How science has shifted our sense of identity

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In the iconic frontispiece to Thomas Henry Huxley's *Evidence as to Man's Place in Nature* (1863), primate skeletons march across the page and, presumably, into the future: "Gibbon, Orang, Chimpanzee, Gorilla, Man." Fresh evidence from anatomy and palaeontology had made humans' place on the scala naturae scientifically irrefutable. We were unequivocally with the animals — albeit at the head of the line.

Nicolaus Copernicus had displaced us from the centre of the Universe; now Charles Darwin had displaced us from the centre of the living world. Regardless of how one took this demotion (Huxley wasn't troubled; Darwin was), there was no doubting Huxley's larger message: science alone can answer what he called the 'question of questions': "Man's place in nature and his relations to the Universe of things."

Huxley's question had a prominent place in the early issues of *Nature* magazine. Witty and provocative, 'Darwin's bulldog' was among the most in-demand essayists of the day. Norman Lockyer, the magazine's founding editor, scored a coup when he persuaded his friend to become a regular contributor. And Huxley knew a soapbox when he saw one. He hopped up and used *Nature*'s pages to make his case for Darwinism and the public utility of science.

It was in the seventh issue — 16 December 1869 — that Huxley advanced a scheme for what he called 'practical Darwinism' and we call eugenics. Convinced that continued dominance of the British Empire would depend on the "energetic enterprising" English character, he mused about selecting for a can-do attitude among Britons[1]. Acknowledging that the law, not to mention ethics, might get in the way, he nevertheless wrote: "it may be possible, indirectly, to influence the character and prosperity of our descendants." Francis Galton — Darwin's cousin and an outer planet of Huxley's solar system — was already writing about similar ideas and would come to be known as the father of eugenics. When this magazine appeared, then, the idea of 'improving' human heredity was on many people's minds — not least as a potent tool of empire.

Huxley's sunny view — of infinite human progress and triumph, brought about by the inexorable march of science — epitomizes a problem with so-called Enlightenment values. The precept that society should be based on reason, facts and universal truths has been a guiding theme of modern times. Which in many ways is a splendid thing (lately I've seen enough governance without facts for one lifetime). Yet Occam's razor is double edged. Enlightenment values have accommodated screechingly discordant beliefs, such as that all men are created equal, that aristocrats should be decapitated and that people can be traded as chattel.

I want to suggest that many of the worst chapters of this history result from scientism: the ideology that science is the only valid way to understand the world and solve social problems. Where science has often expanded and liberated our sense of self, scientism has constrained it.

Across the arc of the past 150 years, we can see both science and scientism shaping human identity in many ways. Developmental psychology zeroed in on the intellect, leading to the transformation of IQ (intelligence quotient) from an educational tool into a weapon of social control. Immunology redefined the 'self' in terms of 'non-self'. Information theory provided fresh metaphors that recast identity as residing in a text or a wiring diagram. More recently, cell and molecular studies have relaxed the borders of the self. Reproductive technology, genetic engineering and synthetic biology have made human nature more malleable, epigenetics and microbiology complicate notions of individuality and autonomy, and biotechnology and information technology suggest a world where the self is distributed, dispersed, atomized.

Individual identities, rooted in biology, have perhaps never played a larger part in social life, even as their bounds and parameters grow ever fuzzier.

Frontispiece to Thomas Henry Huxley's *Evidence as to Man's Place in Nature* (1863).Credit: Paul D. Stewart/SPL

Designs on intelligence

"Methods of scientific precision must be introduced into all educational work, to carry everywhere good sense and light," wrote the French psychologist Alfred Binet in 1907 (English translation published in 1914 (ref. [2])). A decade earlier, Binet and Théodore Simon developed a series of tests for French schoolchildren to measure what they called 'mental age'. If a child's mental age was less than her chronological age, she could receive extra help to catch up. The German psychologist William Stern took the ratio of mental to chronological age, giving what he called the IQ and, theoretically, making it comparable across groups. Meanwhile, Charles Spearman, a British statistician and eugenicist of the Galton school, found a correlation between a child's performance on different tests. To explain the correlations, he theorized an innate, fixed, underlying quality he called 'g', for 'general intelligence'. Then the American psychologist Henry Goddard, with the eugenicist Charles Davenport whispering in his ear, claimed that low IQ was a simple Mendelian trait. Thus, step by scientistic step, IQ was converted from a measure of a given child's past performance to a predictor of any child's future performance.

IQ became a measure not of what you do, but of who you are — a score for one's inherent worth as a person. In the Progressive era, eugenicists became obsessed with low intelligence, believing it to be the root of crime, poverty, promiscuity and disease. By the time Adolf Hitler expanded eugenics to cover entire ethnic and cultural groups, tens of thousands of people worldwide had already been yanked from the gene pool, sterilized, institutionalized, or both.

