What the public thinks it knows about science

Popular culture and its role in shaping the public's perception of science and scientists

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Popular culture probably does more than formal science education to shape most people's understanding of science and scientists. It is more pervasive, more eye-catching, and (with rare exceptions) more memorable. No genetics textbook can hope to compete with *Jurassic Park*, and no lecture on biophysics can match the sight of Dr Frankenstein pulling lightning down from the stormy sky to animate his creature. What messages about science, then, is the public likely to draw from popular culture? This essay discusses some of the most common, but there are of course many others. Science is complex and multi-faceted, and so is popular culture's portrayal of it.

The idea that natural laws are constant across space and time is the philosophical foundation of modern science. Mainstream popular culture takes a more relaxed approach, flexing the laws of nature when required. It creates exceptions to natural laws, or ignores them altogether, whenever they threaten to conflict with the story being

told. Most suspensions of natural law in popular culture are casual and—except to audiences with scientific backgrounds—obscure. Every action has an equal and opposite reaction, but action heroes like Clint Eastwood in *Dirty Harry* (1971) and Sylvester Stallone's Rambo (*First Blood*, 1982) barely flinch when they fire bullets that seconds later knock a villain off his feet. There is no air in space to carry sound waves, yet spaceships routinely blow up with a thunderous roar or make a 'whoosh' sound like an express train when they pass. Light travels at around $300,000 \text{ km s}^{-1}$, but in a *Star Wars*-style gun battle, the heroes can dive away from a laser beam after it is fired. Ecosystems on Earth require large populations of prey to sustain even modest populations of predators, but the ecosystems of alien planets include abundant predators and scant prey. There are, of course, sound dramatic reasons for such scientific transgressions. Action heroes are meant to be superhuman, soundless explosions would feel as wrong as a red ace of spades, and lasers that behaved like real lasers would turn futuristic gunfight scenes into an incomprehensible jumble of beams.

The preference of popular culture for drama over scientific reality is especially apparent in its treatment of faster-than-light (FTL) travel. This treatment ignores two key implications of the special theory of relativity: the apparent impossibility of accelerating a spaceship (or any object) to the speed of light, and the slowing of time that would take place within the spaceship as its speed increased. Spacecraft in *Star Wars* (1977) and *Star Trek* (1966), as well as in countless other science-fiction tales, routinely travel faster than light while ignoring these effects.

Their crews cross interstellar distances in a matter of days and return to find that time has passed no more quickly at home than it has aboard ship. These fictional explorers treat FTL travel as unremarkable. Explanations, if provided at all, consist of casual references to 'hyperspace', 'jump gates', 'space warps' or simply the 'drive'. Such comments imply that technology has overcome the effects of relativity, or that science has replaced Einstein's view of the universe with one in which FTL travel is possible. Both interpretations lead to similar optimistic conclusions: either the universe will be found to conform to human needs or it will be made to conform to human needs.

DNA IS DESTINY

Natural laws may be flexible in popular culture, but the relationship between genes and the characteristics for which they code is rigid. Popular culture routinely glosses over the complex interactions between genes, and the equally complex interplay of genes and the environment that Richard Lewontin has dubbed the "triple helix". By treating single genes as if they invariably and inevitably produce specific traits, regardless of other influences or

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even of transplantation into a different organism, popular culture has deemed that our DNA is our destiny.

Michael Crichton's 1990 novel *Jurassic Park* and its 1992 film adaptation by Steven Spielberg is a classic expression of this idea. Crichton's manufactured dinosaurs are reconstructed using DNA from fossilized dinosaur blood, patched where it is incomplete with DNA from extant species of frogs. Grown in ostrich eggs, hatched in a laboratory and raised in an environment 100 million years removed from the one in which their ancestors evolved, they grow to adulthood fully functional and lethally well adapted. Despite being raised without older members of their own species to imitate, they duplicate the behaviour of their ancestors as well as their anatomy. Hadrosaurs' tendency to collect into packs and velociraptors' ability to hunt cooperatively are, evidently, fully programmed into their genes. The only exception to this perfect reproduction is the dinosaurs' own reproductive system. Here, the interpolated frog DNA has manifested itself with crisp perfection. The dinosaurs are, like the frogs from which their DNA patches came, hermaphrodites. The biological implausibility of such a change, like the physical implausibility of FTL travel, is glossed over quickly and casually.

