

SCIENCE, SCIENTISTS AND LITERATURE

THE ROLE OF LITERATURE IN PROMOTING SCIENCE AND TECHNOLOGY

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Innovative ideas and technological advances in science and technology have been reflected by numerous well-known and representative literary works. This was first witnessed at the beginning of the nineteenth century, a time marked by the most notorious social impact of scientific activity. Here, we show how the debate between science and humanities is unproductive. The mutual influence of these two ways of thinking shows that they are equally human and have constantly influenced each other, and even more so today. In this article we discuss countless examples of novels and stories influenced by new scientific ideas, and also some cases where literary creativity has coined some highly original scientific vocabulary.

Keywords: science and literature, science outreach, science-technology-society (STS).

From 1959 onwards a cliché in the Western World has been to refer to the division between the two cultures (Snow, 1965): the culture of humanists and that of scientists and technicians, and the communication problems between them. There are some who do not even believe that the latter group may be called a culture, and consequently there is also discussion about scientists' lack of culture. Others attribute this to scientists' excessive specialisation. However, as this article will show, the important interactions between science and the cultural sphere (with architecture, religion, the philosophy of the Enlightenment, or literature) throughout history demonstrate that science is a fundamental component of culture (Solbes, 2002). Given that we now understand science to be a form of thinking and formal reasoning which originated in the Renaissance, we will show the relationship between science and literature during that period, before looking at contemporary science, when this relationship has had more significant effects. This means that science is present in literature, in the form of topics, characters, and even authors, which as we will see, allows literature to be used as a means to spread knowledge about science and its social context.

■ SCIENCE AND MODERN LITERATURE

During the Renaissance and the Baroque period, literature began to portray scientific characters, especially doctors, surgeons and chemists, owing to their larger numbers and role in human affairs such as illness and death (Solbes, 2002). The fact that mathematics and other sciences were crowning glories of the Enlightenment can be seen in the literature of that period. Thus, Jonathan Swift, in his work *Gulliver's Travels* (1726), depicts an island, Laputa, which is held up magnetically in the air, and inhabited by men who are totally dedicated to mathematics and music. From the perspective of the flying Island it is «easy [...] for a prince to bring under his obedience whatever country lay within the attraction of that magnet». In this regard, Swift was able to foresee science being a natural ally to power, used to dominate humans and nature. The natural scientists appearing in Swift's Grand Academy of Lagado do not enjoy such respect; they spend their time extracting solar rays from cucumbers and transforming human excrement into food, thus reversing nature's phenomena. Voltaire took inspiration from Swift when writing his short

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story *Micromégas* (1752), where he narrated the space travels that bring the eponymous giant to Earth in order to satirise human behaviour and praise science, which seems to be the only point on which Swift and Voltaire can agree.

Johann W. Goethe tried to contribute to scientific knowledge. Aside from his natural philosophy he wrote an erroneous theory about colour and made interesting contributions to the areas of plant and human morphology. In *Elective Affinities* (1809), Goethe bases his writing around the idea that the human passion between the protagonists cannot be explained with rational foresight, just like chemical bonds and separations, as was believed at the time. From his vitalist perspective, Goethe opposes chemical activity against that of the kingdom of mechanical laws.

In the great classics of the nineteenth century (Stendhal, Balzac, Dickens, Flaubert, Dostoyevsky, Tolstoy, Galdós, Clarín, Oller), the rise of the

«THE METHODS SHERLOCK HOLMES USED FOR HIS INVESTIGATIONS ARE BASED ON THE POSITIVIST SCIENTIFIC METHODS TAUGHT TO THE AUTHOR AS A MEDICAL STUDENT»

bourgeoisie and the importance of capital are well documented, but the industrial revolution and the birth of the workers' movement receive less attention. Even Dickens, despite the fact that the industrial revolution began in England, only deals with the issue in *Hard Times* (1854), which is set in an industrial city. In all of his works, Dickens is very critical of employers, bankers, politicians and judges, who are perfectly aware of the awful living conditions of workers and other deprived people, but he thinks the problem should be resolved through the charity of those in power and not through the union of the oppressed. It would not be until some years later, when Zola wrote *Germinal* (1885), that industrialism and workers were given a starring role. The novel describes the physical and moral misery of miners, the hard working conditions in a mine, and the different viewpoints within the workers movement (socialists, anarchists), a strike and the consequent bloody repression. If industrialism took so long to appear in literature, one might suppose