Not me

Immunologists took another approach, They located identity in the body, defining it in relational rather than absolute terms: self and non-self. Tissue-graft rejection, allergies and autoimmune reactions could be understood not as a war but as an identity crisis. This was pretty philosophical territory. Indeed, the historian Warwick Anderson has suggested that[3] in immunology, biological and social thought have been "mixing promiscuously in a common

tropical setting, under the palm trees".

The immunological Plato was the Australian immunologist Frank MacFarlane Burnet. Burnet's fashioning of immunology as the science of the self was a direct response to his reading of the philosopher Alfred North Whitehead. Tit for tat, social theorists from Jacques Derrida to Bruno Latour and Donna Haraway have leaned on immunological imagery and concepts in theorizing the self in society. The point is that scientific and social thought are deeply entangled, resonant, co-constructed. You can't fully understand one without the other.

Later, Burnet was drawn to new metaphors taken from cybernetics and information theory. "It is in the spirit of the times," he wrote in 1954[4], to believe there would soon be "a 'communications theory' of the living organism." Indeed there was. In the same period, molecular biologists also became enamoured of information metaphors. After the 1953 solution of the DNA double helix, as the problem of the genetic code took shape, molecular biologists found analogies with information, text and communication irresistible, borrowing words such as 'transcription', 'translation', 'messengers', 'transfers' and 'signalling'. The genome 'spells' in an 'alphabet' of four letters, and is almost invariably discussed as a text, whether it is a book, manual or parts list. Not coincidentally, these fields grew up alongside computer science and the computing industry.

The postwar self became a cipher to be decoded. DNA sequences could be digitized. Its messages could, at least in theory, be intercepted, decoded and programmed. Soon it became hard not to think of human nature in terms of information. By the 1960s, DNA was becoming known as the 'secret of life'.

Many selves

In the late 1960s and 1970s, critics (including a number of scientists) grew concerned that the new biology could alter what it means to be human. The ethical and social issues raised were "far too important to be left solely in the hands of the scientific and medical communities", wrote James Watson (of DNA fame and later infamy) in 1971.

In 1978, Patrick Steptoe and Robert Edwards succeeded with human *in vitro* fertilization, leading to the birth of Louise Brown, the first 'test-tube baby'. By 1996, human cloning seemed to be around the corner, with the cloning of a sheep that Ian Wilmut and his team named Dolly.

Cloning and genetic engineering have prompted much soul-searching but little soul-finding. There has long been something both terrible and fascinating about the idea of a human-made, perhaps not-quite-person. Would a cloned individual have the same rights as the naturally born? Would a baby conceived or engineered to be a tissue donor be somehow dehumanized? Do we have a right to alter the genes of the unborn? Or, as provocateurs have argued, do we have an obligation to do so? The recent development of potent gene-editing tools such as CRISPR has only made widening participation in such decision-making more urgent.

A macaque undergoing a liver transplant from a pig in China in 2013.Credit: VCG/Getty

Arguments, both pro and con, around engineering humans often lean on an overly deterministic understanding of genetic identity. Scientism can cut both ways. A deep reductionism located human nature inside the cell nucleus. In 1902, the English physician Archibald Garrod had written[5] of genetically based “chemical individuality”. In the 1990s, as the first tsunamis of genomic sequence data began to wash up on the shores of basic science, it became obvious that human genetic variation was much more extensive than we had realized. Garrod has become a totem of the genome age.

By the end of the century, visionaries had begun to tout the coming of ‘personalized medicine’ based on your genome. No more ‘one size fits all’, went the slogan. Instead, diagnostics and therapy would be tailored to you — that is, to your DNA. After the Human Genome Project, the cost of DNA sequencing nosedived, making ‘getting your genome done’ part of mass culture.

Today, tech-forward colleges offer genome profiles to all incoming first-years. Hip companies purport to use your genome to compose personalized wine lists, nutritional supplements, skin cream, smoothies or lip balm. The sequence has become the self. As it says on the DNA testing kit from sequencing company 23andMe, “Welcome to you.”

Boundaries blur

But you are not all you — not by a long shot. The DNA-as-blueprint model is outdated, almost quaint. For starters, all of the cells in a body do not have the same chromosomes. Cisgender women are mosaics: the random inactivation of one X chromosome in each cell means that half a woman’s cells express her mother’s X and half express her father’s. Mothers are also chimaeras, thanks to the exchange of cells with a fetus through the placenta.

Chimaerism can cross the species boundary, too. Human–chimpanzee embryos have been made in the laboratory, and researchers are hard at work trying to grow immune-tolerant human organs in pigs. Genes, proteins and microorganisms stream continuously among almost any life forms living cheek by jowl. John Lennon was right: “I am he as you are he as you are me and we are all together.”

Even in strictly scientific terms, ‘you’ are more than the contents of your chromosomes. The human body contains at least as many non-human cells (mostly bacteria, archaea and fungi) as human ones[6]. Tens of thousands of microbial species crowd and jostle over and through the body, with profound effects on digestion, complexion, disease resistance, vision and mood. Without them, you don’t feel like you; in fact, you aren’t really you. The biological self has been reframed as a cluster of communities, all in communication with each other.