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Similar assumptions about the simplicity of DNA coding appear in stories about humans augmented with genes from other species. Max, the transgenic heroine of James Cameron's television adventure series *Dark Angel* (2000), carries both human and feline DNA. She looks like a normal, although exotically beautiful, young woman in her early twenties, but has the enhanced senses and superhuman agility of a cat, as

well as a female cat's tendency to go into heat once a month. Mole, another transgenic character introduced later in the series, carries the DNA of a desert-dwelling lizard and looks like a man with the head and hands of an iguana. Designed by his human creators to be a desert warrior, he has a man's intelligence (and love of cigars) and a lizard's ability to thrive in hot climates with little water.

Popular culture's assumption that specific genes invariably produce specific traits extends beyond the physical appearance of the organism. Dr Harry Wolper, the scientist-hero of the novel and film *Creator* (1985), works to clone his dead wife because he believes that the clone will not just resemble but be his lost love. The 1997 film *Gattaca*, a cautionary tale about a society in which prenatal manipulation is routine, posits a future in which physical perfection—beauty and athletic ability, as well as freedom from disease—has become the norm. The idea that qualities as complex and culturally dependent as personality, beauty and intelligence can be created by plugging the right genes into the right places in the genome of an individual is, at best, debatable. It is fully consistent, however, with popular culture's vision of genetic engineering as a technology that borders on magic—able to transform any living thing into any other.

KING OF CREATION

Until Copernicus and Darwin showed otherwise, humans imagined themselves as the centre of the Universe and the pinnacle of the living world. Until genetics and primatology revealed the truth, humans believed that a wide gulf lay between them and the 'lower animals'. These changes in attitude have, however, been partial and incomplete at best. Many members of the public continue to assign humankind a unique, privileged place in the natural world. Popular culture regularly reinforces the view that humans are special.

Jean-Baptiste Lamarck (1744–1829) envisioned the course of evolution as a ladder, with *Homo sapiens* occupying the uppermost rung. Charles Darwin (1809–1882) envisioned it as a bush, with *Homo sapiens* as one of hundreds of individual twigs.

Dr Frankenstein and his assistant Igor at work. Scene from the movie *Frankenstein* (1931). Courtesy of Universal Studios Licensing, Inc.

Popular culture's depiction of evolution describes it as linear and progressive, with *Homo sapiens* as its final, finest product

Ernst Haeckel (1834–1919) substituted a towering tree for Darwin's bush, but placed *Homo sapiens* at the tip of its thick trunk and relegated 'lower animals' to the lower branches. Scientific opinion has swung steadily towards Darwin's non-directional model since 1920, but popular opinion has always favoured Haeckel and Lamarck, and the privileged position that they assigned to humans. Popular culture's depiction of evolution describes it as linear and progressive, with *Homo sapiens* as its final, finest product. The Smithsonian Institution's Museum of Natural History, for example, displays a multi-story mural entitled 'The Tower of Time', which arranges the history of life into a narrow vertical column. As the viewer's eye travels up the column, single-celled organisms give rise to marine invertebrates, fishes, amphibians and so on to humans at the top. The most famous visual metaphor for human evolution is a parade of increasingly modern-looking human ancestors walking left-to-right across the page—a direction, as Western cultures read from left-to-right, that implies progress.

Fiction, too, routinely depicts the history of life as progressive, and humans as the pinnacle of that progress. A character in the film *Jurassic Park* (although not in the book), argues that dinosaurs "had their shot" and that "nature selected them for extinction"—language implying that dinosaurs failed and were replaced by something better. The mammoth and sabre-toothed tiger in the animated film *Ice Age* (2002) seem to understand that the advent of humans, even Paleolithic hunters, means that the days of their own species are numbered. Dozens of science-fiction stories—Spider and Jeanne Robinson's *Stardance* trilogy of novels, the television series *Star Trek: The Next Generation* (1987), the films *2001: A Space Odyssey* (1968) and *Mission to Mars* (2000)—suggest that the evolution of life on Earth has been shaped by benevolent aliens. All assume that the goal of the project was to produce intelligent, self-aware, tool-making humanoids: us.