L'Algérie/J. Chape

Jules Verne tried to write a «science novel», a novel including scientific and technical achievements, journeys and explorations and control over the elements. Above, image on the front cover of the magazine *L'Algérie* (1884), showing a caricature of Jules Verne surrounded by some of the fantastic creatures from *Twenty Thousand Leagues Under the Sea*.



that science, a more minor social reality, would have less impact on literature. This is not the case. Soon, authors would emerge who depicted chemists, inventors and engineers. For example, the inventor David Sechard from Balzac's *Lost Illusions* (1837-43) or Pepe Rey, a young engineer who challenges the traditions of a cathedral city, with tragic consequences, in Pérez Galdós' novel *Doña Perfecta* (1876).

Jules Verne goes further than this and tries to write a «science novel» (Navarro, 2005), namely, a novel which includes scientific and technical achievements, journeys and explorations and control over the elements (air and water). Consequently, way ahead of his time, his works include journeys (*From the Earth to the Moon*, 1865), travels under the sea (*Twenty thousand leagues under the sea*, 1870) or the notion of man's controlling nature through science and technology (*The Mysterious Island*, 1874). However, from *The Begum's Fortune* (1879) onwards, one can observe a change in Verne's optimistic vision of science, which changes from being one of the factors driving humanity's progress to becoming a threatening force that can be used for perverse purposes, such as building weapons and factory cities, foreseeing the rise of Nazism. As a result, the book was banned by the German authorities. Also, the scientist, a hero in Verne's previous works, becomes a perverse or crazy anti-hero, a blind instrument of power, a fact that would have a large influence on subsequent literature and cinema.

Herbert G. Wells, who studied at the University of London alongside Thomas Huxley, and taught from 1890 to 1893, is considered along with Verne as a pioneer of science fiction literature, with the novels *The Time Machine* (1895), *The Island of Dr Moreau* (1896), *The Invisible Man* (1897) and *The War of the Worlds* (1898), which have all been made into films.

Recently, some have viewed Mary Shelley's *Frankenstein* (1818) as being a precursor of science fiction. In the work, scientific progress linked to the creation of life is characterised as a monster that turns against its creator.

Science also influences the work of Arthur Conan Doyle. The investigation methods used by his literary creation, the detective Sherlock Holmes, are based on the positivist scientific methods taught to the author as a medical student. To use Holmes' own words

from *A Study in Scarlet* (1887): «I have a turn for both observation and deduction. [...] When a case turns up which is a little more complex. Then I have to bustle about and see things with my own eyes. [...] I still don't have all of the facts [...] It is a capital mistake to theorize before you have all the evidence. It biases the judgment».

This period is portrayed well in historical novels with scientific subject matter, such as John Banville's *The Revolutions Trilogy: Copernicus* (1976), *Kepler* (1981) and *The Newton Letter* (1982); *The Measure of the World* (1997) by Denis Guedj; Isaia Iannaccone's *L'amico di Galileo (Galileo's Friend)* (2006) or *Longitude* (1995); *Galileo's Daughter* (2000) by Dava Sobel, and, *Les confidències del comte de Buffon (The Secrets of the Comte de Buffon)* (1997) by Martí Domínguez. Also, the work of Patrick O'Brian has had a substantial influence due to the cinematic adaptations of the nautical-themed Aubrey-Maturin series of novels (1970-2004), which were the basis

for the film adaptation *Master and Commander* (2003) by the director Peter Weir. Set at the beginning of the nineteenth century, the novels recount the expeditions of the *HMS Surprise*, commanded by Captain Jack Aubrey, accompanied by the doctor, naturalist, and spy Stephen Maturin. These characters evoke the work carried out by scientists such as Charles Darwin and

Alfred Wallace, or Jorge Juan, who combined his geographical projects with secret diplomatic missions.