These, too, cavort promiscuously beneath the palms. Scientists found that they could use a person’s microbiome to identify their sexual partner 86% of the time[7]. The communities of greatest similarity in cohabiting couples, they found, are on the feet. The thigh microbiome, by contrast, is more closely correlated with your biological sex than with the identity of your partner.

A body part, a cesspool, a subway car, a classroom — any place with a characteristic community — can be understood as having a genetic identity. In such a community, genetic information passes within and between individual organisms, through sex, predation, infection and horizontal gene transfer. In the past year, studies have shown that the communities of

symbiotic microbes in deep-sea mussels become genetically isolated over time, like species. In fungi, genes called *Spok* (spore-killer) ebb and flow and recombine across species by 'meiotic drive', a kind of genomic fast-forward button that permits heritable genetic change to occur fast enough to respond to a rapidly changing environment. The genome, as the geneticist Barbara McClintock said long ago, is a sensitive organ of the cell.

Epigenetics dissolves the boundaries of the self even further. Messages coded in the DNA can be modified in many ways — by mixing and matching DNA modules, by capping or hiding bits so that they can't be read, or by changing the message after it's been read, its meaning altered in translation. DNA was once taught as a sacred text handed faithfully down the generations. Now, increasing evidence points to the nuclear genome as more of a grab bag of suggestions, tourist phrases, syllables and gibberish that you use and modify as needed. The genome now seems less like the seat of the self and more of a toolkit for fashioning the self. So who is doing the fashioning?

Distributed self

Brain implants, human–machine interfaces and other neurotechnical devices extend the self into the domain of the 'universe of things'. Elon Musk's company Neuralink in San Francisco, California, seeks to make the seamless mind–machine interface — that sci-fi trope — a (virtual) reality. Natural intelligence and artificial intelligence already meet; it's not far-fetched for them to somehow, someday, meld.

Can the self become not merely extended but distributed? The writer and former *Nature* editor Philip Ball let researchers sample his skin cells, turn them back into stem cells (with the potential to become any organ) and then culture them into a 'mini-brain', neural tissue in a dish that developed electrical firing patterns typical of regions of the brain. Other sci-fi staples, such as growing whole brains in Petri dishes or culturing human organs in farm animals, remain a long way off, but active efforts to achieve them are under way.

Self control

Yet there is a fruit fly in the ointment. Most of these Age-of-Reason notions of identity, and the dominant sci-fi scenarios of post-human futures, have been developed by university-educated men who were not disabled, and who hailed from the middle and upper classes of wealthy nations of the global north. Their ideas reflect not only the findings but also the values of those who have for too long commanded the science system: positivist, reductionist and focused on dominating nature. Those who control the means of sequence production get to write the story.

That has begun to change. Although there is far to go, greater attention to equity, inclusion and diversity has already profoundly shaped thinking about disease, health and what it means to be human. It matters that Henrietta Lacks, whose tumour cells are used in labs all over the world, cultured and distributed without her consent, was a poor African American woman. Her story has stimulated countless conversations about inequities and biases in biomedicine, and changed practices at the United States' largest biomedical funder, the National Institutes of Health.

Considering genomic genealogy from an African American perspective, the sociologist Alondra Nelson has revealed complex, emotionally charged efforts to recover family histories lost to the Middle Passage. In the Native American community, creation of a genetic Native identity was a

co-production of Western science and Indigenous culture, as the historian Kim TallBear has shown. DNA-based conceptions of ethnicity are far from unproblematic. But the impulse to make the technologies of the self more accessible, more democratic — more about self-determination and less about social control — is, at its basis, liberatory.

Nowhere is this clearer than for people living with disabilities and using assistive technologies. They might gain or regain modes of perception, might be able to communicate and express themselves in new ways, and gain new relationships to the universe of things.

The artist Lisa Park plays with these ideas. She uses biofeedback and sensor technologies derived from neuroscience to create what she calls audiovisual representations of the self. A tree of light blooms and dazzles as viewers hold hands; pools of water resonate harmonically in response to Park's electroencephalogram waves; an 'orchestra' of cyborg musicians wearing heart and brain sensors make eerily beautiful music by reacting and interacting in different ways as Park, the conductor, instructs them to remove blindfolds, gaze at one another, wink, laugh, touch or kiss. Yet even this artistic, subjective and interactive sense of self is tied to an identity bounded by biology.

Since the Enlightenment, we have tended to define human identity and worth in terms of the values of science itself, as if it alone could tell us who we are. That is an odd and blinkered notion. In the face of colonialism, slavery, opioid epidemics, environmental degradation and climate change, the idea that Western science and technology are the only reliable sources of self-knowledge is no longer tenable. This isn't to lay all human misery at science's feet — far from it. The problem is scientism. Defining the self only in biological terms tends to obscure other forms of identity, such as one's labour or social role. Maybe the answer to Huxley's 'question of questions' isn't a number, after all.