The idea that humans are the final, most sophisticated product of evolution also permeates popular culture in other ways. Human-like beings, created by humans rather than God or Nature, are typically

depicted as deeply flawed and sometimes as lethally dangerous. HAL 9000, the super-intelligent computer in *2001*, goes insane and murders four of its five human 'masters'. A similar machine in D.F. Jones's *Colossus* trilogy of novels attempts to precipitate a nuclear war, as does the SkyNet system in the *Terminator* films. The lethal androids in the *Terminator* series are human in appearance, but dedicated to the destruction or enslavement of real, flesh-and-blood humans. Human clones receive similarly rough treatment in popular culture, as do animals raised to human-like intelligence: the super-intelligent dog in Olaf Stapledon's novel *Sirius* or the megalomaniac laboratory mouse in the cartoon series *Pinky and the Brain*. Human characters who acquire superhuman powers through human agency, such as H.G. Wells' Invisible Man, are, typically, portrayed less sympathetically than those who acquire them 'naturally' through accident or mutation; for example, the comic book superheroes Spider-Man and the Fantastic Four. Popular culture's underlying message seems to be the same in each case: any human attempt to improve on or even replicate humans is an act of unforgivable arrogance and an affront to Nature.

THE EXOTIC IS DEADLY

The rise of modern medicine, with its chemical 'toolkit' of vaccines and antibiotic drugs, temporarily made heroes of physicians and researchers in the 1930s, 40s and 50s. Film actor Paul Muni, for example, recreated the discovery of the germ theory in *The Story of Louis Pasteur* (1935) and Edward G. Robinson vanquished syphilis in *Dr Ehrlich's Magic Bullet* (1940). Popular non-fiction books like Paul de Kruif's *The Microbe Hunters* (1932) dramatized the work of less familiar researchers, and Sinclair Lewis's novel *Arrowsmith* (1925; filmed in 1931) revolved around a fictional counterpart. Slightly later, Alexander Fleming's discovery of penicillin and Jonas Salk's development of a polio vaccine brought them popular, as

well as scientific, acclaim. Magazine articles, advertisements and other media also proclaimed doctors and medical researchers as cultural heroes, who protected ordinary citizens by doing battle with the diseases that threatened them.

Stories about 'crazy' ideas and their defenders have been common in popular culture for centuries, supplying drama when the hero is ridiculed and a satisfying ending when he is vindicated

The diseases that these doctor-heroes battled—syphilis, polio and bacterial infections—were a routine part of everyday life in the first half of the twentieth century. Since the late 1960s, however, the biological threats featured in popular culture have grown steadily more exotic. Fictional doctors and medical researchers still appear as heroes, but their adversaries are rarely the 'everyday' diseases of the late twentieth century—heart disease, cancer, or AIDS. Instead, they face diseases from the African jungles, from secret government laboratories or even from other worlds.

Michael Crichton's 1969 novel *The Andromeda Strain* (filmed in 1970) concerns a small team of scientists struggling to understand and contain a mysterious virus brought to Earth by a returning space probe. Stephen King's apocalyptic thriller *The Stand* (1978, revised 1991) is set in the aftermath of a devastating plague that kills virtually the entire human race. The movie *Outbreak* (1995), based on Richard Preston's sensationalistic non-fiction bestseller *The Hot Zone*, focuses on a similar team battling an Ebola-like disease carried to California by infected African monkeys. Within the last year alone, the television dramas *Third Watch*, *ER* and *Law and Order* have all featured stories about incipient epidemics of exotic diseases. The common thread in all these stories is their high stakes. Cancer, heart disease or tuberculosis might kill tens of thousands annually, but their exotic, fictional counterparts are able to kill millions in a matter of weeks. The scientists' battle with them is, therefore, not just a battle for a higher quality of life but for the survival of the human race. One scene from *Outbreak*, prominently featured in the advertising campaign, shows a computer projection of how the disease will spread if left unchecked: red shading flows like blood across a map of the United States.

