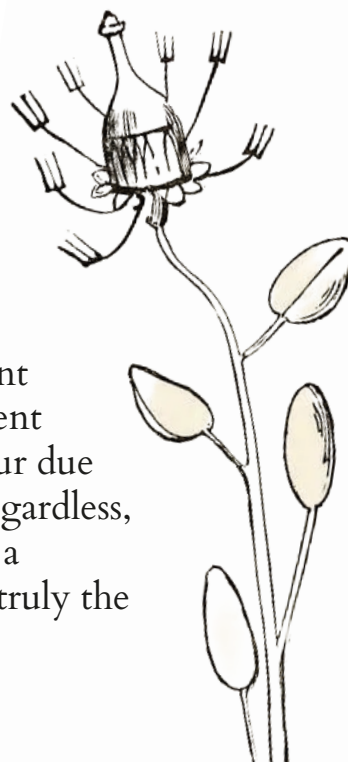
For our ancestors who lacked perfume and deodorant, body odours may have provided a useful biological signal of health in a potential mate. In double-blind trials, human participants rate the body odour of an unwell person as more unpleasant than that of a healthy person. The unwell body odour can be simulated by injection with endotoxin lipopolysaccharide, a chemical which activates an immune response. Additionally, survey data reveals that most people in relationships choose to smell their partner either often (53%) or occasionally (32%). There is tentative evidence that self-report measures of relationship commitment correlate positively with enjoyment of a partner’s

body odour, although this result was only significant for single people speaking about a previous relationship. Perhaps more surprisingly, scent has been linked to platonic relationships. Analysis with an ‘electronic nose’ (an analytical device for smells) reveals that friend pairs smell more like each other than random pairs. Additionally, for same-sex pairs of complete strangers engaged in nonverbal interactions (such as mirroring each other’s movements), those who smell more similar are more likely to mutually report ‘clicking’ with their partner, developing a strong sense of liking and bonding with them instantly.

Therefore, the olfactory system likely plays a role in romantic and platonic connections.

Unfortunately, research is limited and suffers from nonsignificant results.

We may question the causal direction of some evidence: perhaps relationship commitment correlates with enjoyment of a partner’s body odour due to rose-tinted noses. Regardless, it remains unlikely that a pheromone perfume is truly the key to love.



Hijacking the host: a new front in the plant-microbe arms race

Katherine Land

How do you kill a pathogen that takes over control from the plant itself?

Botrytis cinerea is the species of pathogenic fungi that causes grey mould, and can infect most fruit and vegetable crops worldwide. Weiberg et al. (2013) estimate this results in \$10–100 billion in annual losses, a number likely to have increased in recent years. But it doesn't just attack plants through ordinary means. *B. cinerea* is able to hijack the very system that the plants use to regulate their own genes. By sending in vesicles armed with small RNAs (sRNAs), *B. cinerea* takes command of the plant's RNA interference (RNAi) machinery. Now in control of how the plant cell responds to its invasion, *B. cinerea* can silence any attempt the plant makes to rouse an immune response.

It has been known for a long time that pathogens regularly use "effectors" in the form of proteins to suppress host immunity in both plants and animals. However, this form whereby the gene regulatory system itself is hijacked is a far more recent discovery and represents the astounding complexity that develops in these evolutionary arms races.

This struggle for power may seem to be unique to parasitic relationships, and yet scientists are beginning to realise that such targeted warfare could define the interactions between plants and the many microbes inhabiting the soil around them, even in symbiotic relationships.

For instance, it was believed that the symbiotic relationship between arbuscular mycorrhizal (AM) fungi and the plants they associate with was a peaceful one based on mutual exchange of nutrients. However, research has since overthrown this idyllic concept. Instead, their relationship is underpinned by clever and subtle manipulation on either side, where each sends over vesicles full of sRNAs intended to skew the benefit of the relationship at the recipient's expense.

With the field of cross-kingdom RNAi still in its infancy, we are likely to see many developments in our understanding of these more manipulative tactics in the coming years.

art by Holly Bartlett

Through unity, survival: the importance of reconnection

Anna de Boer

The Earth is a highly complex and interconnected place, in which every living entity has a role and function in its ecosystem. Yet it is becoming increasingly clear that humans have forgotten how intertwined our relationship with nature is. We have been socialised to view ourselves as different, even superior to nature, encouraging us to see it merely as a resource for human use, rather than recognising it as a partner of life. Since the Industrial Revolution, this perspective has pushed nature out of balance and caused increasingly devastating consequences.

Natural resources have been fundamental for the evolution of human societies, from food, to medicines, to shelter, yet our role within the natural world is greatly overlooked. Many have been taught the simple, yet vital water, carbon and nitrogen cycles, which reveal some of the intricate webs of interdependence in nature. Nevertheless, incredibly sophisticated relationships are often dismissed due to a widespread societal misunderstanding of the natural world. For example, scientists have discovered a large-

scale interconnection between trees in a forest through fungal networks in the soil. These fungi, known as the mycorrhizal network, inhabit the roots of trees and exchange mineral nutrients for carbohydrates to form a delicate symbiotic relationship.

More personally, epigenetics is a physiological process that responds to environmental changes by quickly altering genetic expression. Without modifying the genes themselves, this process shapes our behaviour and demonstrates how our internal world is directly connected to our external environment. Even at the microscopic level, thousands of bacterial species form a dynamic and sophisticated ecosystem within our bodies, called the gut microbiome. By supporting vital processes like our immune system, this relationship is critical for both their survival and ours. Despite numerous examples of the vital connections which maintain life, human centric attitudes with respect to nature have isolated us from the interconnectedness of our existence and, consequently, these natural connections are forced into conflict with human interest.

Just as disconnection between humans has led to a global loneliness epidemic, our detachment from the non-human world has caused ecological suffering. Pesticides destroy the fungi and organisms that keep soil healthy, depleting the nutrients in the plants that sustain

the food chain. Unsustainable fishing practices disrupt marine ecosystems and wipe out fish populations responsible for purifying the waters. Deforestation, oil drilling and, more recently, the emergence of AI and big data centres which rely on extensive water consumption, continue to decimate the planet at an alarming rate. While this exploitation is forcing the world out of equilibrium, we often forget that we are animals too, and a part of this ecosystem. By seeing ourselves as above nature, we are not only endangering the planet's survival but our own.

Ultimately, disconnection and human-centred thinking have fuelled the Earth's destruction. By severing our ties to the world, we have allowed its exploitation to become normalised, now culminating in the climate crisis. Reconnection is the only path toward solving this problem. We must therefore remember the sacred webs of life, and learn to live with the land, not against it. A lone tree will not survive the storm, but a forest will.