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■ SCIENCE AND LITERATURE IN THE TWENTIETH CENTURY

We will now show how there has been an increase in interaction between science and culture in the twentieth century. During the early decades of the century, a revolutionary period on all levels (political, economic, artistic and scientific) the second industrial revolution led to an assessment of new technical and scientific progress. Value was placed on the aesthetic effects of mass production (the consistent design and quality of finish), new motors and turbines and the aerodynamic properties of vehicles, constituting the culmination of refined and precise engineering. Without new materials and technologies, it would have been impossible to construct symbols of modernity such as skyscrapers.



National Portrait Gallery, London

Richard Rothwell. *Mary Wollstonecraft Shelley*, 1840. Oil on board, 61 × 73.7 cm. Some consider Mary Shelley's *Frankenstein* (1818) to be a forerunner of science fiction. In this novel scientific progress, related to the generation of life, is cast as a monster that turns against its creator.

The pollution of the first industrial revolution (smoke and soot) contrasts with the apparent cleanness of the second, which had not yet produced its excesses – automobile, petrol and chemical, amongst others. (Solbes, 2002).

The first artists of technological civilization were the futurists (this school began in 1909 with Marinetti's manifesto); they exalted speed, sport, mechanical civilisation and the achievements of technology, machinery, aviation, electricity and manufactured products. One of the principal proponents was the Russian Mayakovski.

Within this context, the theory of relativity, which the press presented as the Revolutionary theory par excellence, had a great impact, both on scientists and artists, writers and philosophers. Relativity had clear implications on the perception of space and time. This influenced painting (for example the plurality of perspectives in cubist art or the drawings of Escher), and the rationalistic and functional architecture of the Bauhaus movement. In literature, the influences of this new vision of space and time are evident in

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the narration of stories from multiple viewpoints or in works where time is slowed down by authors such as Virginia Woolf, William Faulkner, James Joyce and Thomas Mann. There are even meditations on time in novels such as Mann's *The Magic Mountain* (1924) or on the four dimensions in Lawrence Durrell's tetralogy *The Alexandria Quartet* (1957-60). In the case of James Joyce, his most emblematic works play around with a very special narration of time. This is evident in *Ulysses* (1922), where the author makes an innovative use of time. The one thousand page tome, which could form an extensive story taking place over many years in another literary style, is used by Joyce to narrate just 25 hours, one day in the life of the protagonist Leopold Bloom, as he travels across the city of Dublin. However, it is in his last book, *Finnegan's Wake* (1939) that Joyce makes his most original use of time. This work may be considered a practical joke by the majority of readers, and also an unrepeatable masterpiece which is almost impossible to translate. Time is cyclical in the work, which becomes evident the moment reading begins, as it opens with the last part of an incomplete sentence, and finishes with a fragment that can be turned into a complete sentence by attaching it to the first words

of the book. Moreover, the book made a curious contribution to scientific vocabulary. According to Murray Gell-Mann, he proposed the word quark to denote the internal components of hadrons based on one of the numerous enigmatic phrases contained in the work: *Three quarks for Muster Mark!*

Furthermore, some scientists have made important contributions to art, especially literature. This is not just limited to doctors, as was the

case in the nineteenth century (Chekov, Doyle), but also chemists such as Snow, who introduced the idea of two cultures, or Primo Levi. In his book *If This Is a Man* (1956) he shows the horror of the Nazi concentration camps and how he managed to survive thanks to his knowledge of chemistry. The physicist Aleksandr Solzhenitsyn, a Nobel Literature laureate, showed in his *In the First Circle* (1968) how scientists and engineers imprisoned in concentration camps were required to investigate on behalf of the KGB, a USSR organisation. In his work entitled *Life and Fate* (1959), the engineer Vasily Grossman created a twentieth-century version of *War and*



Many science fiction authors were scientists in practice or in training, such as Carl Sagan, Professor of Astronomy and Space Sciences. His novel *Contact* depicts the difficulties facing women scientists.

Peace, using many stories from the Second World War, in which he narrates the difficulties of life as a physicist under Stalin's dictatorship.