CRAZY IDEAS

The verses of "They All Laughed", a popular American song of the 1930s, list famous historical figures—Christopher Columbus, Henry Ford, the Wright Brothers—who were ridiculed for ideas that are now taken for granted. Even then, 70 years ago, the theme was far from new. Stories about 'crazy' ideas and their defenders have been common in popular culture for centuries, supplying drama when the hero is ridiculed, and a satisfying ending when he is vindicated. The formula is particularly common in stories about inventors, but it also appears regularly in stories about scientists.

Victor Frankenstein, in both Mary Shelley's novel and the dozens of film adaptations, is opposed by learned men who insist that electricity cannot bring life to dead flesh. Ian Malcolm, the mathematician who predicts that the dinosaurs of *Jurassic Park* will escape human control, is dismissed by the park's creator as a Cassandra. Theodore Honey, a research metallurgist in Nevil Shute's novel *No Highway* (filmed in 1951 as *No Highway in the Sky*), tries in vain to convince the aircraft-maker that employs him of a potentially fatal metal-fatigue problem in their new airliner. All three, of course, are proved right—as are the based-on-fact heroes of films like *Madame Curie* (1943), *The Story of Louis Pasteur* and *And the Band Played On* (1993; about scientists grappling with the early stages of the AIDS epidemic).

There is, of course, nothing inherently wrong or inaccurate with such stories. The history of science is studded with ideas that won wide acceptance after initially being dismissed as outlandish: the heliocentric

universe, the kinetic theory of heat and plate tectonics, for example. Popular culture departs from reality, however, when the hero's outlandish idea always proves to be correct, and orthodox scientists' dismissals of it always turn out to be wrong. Popular culture also—for obvious dramatic reasons—compresses the process by which a new idea is accepted. Max Planck's famous dictum that new ideas triumph only when their opponents die off has no place in popular culture's view of science. Neither does Linus Pauling's observation that a scientist needs to have lots of ideas, as most of them will be wrong. Especially in the movies, new ideas are almost invariably right, and triumph over entrenched scepticism in a matter of weeks, days, or even hours. When a brash, young fictional scientist predicts that a great white shark is hunting close inshore (*Jaws*, 1975), a volcano is about to form in downtown Los Angeles (*Volcano*, 1997), or a comet is about to hit the Earth (*Deep Impact*, 1998), audiences can be sure that the scientist will soon be proven right.

Ultimately, we all wish that people had a better grasp of basic science, and that they could—when they saw it happen—recognize when dramatic license is being taken with the laws of nature. The question, of course, is how to achieve that goal. Simply complaining about the scientific inaccuracies in popular culture is not a solution. Done privately, it accomplishes nothing; done publicly, it is less likely to open someone's eyes than to reinforce their belief that most scientists are humourless drones.

A better solution is to accept popular culture's treatment of science for what it is—entertainment—and use it as a springboard for dialogue with the public. Popular culture does occasionally get it right, and every case where it does so provides a 'teachable moment' in which a concept can be vividly reinforced. Ben Bova's novels *Mars* and *Moonrise*, and their sequels, are scientifically literate depictions of conditions on other worlds. *Gattaca* raises serious questions about genetic discrimination before mutating into a conventional thriller. Carl Sagan's novel *Contact* (and its movie adaptation in 1997) offers a knowing portrayal of government-funded 'big science'. Even the many cases where popular culture gets it wrong can be useful.

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A step-by-step explanation of why the physics and astronomy in *Armageddon* (1998) are nonsense would, for example, make a serviceable introduction to the basics of orbital mechanics.

Popular culture can be a shared frame of reference, within which scientists and the public can discuss both science and its social implications, but it can only serve that role if scientists are willing to take it seriously.

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