Killer connection: incredible interactions between humans and orcas

Alex Wan

At first glance, it's hard to see any similarities between hairless apes and toothy, ten-tonne living torpedoes; dive a little deeper, and the similarities between humans and orcas become much more apparent. We are both intelligent, socially and emotionally complex creatures that live long after we stop reproducing and mourn those we've lost. It may come as no surprise, then, that orcas and humans have interacted in some truly fascinating ways over the years.

Don't look a gift orca in the mouth

What would you do if you were offered a meal by a wild orca? This is a scenario more than 30 people encountered from 2004 to 2024. Although orcas are known for sharing food among their family groups, interspecies sharing is highly unusual among animals. The actual reasons for this gifting behaviour remain uncertain, though scientists have proposed several. While some individuals were likely just playing, many were thought to be exploring,

which suggests they were deliberately trying to learn about humans and our responses to their gifts. This could be because the populations of orcas that offered humans food were generalists, animals that use a wide range of resources and tolerate a variety of environmental conditions. Generalists often benefit from and are thus naturally selected to display exploratory behaviours because this allows them to respond to the changing environments they inhabit, which may explain why these orcas shared their food with humans. Orcas may also be curious about the possibility of living alongside or forming an interspecies relationship with humans, resulting in their prey provisioning attempts. Finally, the social intelligence hypothesis suggests this may be a Machiavellian behaviour, where the information that orcas collect from these interactions could help them predict, respond to and manipulate other species. Although no humans have been killed by orcas outside of captivity, caution is recommended in response to this behaviour in these wild and powerful individuals.

Kindred killers

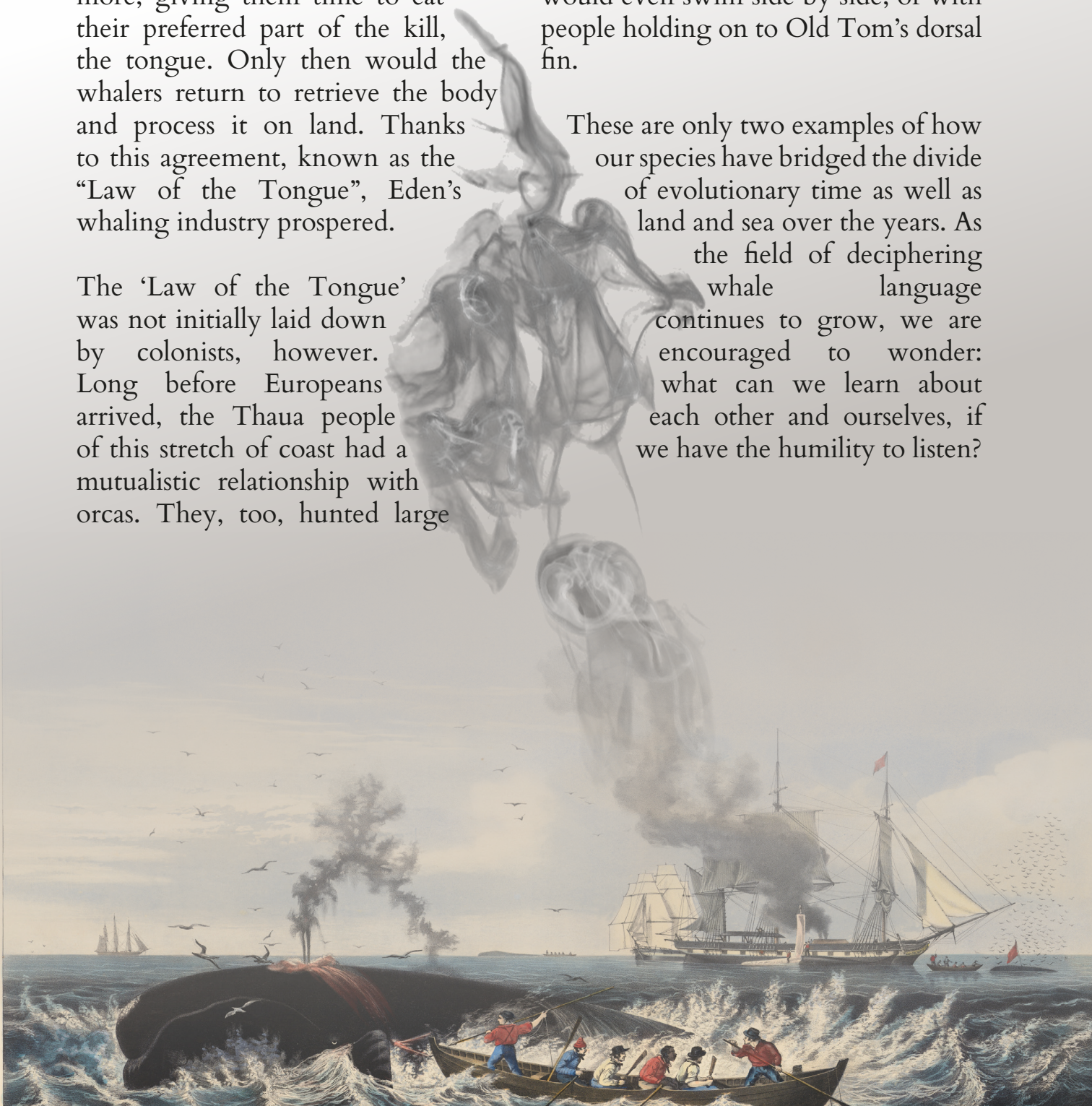
Equally fascinating are the partnerships that a group of whale-hunting orcas once formed with human whalers. From 1844 to 1928, these orcas came to the waters of Eden, Australia. Some individuals would corral, injure and weaken their prey, while others, including a male known as Old Tom, would alert their colonist whaler

allies by making noise in front of the whaling station. Locals claimed that Old Tom would pull the whaling boats along to speed up their journey to the hunt. Once they arrived, the whalers would use harpoons and lances to deal the finishing blow to their prey. When the hunt ended, people left the whale carcass to the orcas for a day or more, giving them time to eat their preferred part of the kill, the tongue. Only then would the whalers return to retrieve the body and process it on land. Thanks to this agreement, known as the “Law of the Tongue”, Eden’s whaling industry prospered.

The ‘Law of the Tongue’ was not initially laid down by colonists, however. Long before Europeans arrived, the Thaua people of this stretch of coast had a mutualistic relationship with orcas. They, too, hunted large

whales side by side and divided the spoils, with the tongue going to the ocean’s apex predators and the rest going to the rulers of the land. The Thaua-orca relationship extended beyond mere cooperation: humans and orcas would follow each other along beaches, communicating across the divide of land and sea. Sometimes they would even swim side by side, or with people holding on to Old Tom’s dorsal fin.