Within the Spanish-speaking world, we should not forget the physicist Ernesto Sábato, whose first book *Uno y el Universo* ("One and the Universe") (1945), criticises the apparent moral neutrality of science and the dehumanising processes of technological societies. Nor should we forget the engineer Juan Benet, with his scientific geographical descriptions in *Return to Región* (1967). Lastly, there are various physicians to consider: Pío Baroja (Fuster, 2013), who in works such as *Aventuras, inventos y mistificaciones de Silvestre Paradox* ("The Adventures, Inventions and Mystifications of Silvestre Paradox", 1901), *La dama errante* ("The Errant Lady", 1908) or *The Tree of Knowledge* (1911) sets rhetoric popular in Spain during the Restoration, against the scientific mindset; Llorenç Villalonga, who depicts the limitations of industrialism in his one and only incursion into science fiction, *Andrea Victrix* (1973) or Luis Martín Santos, who shows the difficult working conditions of scientists during the years under Franco in the book *Time of Silence* (1961).

However, it is not necessary to be a scientist in order to write works in which science and scientists have an important role. Consider for example,

Marguerite Yourcenar's marvellous book *The Abyss* (1968) which depicts the difficulties and persecution of scientists in the sixteenth century; or Umberto Eco, whose book *The Name of the Rose* (1980) portrays medieval science and the ideas of Roger Bacon; or Michel Houellebecq's book *The Elementary Particles* (1998), where one of the main characters is a physicist who changes his field of investigation in order to devote himself to genetics, as did Francis Crick. The novel *In Search of Klingsor* (1999), by Jorge Volpi, portrays physics and quantum and nuclear physicists in Germany during the period of Hitler, and does so with a surprising didactic capacity, and *Season of Ash* (2006) deals with themes such as biological warfare, artificial intelligence and the Human Genome Project. Lastly, science plays an important role in the novels of Ian McEwan (Duran, 2013). In 1997 he published *Enduring Love*, a work which depicts the confrontation between a rational scientist and a woman of culture. He would return to science again in *Saturday* (2005), which recounts a day in the life of a neurosurgeon set against the backdrop of the protests against the war in Iraq in February 2003. His novel *Solar* (2010) deals with a Nobel-winning physicist who is initially sceptical about climate change. However, thanks to a system to produce clean energy, he glimpses a means to come back into the limelight, achieve success with the opposite sex, and make some lucrative profits.

Science has not only provided authors, but also themes, such as the moral responsibility of scientists (nuclear physics already posed the question, and its echo resounds in current debates regarding genetic engineering), with works such as *Life of Galileo* (1939) by Bertolt Brecht, or *The Physicists* (1962) by Friedrich Dürrenmatt, or the use of science and technology in future societies, such as the dystopias of *A Brave New World* (1932) by Aldous Huxley, *1984* (1949) by George Orwell, or *Fahrenheit 451* (1953) by Ray Bradbury.

Likewise, science contributed to the creation of a literary genre: science fiction. Many of the genre's best authors have been or are practicing scientists, such as Fred Hoyle, Gregory Benford, Carl Sagan, or studied to be scientists, such as Isaac Asimov, Robert A. Heinlein, Arthur C. Clarke or Michael Crichton. Specifically, Hoyle, director of the Institute of Astronomy at Cambridge, predicted the existence of energy levels in carbon atoms, which help to explain stellar nucleosynthesis, and he co-authored the steady-state model of the universe. Benford is a professor of astrophysics at the University of California, Irvine, and member of the NASA's