These are only two examples of how our species have bridged the divide of evolutionary time as well as land and sea over the years. As the field of deciphering whale language continues to grow, we are encouraged to wonder: what can we learn about each other and ourselves, if we have the humility to listen?



The IMITATION GAME:

Parallels Between the Human Brain and Artificial Intelligence

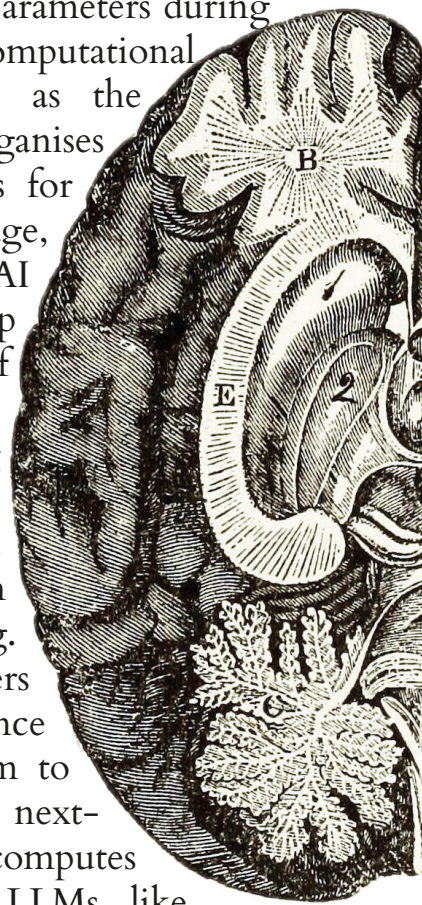
Anna Philippopoulou

Artificial intelligence is now woven into our daily lives, already capable of executing tasks once considered exclusive to humans. We have long comforted ourselves with the notion that humans hold the upper hand as long as AI lacks our emotional intelligence and nuanced thought processes. Nevertheless, new research on the similarities between large language models (LLMs) and the brain structure leads us to question this belief. Could LLMs one day achieve the emotional intelligence and critical thinking they currently lack, or do our development processes for these models belie our limited understanding of these concepts?

Scientists at MIT compared fMRI brain data with LLMs like GPT-4 and found that their internal structure mirrors the brain's neural networks. In the human brain, neurons communicate through electrical and chemical signals sent

across synapses, akin to how artificial neural networks pass signals between nodes. The brain constantly refines these synapses in response to stimuli, an ability referred to as neuroplasticity. Similarly, AI models adjust parameters during training and computational optimisation. Just as the human cortex organises specialised regions for vision, language, and reasoning, AI models develop similar clusters of artificial neurons.

The reasoning processes of LLMs and the human brain also seem to be converging. Recently, researchers at Sapien Intelligence in Singapore claim to have developed a next-generation AI that computes differently from LLMs like ChatGPT, emulating human thought more closely, and potentially surpassing today's models. Most current LLMs use Chain Of Thought (CoT) reasoning, where the model effectively "thinks out loud", writing its reasoning steps as text and feeding its own output into the next step. For example, when asked 'What is 17×24 ?', it might respond: $17 \times 20 = 340$, and $17 \times 4 = 68$, so the total is 408.' Each sentence



is both part of its reasoning and visible output. This method requires vast training data (3–5 trillion example datapoints) and is vulnerable to one wrong step causing a chain of wrong answers. Conversely, the Hierarchical Reasoning Model (HRM) reasons in hidden layers, much like how humans think silently before speaking. It is “hierarchical” because it combines a fast low-level computation system with high-level system for slower, abstract planning. The former runs multiple cycles until it stabilises before the latter advances, a process named “hierarchical convergence”. Such models are intended to be faster, more efficient (only 27 million example datapoints), and less prone to linguistic error.

With the LLMs’ structure becoming increasingly brain-like, we should ask whether deeper philosophical questions emerge from this progress. Even if such models perfectly replicated our neural architecture (still not fully understood), would this lead to genuine understanding? According to Richard Sutton’s Bitter Lesson (2019), that AI’s biggest advances come from simply adding computation,

suggesting that its “intelligence” might be a property of scale rather than design. Are fast computation and unlimited availability of data equivalent to critical thought or merely efficient problem solving? The human brain emerged from natural selection, a slow adaptive process perfected for survival not abstract thinking. Similarly to how human intelligence was shaped by countless survival trials; AI is shaped by endless cycles of data and refinement. The line between neuron and algorithm is increasingly blurred. Perhaps the question is no longer whether AI can be intelligent, but how do we define intelligence in the first place. After all, we struggle to recognise forms of thinking that don’t mirror our own. Must intelligence be accompanied by the emotional and subjective experience we call “consciousness”?

On the technological front, after recognising the parallels between LLM structure and that of the brain, researchers face a choice: to build ever-larger silicon systems that imitate the brain’s complexity, or to travel to the realm of science fiction and attempt to integrate computational systems directly into animal and human brains. Each path carries vast potential, alongside profound ethical and philosophical challenges.

Ultimately, the danger may not lie in AI itself, but in our complacency. As we trade the slow, imperfect thinking process for instant answers, we are training AI to creep closer to consciousness while we drift further from our own.

Cosmic shortcuts: making sense of space-time with wormholes

Olivia Miller

The black hole bridge

Wormholes are the stuff of science fiction legend and every space traveller's dream come true. But what are wormholes, really? How do they work? And, most importantly, are they real?

Geometrically, wormholes connect two black holes—or rather, a black hole and its opposite: a white hole. Black holes are gravity cavities: regions of extraordinary density, where vast mass exists within a small space and generates superpowerful gravitational forces that swallow everything in the vicinity. White holes are time-reversed black holes. Whereas black holes suck things up, white holes spit things out.

A wormhole connects both the time and location of each respective hole. The wormhole creates a bridge, or tube, between two points in space-time by creating a shorter path between them than the path that already exists—humans could, theoretically, use the shorter path as a shortcut through space. Because wormholes connect points in time, too, humans could reach their destination either earlier or later than when they left. What's more, if the black and white holes exist in separate universes, then a wormhole could allow for trans-universal travel.

A study in space time

Albert Einstein himself, along with Nathan Rosen, was among the first to mathematically investigate the physical possibility of the wormhole. His theory, general relativity, was incomplete because of mathematical singularities (points at which the math misbehaves—think “dividing by zero”) which demanded new physical explanations.

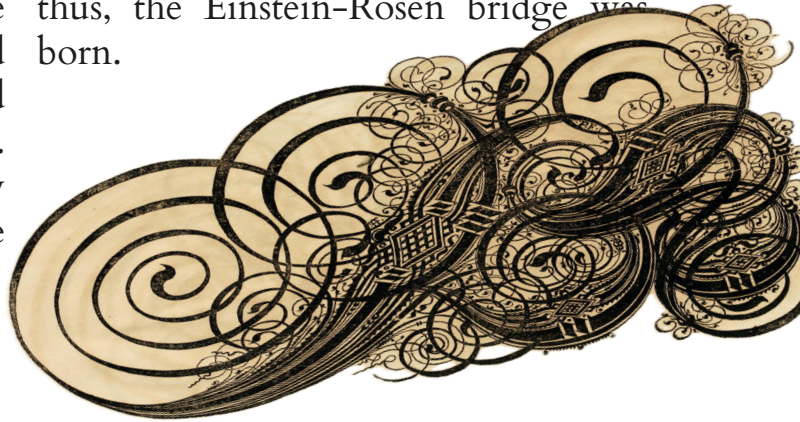
In particular, Einstein and Rosen looked at the mathematical anomaly that occurs at a black hole's event horizon—the point of no return—in the equation for the gravitational field of a sphere called the Schwarzschild solution. The Schwarzschild solution includes a term

with $1 - (2m/r)$ in the denominator... and the event horizon is $r=2m$, which would result in a term with division by zero. See the problem? But in order to fully understand the issue at hand, we must first turn our attention to space-time and look at the universe through Einstein's eyes.

Einstein's teacher, Hermann Minkowski, developed a model of the universe according to "space-time": a four-dimensional, continuous coordinate system that incorporates the three dimensions of space and the single dimension of time. Space and time are fundamentally connected, and Minkowski's model unified the two. Then, Einstein proposed that gravity is the curvature of that space-time

continuum. That curvature determines where objects move and how fast. And when that curvature spikes to infinity, like it does at a black hole, it raises some red flags.

In order to account for this mathematical discrepancy, Einstein and Rosen revisited the Schwarzschild solution. They performed some mathematical magic tricks to find a new solution: rather than continuing forever, the spacetime "tube" connects to another path that opens into a new plan, and thus, the Einstein-Rosen bridge was born.

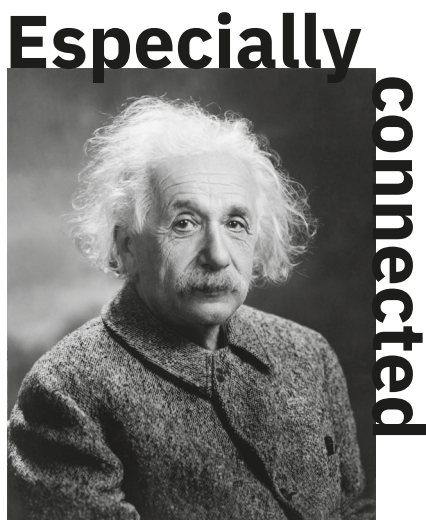


Too good to be traversable

Unfortunately, there are two problems. First, white holes don't actually exist, as far as we know, and they probably can't. Their existence would break the second law of thermodynamics, which says that a closed system constantly approaches a state of disorder. White holes spontaneously generate matter, which decreases the entropy of a system by increasing the concentration of energy inside of it. The Einstein-Rosen bridge relies on the symmetry of time as it moves forward or backward—hence the "time-reversed" black hole. But scientists haven't quite figured out how to make time symmetry fit together with thermodynamics.

Second, even if a wormhole could exist, humans wouldn't be able to travel through them. Wormholes would be infinitely skinny because they connect two points, each with no volume—making them effectively untraversable. Wormholes would also be too unstable to stay open long enough for even light to travel through.

As noted earlier, though, all the theories that lead us to these conclusions are incomplete. Someday we might learn the truth about wormholes, and then we can bask in the triumph of time travel.



the underlying connections behind Einstein's theory of relativity

Edison Fu

It is popularly believed that scientific progress is made in discrete, monolithic jumps. For example, one might get the idea that Newton made the laws of motion appear out of thin air, or that Einstein decided randomly one day that time is a dimension. But this is, in fact, a huge misconception. Science is a highly interconnected (and very messy) web brimming with new ideas, and none of these advances would have been possible without all-pervasive connections between existing and new theories, between one scientist and another. We shall examine how connections produced Einstein's Theory of Special Relativity—a theory that is often mistaken for being produced without them.

The philosophy behind Special Relativity dates at least to the time of Galileo Galilei. The nature of space and time had been a philosophical debate for millennia by then. Some postulated that there existed absolute time, which was consistent for all objects in the universe, as well as an unmoving space in which objects lived. Newton in particular used

these concepts as mathematical tools to build his laws of motion. Others, like Newton's contemporary Leibniz, thought absolute space and time were meaningless, and that only the relative motion between objects should matter in any physical theory—what might be called the “relativistic” view.

Galileo was one of the first to rigorously formulate the relativistic view. He observed that a person on a ship sailing smoothly would feel like they were stationary, as would someone standing on sturdy ground. He was one of the first to describe the “principle of relativity”, which in its modern form says that the laws of physics appear the same from the point of view of anyone moving in a straight line at unchanging speed. Galileo's specific interpretation of the principle of relativity (known as Galilean relativity) also described how the coordinates of absolute space should be transformed for a moving observer according to the Galilean transformations, in a way that later proved to be consistent with Newton's laws of motion. This was an important

feature Newton himself recognised. Thus, in this view, absolute space as introduced by Newton was only a mathematical artifact, and only relative space was meaningful. For centuries, all experimental evidence pointed to the correctness of Galilean relativity.

The necessity for Einstein's Special Relativity, however, only appeared in the 19th century, through an unexpected connection to the theory of optics and electromagnetism. In the early 19th century, experiments in optics revealed new properties of light, in particular properties which were consistent with well-established theories of mechanical waves in solids. Combined with the work of theorists like Augustin-Jean Fresnel, this seemed to provide conclusive evidence that light was a wave. However, a problem arose—it was supposed that all waves needed a medium to propagate through, as this was the only view consistent with contemporary knowledge. The medium for light was obviously not ordinary matter, as light could propagate in the vacuum between the Sun and the Earth. So, it was theorised that a sparse substance, named aether, filled all empty space, and that this medium was what light propagated through.