Science Advisory Committee. Sagan was a Professor of Astronomy and Space Sciences and director of the Laboratory for Planetary Studies at Cornell University. Clarke studies mathematics and physics at Kings College London and served in the Royal Air Force where he participated in the development of a radar defence system. In the article «Extra-terrestrial Relays» he lays the foundations for geostationary satellites. Asimov, Heinlein and Crichton studied biochemistry, mechanical engineering and medicine, respectively. They in turn have enriched the genre with new ideas which were not dealt with by their precursors, Verne and Wells. For example, robots and the colonisation of the moon in *The Moon is a Harsh Mistress* (1966) by Heinlein and *Red Mars* (1992) by Robinson; the solar system in the series *Space Odyssey* (1968-1996) by Clarke and *The Foundation Trilogy* (1951-53) by Asimov; planetary ecology in *Dune* (1966), by Frank Herbert, or the dangers of biotechnology and genetic engineering in *The Andromeda Strain* (1969) or *Jurassic Park* (1990) both by Crichton. There are science-fiction authors who describe the life of scientists in a very credible way, such as Ursula K. Le Guin in *The Dispossessed* (1974) which depicts the problems of a physicist who proposes a revolutionary theory; Benford, in *Timescape* (1980), which shows scientists who are more concerned with grants and newspaper coverage than with experiments while others are constrained by bureaucracy; in *The Gods Themselves* (1972), Asimov portrays the obstacles which young scientists face when confronted by powerful scientists, and in *Contact* (1985), Sagan depicts the difficulties of female scientists.

■ CONCLUSIONS

In Spain, we often talk about science and culture as if dealing with two completely different topics, and people are considered educated despite having insufficient knowledge of the scientific and technological advances upon which our daily lives depend. It is interesting to note the great difference in criteria with which we judge the lack of scientific education in relation to other areas, for example in press articles. There is a great tendency to worry about spelling or vocabulary mistakes, which, evidently, we all agree on. The duly angry reactions, which these mistakes usually provoke, are not displayed with the same intensity for scientific errors. This leads to foolish things being written, like «chemical elements such as nitrogen oxides» (Fernández-Rañada, 1995; Elías, 2008). Perhaps



AP Photo

Arthur C. Clarke studied mathematics and physics at King's College, London. Author of *A Space Odyssey*, he imagined the colonization of the Moon by robots, among other things.

scientific knowledge is considered to be inaccessible and therefore more likely to be lacked by members of the public who have an average education and who do not consider this deficit to be serious.

Bearing this in mind, we wish to reflect on the best way to end this critical disparity when deciding the type of general knowledge every educated person should possess in relation to all areas of human thought. So, we have looked at examples which help to unite literary creation and scientific thought. To this effect, we have shown a series of novels (and the occasional theatre play) by different authors that may help to overcome the debate of the two cultures alluded to by Snow. Furthermore, reading books discussed in this article can help students and the general public to approach scientific ideas and concepts. Some works, such as *In Search of Klingsor*, by Volpi, can also help to teach science students about quantum theory or game theory. However,




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the works are not only about scientific concepts, some also depict the way in which scientists work, the so-called scientific method. The majority of literature mentioned here helps to convey the human side of science, the social and historical contexts in which science develops or the position of scientists in certain societies. The books mentioned here by Baroja, Martín Santos or Grossman, teach us as much about science in Spain during the Restoration and the Franco years or the USSR under Stalin, as historical

and sociological treatises about science can ever hope to. Thus, it is not surprising that many scientists and science teachers recount how their professional careers were more inspired by reading authors such as Verne and Asimov amongst others, than by their scientific education at school.

Recently it has also been shown how literature can allow readers to walk in the footsteps of the main characters, thus opening their minds to other experiences and perspectives. This is a positive step for their theory of mind, namely, their capacity to empathise with the other (Kidd and Castano, 2013). This effect is greater for those who read literature than for those who read popular fiction (science fiction, romantic novels), non-fiction or nothing at all. However, any quality literature, like the majority of books mentioned here, with intensely human characters, allows for this. Poor literature with superficial characters does not. Although Kidd and Castano (2013) consider science fiction to be a sub-genre, there are works of high quality, such as *The Left Hand of Darkness* (1969) by Le Guin or even *The Gods Themselves* by Asimov, which are written with great empathy. Moreover, science fiction can offer a vision of humanity's future and the role that science and scientists will have in it, a vision that no other type of literary fiction contributes. (Petit and Solbes, 2012).

In conclusion, for the worlds of knowledge to come together, science needs to be integrated into global culture, becoming a fundamental aspect of culture. Meanwhile, for anyone who chooses to read it, literature concerning scientists and science can help to spread knowledge about science's greatest achievements and how it is linked to our daily lives. 

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