In the latter half of the 19th century, unexpected connections were revealed between electromagnetic phenomena and light, the most important being James Clerk Maxwell's theory of electromagnetism. He introduced the

concept of the electromagnetic fields, and predicted that light was simply an electromagnetic wave, thus unifying optics and electromagnetism. This theory was immensely successful, but it suffered from a problem—the theory was inconsistent with the principle of relativity. For example, it predicted that all electromagnetic waves had to propagate at the same fixed speed through absolute space, which implied that observers with different velocities relative to absolute space would see light travelling at different speeds. This seemed to violate the principle of relativity.

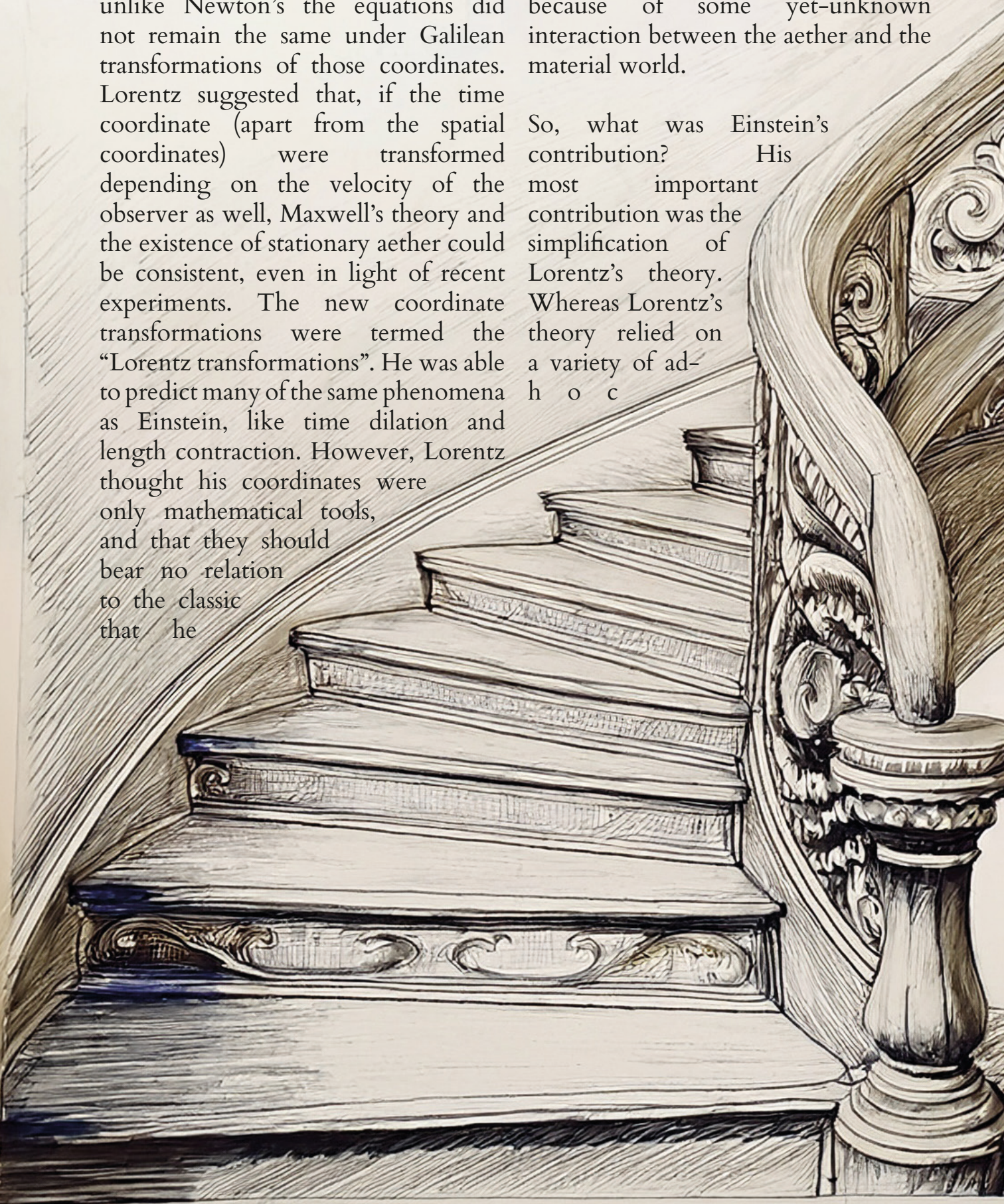
The problem was hastily fixed by supposing that the electromagnetic fields described deformations in the same aether that was postulated to be the medium for light waves, and that Maxwell's theory was only true from a point of view that was not moving with respect to the aether. The principle of relativity would then still technically be true, as the relative motion of the observer and the aether would then be different (although the motion of the aether itself was unexplained). An increasingly elaborate series of experiments were conducted to try and detect changes in the speed of light due to this relative motion, but to no avail, culminating in the famous Michelson-Morley experiment which is widely considered to have disproved the idea of an aether which obeyed the Galilean Transformations.

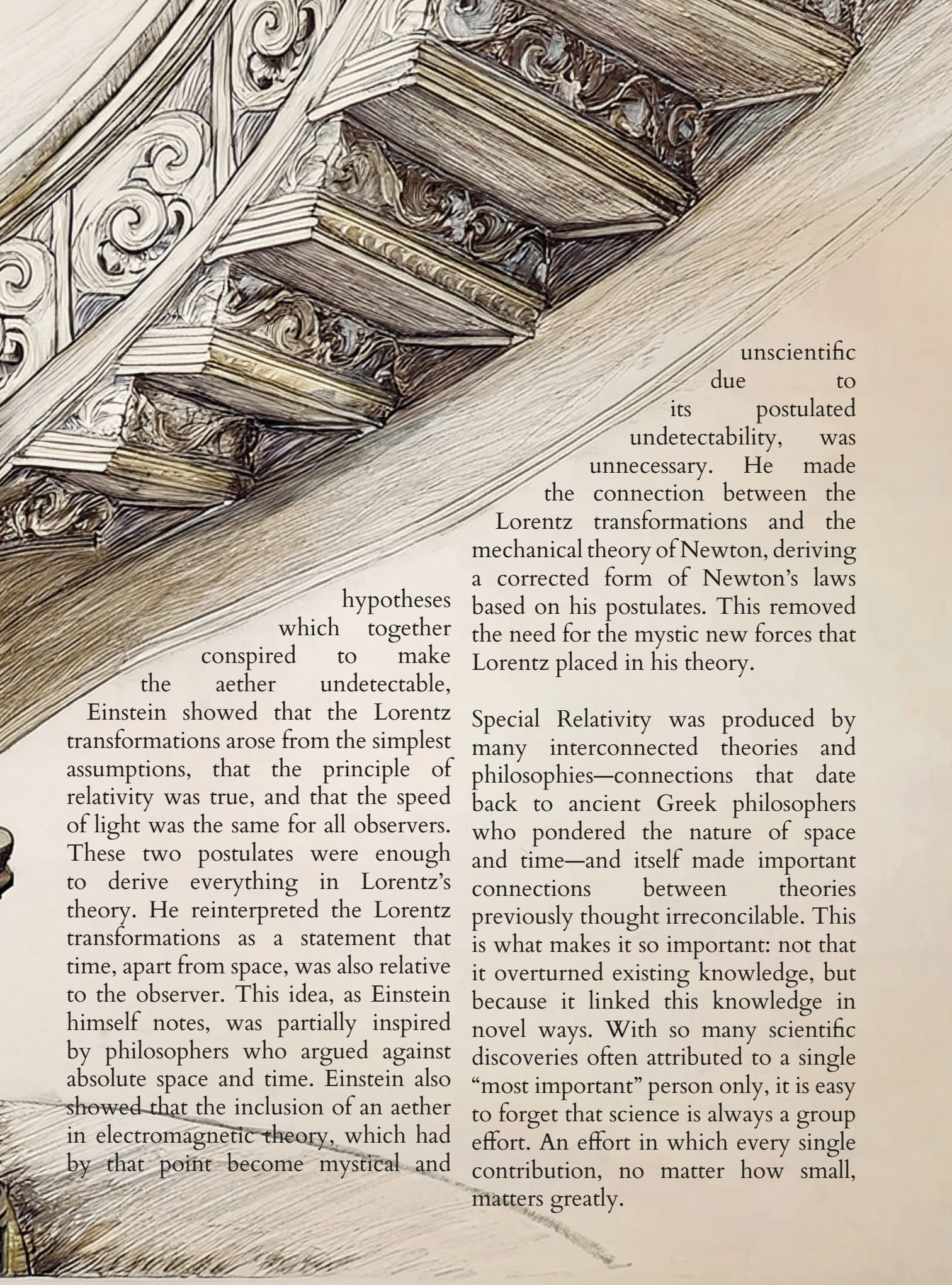
The next breakthrough came from

Hendrik Lorentz. Maxwell's theory, like Newton's, depended on absolute space and time coordinates, but unlike Newton's the equations did not remain the same under Galilean transformations of those coordinates. Lorentz suggested that, if the time coordinate (apart from the spatial coordinates) were transformed depending on the velocity of the observer as well, Maxwell's theory and the existence of stationary aether could be consistent, even in light of recent experiments. The new coordinate transformations were termed the "Lorentz transformations". He was able to predict many of the same phenomena as Einstein, like time dilation and length contraction. However, Lorentz thought his coordinates were only mathematical tools, and that they should bear no relation to the classic that he

thought were "more real". Instead, he postulated that physically observable effects like length contraction occurred because of some yet-unknown interaction between the aether and the material world.

So, what was Einstein's contribution? His most important contribution was the simplification of Lorentz's theory. Whereas Lorentz's theory relied on a variety of ad-hoc





unscientific
due to
its postulated
undetectability, was
unnecessary. He made
the connection between the
Lorentz transformations and the
mechanical theory of Newton, deriving
a corrected form of Newton's laws
based on his postulates. This removed
the need for the mystic new forces that
Lorentz placed in his theory.

hypotheses
which together
conspired to make
the aether undetectable,

Einstein showed that the Lorentz transformations arose from the simplest assumptions, that the principle of relativity was true, and that the speed of light was the same for all observers. These two postulates were enough to derive everything in Lorentz's theory. He reinterpreted the Lorentz transformations as a statement that time, apart from space, was also relative to the observer. This idea, as Einstein himself notes, was partially inspired by philosophers who argued against absolute space and time. Einstein also showed that the inclusion of an aether in electromagnetic theory, which had by that point become mystical and

Special Relativity was produced by many interconnected theories and philosophies—connections that date back to ancient Greek philosophers who pondered the nature of space and time—and itself made important connections between theories previously thought irreconcilable. This is what makes it so important: not that it overturned existing knowledge, but because it linked this knowledge in novel ways. With so many scientific discoveries often attributed to a single “most important” person only, it is easy to forget that science is always a group effort. An effort in which every single contribution, no matter how small, matters greatly.



The patriarchy and planetary plunder

Myles Wilkinson

The climate crisis. The war on women. The rise of the far-right. These issues are frequently believed to be unrelated phenomena, yet the reverse is true. We separate these issues to our detriment, for the oppression of women and the exploitation of nature are inextricably linked. The mechanisms of objectification, devaluation, and violence experienced by women and minorities are paralleled in how humans treat nature. This connection is at the forefront of ecofeminist thinking. Ecofeminism integrates feminist principles with political ecology, drawing connections between current capitalist and patriarchal systems. These systems are suggested as root causes of oppression and exploitation of women and nature.

The patriarchy, a system rooted in male authority and dominance, operates through a variety of social, political, and economic structures and norms. The prominent Indian ecofeminist Vandana Shiva proposes that patriarchal capitalist development views both women and nature as reservoirs of value to be exploited for economic

gain. This provides insight into why the patriarchy has enabled centuries of colonial expansion, industrialisation, and ecological destruction.

Phrases like “Mother Earth” and “Mother Nature” reinforce both nature’s and women’s feminine exploitability under the patriarchy. Women are more closely associated with nature and are more likely to have positive environmental attitudes and behaviours than men, in part because taking a pro-environmental stance threatens the fragile idea of masculinity the patriarchy promotes. Encouraging more men to actively care for the environment would help debunk the myth of Mother Nature as exploitable and would begin to deconstruct the harmful idea of humans being against nature.

Patriarchal systems promote binaries such as humans versus nature, white versus non-white, and men versus women. These binaries rely on the idea of false superiority and inferiority which is essential for perpetuating a masculinist exploitative system. These oversimplified divisions justify oppression by making patriarchal norms seemingly more logical via a reductionist worldview. The effects of these ideas shape both global environmental movements and

academia. Ecofeminism aims to dispel these binaries, promoting a holistic framework to recognise and respond to crises like the climate crisis.

The effects of climate change are not uniform. Interactions of factors such as geographic location, human vulnerability, and ocean currents cause disproportionate impacts on some groups, particularly in the Global South. This is deemed a “climate injustice” as less developed countries have smaller contributions to current total emissions compared to the Global North. Disproportionate impacts of climate change on women are especially evident in the Global South, largely due to the role of women as primary caregivers and providers of food and fuel. UN figures indicate 80% of those displaced by climate change are women, and they are more likely to die in natural disasters. After the 2004 Boxing Day tsunami, surviving men outnumbered women by almost 3:1 in Sri Lanka, Indonesia, and India.

Intersectionality is a central tenet of ecofeminism, defined as the interaction and cumulative effects of multiple forms of discrimination affecting the daily lives of individuals, particularly women of colour.

This recognises not all women experience the same forms of oppression in a patriarchal society. Hurricane Katrina exemplified this, where African American women, many of whom were single mothers in poverty, were the worst affected by flooding in

New Orleans.

Ecofeminism is as much a practice as it is a theory. Distinct ecofeminist movements have arisen on separate continents involving women taking action against corporations and governments, often due to pollution and deforestation. The Chipko movement in modern-day Uttarakhand, India, is a notable example of this. Chipko, in Hindi meaning to hug or to cling, was a passive resistance movement reliant on rural villagers, primarily women, who formed rings around trees to protest government-led logging.

In short, the climate crisis and the fight for the rights of women and minorities are interdependent issues that must be viewed through an intersectional lens. Achieving gender and climate justice requires individual and collective dismantling of capitalist and patriarchal thinking, embracing ecofeminist perspectives.

art by Holly Bartlett



Subsurface power struggles – renewables, sustainability and innovation (adaptability)

Konstantin Nazarov



Public narratives of the green transition are filled with optimism. Politicians and innovators alike celebrate the promise of clean energy, technological ingenuity, and a sustainable future. Future powered by solar panels and s, wind turbines. , and Yet beneath this story of progress lies another, less visible narrative, the Oone rooted not in renewal, but in extraction. The shift away from fossil fuels has merely changed which parts of the planet we exploitcontinuing/prolonging without ending humanity's dependence on the Earth's resources.

At the heart of this new scramble are critical minerals, such as lithium, cobalt, nickel, rare earth elements, and copper, materials essential for the batteries that drive electric vehicles, the magnets that spin wind turbines, and the semiconductors that manage energy grids. Far from heralding the end of extractivism, the green transition has intensified it. The demand for these minerals is projected to grow severalfold by 2040, potentially reshaping global trade and sparking geopolitical rivalries that echo the oil politics of the twentieth century. "Energy independence" now

means control not only over fossil fuels and renewables but over the minerals buried deep beneath Earth'sthe surface. What's driving this contest is not simply environmental ambition, but strategic competition for control of profitable supply chains. The technologies underpinning decarbonisation depend on supply chains that are geographically concentrated and politically fragile. China is an example that refines over 70% of the world's lithium and dominates rare earth processing using this dominance as a political leverage while the Democratic Republic of Congo produces roughly two-thirds of global cobalt majority of which is owned by Chinese businessmen. As tensions rise between major powers, the security of these supply lines has become a matter of national security. Science sits at the centre of this struggle. Just as wartime urgency once accelerated advances in nuclear physics and aerospace engineering, today's resource insecurity is spurring innovation in geology, materials science, and planetary sensing. Satellite-based remote sensing, hyperspectral imaging, and AI-driven geological modelling

are revolutionising how we locate and assess deposits. By combining machine learning with vast geological datasets, geologists can predict mineral-rich zones with unprecedented precision and material scientists design new refining flowsheets with prodigious efficiency.

Meanwhile, new extraction frontiers are emerging. Lithium-rich brines in South America's "Lithium Triangle," deep-sea nodules on the Pacific seabed, and geothermal reservoirs in Iceland or Kenya are being reimagined as sources of strategic wealth. Researchers are developing chemical processes to extract minerals from seawater, mine tailings, and even electronic waste, efforts that blur the line between environmental remediation and profit-seeking innovation. Yet these disruptive approaches on critical mineral sourcing raise profound questions: who owns these resources, who benefits from their exploitation, and who bears the environmental cost?

The rhetoric of a "clean" transition often obscures such dilemmas. Mining for green technologies may emit less carbon than drilling for oil, but it still reshapes landscapes, displaces communities, and generates pollution. In this sense, the energy transition is not an escape from extractivism but its technological transformation. Science, far from being neutral, is implicated in the global race for subsurface power.

Geopolitical leverage, rather than environmental concern, links these new mining frontiers to broader shifts in global influence. The United States

and its allies are investing heavily in domestic mining, processing, and recycling capacities to reduce dependence on China. The European Union has launched its Critical Raw Materials Act to secure "strategic autonomy." Even small mineral-rich nations, from Chile to Indonesia, are renegotiating contracts to capture more value and sovereignty from their resources. As the focus of competition moves underground, knowledge itself becomes a resource. For instance, the balance of power can be shaped by data and technology, on geological formations, extraction chemistry, and material substitution, similarly just as military strength once did.

Ultimately, the real energy transition is not only happening above ground in gleaming solar arrays or wind farms — it is unfolding in laboratories and deep below the surface. It is a transformation of both matter and meaning, i.e. a reconfiguration of how science, technology, and geopolitics interact. Recognising this complexity does not diminish the urgency of decarbonisation, but it does challenge the comforting notion that sustainability and extraction are incompatible.

To wind up the underground geopolitics, it seems that the path to a sustainable future runs not just through innovation and idealism, but through the very bedrock of the Earth and through the competing visions of who will control it.

Medical misinformation: the winners and the losers

Isobel Reid

Would you trust health information from the US President? Probably not. Maybe the Secretary of Health and Human Services (HSS), or the director of the Centre for Disease Control (CDC). A paper published in *The Lancet*, perhaps. A doctor.

Of course, we'd all hope to "do our own research" before accepting anything as fact—review the evidence, apply a critical eye, perhaps consult an academic or two. After deep consideration, we'd form a tentative opinion, aware that one can never truly be certain in science. But that takes considerable time. Journal paywalls must be bypassed, and an understanding of diverse literature requires impossible breadth and depth of scientific expertise. If scientists and doctors cannot read every *Nature* issue cover-to-cover, a busy mother with no scientific background and no university login code cannot be expected to "do her own research". At some point, we must all just trust that information is credible.

Trump's recent comments

On 22 September, Trump held a press conference alongside RFK Jr, who he appointed Secretary of the HSS in

February. They spoke about plans to tackle the sharp increase in autism spectrum disorder (ASD) diagnoses over the last decades. Experts have explained this rise by pointing to broader diagnostic criteria, awareness of ASD presentation in girls and racial minorities, screening, and societal acceptance. Trump and RFK Jr disagreed, instead blaming Tylenol and vaccines.

Tylenol (paracetamol in the UK) is the generic drug acetaminophen. It is the most common painkiller globally, and as one of the few safe for use during pregnancy, it is the recommended first-line therapy. Despite this, Trump repeatedly warned, 'Tylenol during pregnancy can be associated with a very increased risk of autism', 'Don't take it'. So, what should pregnant people do when in pain? 'Tough it out' of course. International health agencies jumped to defend acetaminophen use, clearly stating that no link exists between paracetamol use and autism. They also highlighted that pain management is critical to psychological and physical health, and unmanaged fevers pose a real risk to both mother and foetus.

Trump rambled on to the topic of vaccines, again incorrectly positing an increased autism risk. His words were characteristically nonsensical, relying on emotion rather than fact:

'The MMR, I think should be taken separately. This is based on what I feel. The mumps, measles and the three should be taken separately.'

‘And they pump so much stuff into those beautiful little babies, it’s a disgrace. I don’t see it. I think it’s very bad. They’re pumping — it looks like they’re pumping into a horse.

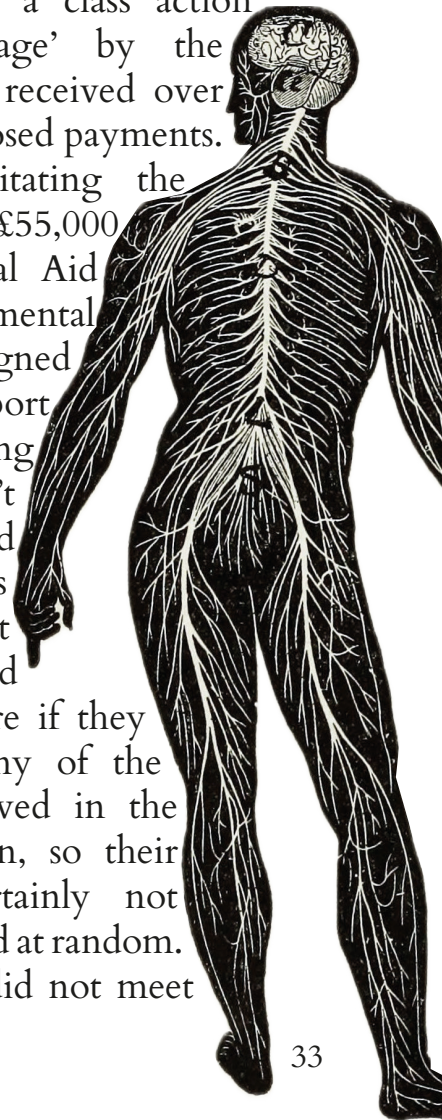
The vaccine Trump repeatedly referenced is the combined (polyvalent) MMR vaccination that has been used since the 1970s to protect against three potentially fatal viruses: measles, mumps, and rubella. Measles vaccines, including MMR, have saved an estimated 94 million lives since 1974. Unfortunately, this anti-vax rhetoric is not new. The erroneous link between vaccines and autism that still haunts conversations, publications, and policies, can be traced back to an infamous paper published in 1998 by a British doctor named Andrew Wakefield.

Wakefield’s fraudulent paper that started it all

A poorly designed (to put it kindly) case series, the study was published in prestigious journal, *The Lancet*. It followed twelve children with regressive developmental disorder (majority ASD) and chronic enterocolitis through a series of invasive and painful procedures, including colonoscopies and lumbar punctures. The key finding: ‘onset of behavioural symptoms was associated, by the parents, with measles, mumps, and rubella vaccination in eight of the 12 children’. Yes, ‘by the parents’. In an accompanying press conference, Wakefield suggested that splitting the polyvalent MMR vaccine

into three monovalent vaccinations would eliminate the risk of autism. Trump echoed this in September, and the director of the CDC subsequently called for monovalent MMR vaccines.

If weak scientific method and accreditation of their conclusion to the parents was not enough to completely discredit the study, investigative journalist Brian Deer revealed a litany of fraudulent behaviours and flagrant ethics violations by Wakefield. Any scientist knows to check a paper’s funding and authorial conflicts of interest. Although none were listed, it transpired that Wakefield had been hired at £150 per hour, plus expenses, by a lawyer filing a class action for ‘vaccine damage’ by the MMR vaccine. He received over £400,000 in undisclosed payments. The hospital facilitating the study received £55,000 from the UK Legal Aid Board, a governmental organisation designed to financially support people accessing justice. It doesn’t stop there: Wakefield had filed patents on monovalent vaccinations, so stood to make much more if they were adopted. Many of the parents were involved in the anti-MMR litigation, so their children were certainly not referred to Wakefield at random. Additionally, they did not meet



the study criteria – only one was clearly diagnosed with regressive autism, and nine had no colon pathologies. This means risky testing was unnecessary and unethical.

The saga played out dramatically, with Deer publishing a series of scathing exposés in *The Sunday Times* and a Channel 4 documentary. Wakefield attempted to sue Deer and Channel 4 but eventually dropped the suit and paid all defendant costs. The General Medical Council charged Wakefield with professional misconduct and struck him from the medical register. During the hearing, it was revealed that Wakefield had made a habit of unethical experimentation, having paid children attending his son's tenth birthday party £5 for blood samples for his research. Wakefield, disgraced and unable to practice in the UK, migrated to the US, where he became a prominent figure in the anti-vax movement.

Thanks to Deer, Wakefield's fraud was exposed. But the damage to public perception of vaccines was significant, and it persists today. MMR vaccine rates fell dramatically in the twelve years it took for the paper to be retracted and Wakefield disbarred. Elimination of measles was a monumental scientific victory, but it's now rearing its ugly head.

The impact on science and public health today

The fraudulent link between vaccines or acetaminophen and autism is just one example of how individual greed

impacts public health. Measles is on the rise. Pregnant people and those with ASD are being used as political chess pieces. And how can we quantify the damage of redirecting funding, or restructuring scientific organisations? Since his appointment, RFK Jr. has fired all 17 members of the Advisory Committee on Immunization Practices, replacing them with eight members, half of whom have a history of distrust in vaccines. He is in the process of laying off over 10,000 researchers, doctors, and health officials. Four directors at the National Institutes of Health have been fired after whistleblowing on Trump's anti-vax agenda and politicisation of grant approvals.

Public trust in science is critical. To uphold it, scientists must be free to conduct rigorous, honest research, and journals must review literature carefully before publication (without hefty paywalls). Findings need to be communicated clearly to the public, so journalists should analyse primary literature and consult scientists before reporting sensationalist spins on misinterpreted abstracts. Finally, those making decisions about funding research, medical protocols, and drug availability—like Trump and RFK Jr.—should listen to experts and act according to public and scientific interests, not political ones. Our lives depend on it.



