LITERATURE AND SCIENCE. CONVERGENCE AND DIVERGENCE

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0. Introduction

In the Middle Ages it was considered that all the knowledge of classical antiquity was contained in what was then known as the seven liberal arts. These were subdivided by medieval scholastics into two groups: the *trivium*, which consisted of discursive knowledge (grammar, rhetoric and dialectic) and the *quadrivium*, which contained mathematical knowledge (arithmetic, geometry, astronomy and music). All cultured men at that time (women had no access to education) were trained in both the liberal arts and in the fine arts (architecture, sculpture, painting, declamation and poetry, theatre and dance). It was therefore quite common to find poets with a sound knowledge of astronomy or public figures with a surprising mastery of dialectic and understanding of painting and sculpture. However, the gradual accumulation of knowledge, the growing amount of information and the Western man's obsession with classification gradually divided up a reality that is, by its very nature, irreducible and complex. However, knowledge did not only divide its object of study, reality, it ended up dividing itself as well. As a result, new disciplines emerged: a way of understanding reality characterised by 1) an object of study (a part of reality), 2) a method (or strategy of knowledge) and 3) a language (in which this knowledge will be expressed). Over the 17th century, the newly founded "modern science" was to radically transform these three characteristics that define a specific discipline and was to become an area of knowledge quite unlike any other that had been known up to that time.

In this article, we will analyse the epistemological transformation that the introduction of scientific tools led to, not just for the development of science itself but also for the relationship it had with other forms of understanding. In particular, we will see that the introduction of the telescope and the microscope by science drastically modified its object of study and consequently opened up a profound division with other areas of knowledge. The incorporation of these tools into scientific work led to a problem of scale: scientific knowledge then had privileged access to the micro- and macrocosm. Science's new objects of study left the human scale behind and started diverging from what interested other domains. However, in the last few decades, we have seen that various spheres of knowledge have once again become interested in the same topics. In this article, we will discuss how this renewed convergence in subject matter may enable literature and science to come together once again. Nevertheless, this kind of hybridisation must be accompanied by a new epistemological framework that makes the integration of a variety of languages and methodologies possible.

1. The great divide

Galileo introduced the three elements that were to lead to the radical break of science with other forms of knowledge, by changing its language, its method and its object of study. In *Il saggiatore* Galileo wrote: "Philosophy is written in this enormous book that we continually have open before our very eyes…"; before adding "[that] is written in mathematical language, and the characters are triangles, circles, and other geometrical figures, without which it is impossible to understand a single word." Paradoxically, the emerging modern science legitimized itself through the metaphor of a book as a valid form of knowledge while at the same time it distanced itself from previous formulations by proposing the use of a completely different language; if knowledge is contained in a book, it is one that cannot be read by men of letters. The language of science is that of mathematics.

In terms of methodological concerns, that is, of the way of acquiring knowledge, Galileo broke (as far as he could) with Aristotelianism and turned towards experimentation, towards an empiricism that began to take shape around that time. The idea that through detailed, exhaustive experiments and observations it is possible to obtain genuine knowledge of the world constitutes the basis of the scientific method and was first comprehensively developed in the work carried out by the English philosopher, Francis Bacon. The empiricism proposed by Bacon not only represented a new way of approaching reality but also established the limits of a new discipline and the protocols of knowledge acquisition. As a result, it separated the spheres of (what nowadays we would call) the humanities from natural philosophy (or science) (Levine, 1989).

The very adoption of empiricism and mathematical language to develop science also established its possible objects of study. This implied that what couldn't be tested in a controlled way, with reproducible results, or what couldn't be expressed in mathematical language, was no concern of science; the method and language thus (partly) determined the object of study. Galileo also introduced another of the factors that was to be decisive for the separation of science and literature: the use of scientific instruments. Until 1609, the telescope, which invention (towards the end of the 16th century) is generally attributed to Hans Lippershey, had only been used for military purposes. The English astronomer, Tomas Harriot, and a few months later Galileo himself, used the telescope for the first time in order to observe heavenly bodies. This apparently trivial act would bring a permanent change to astronomy, to modern science and its relationship with other forms of knowledge. The concepts of distance, size and even the relations between heavenly and earthly bodies were then radically altered in Western culture (Hewitt, 2007). The telescope suddenly opened a window onto a much larger and richer universe than the naked eye could ever perceive. However, looking through this window required a degree of preparation and a theoretical background that only science could provide.

The microscope's appearance parallels that of the telescope. Although both date of invention and name of inventor are contentious, it is presumed that it was invented around 1590 by Zacharias Janssen. As was the case with the telescope, this new instrument opened up a window that had been unimaginable before, encouraging not only serious interest in the microcosm but also fantasies and satires about these new micro-worlds. Once again, science ventured through territories that were beyond the reach of our senses and beyond the understanding of the uninitiated, because looking through this new window was not just a matter of instrumentation. A microscope (or a telescope) required a trained, well-prepared gaze (Hewitt, 2007). For a certain time, even the representational legitimacy and authenticity of the images that could be observed through these instruments was questioned (Schwartz, 2014).

Until the introduction of scientific instruments like microscopes and telescopes, observable phenomena (a tree, an eclipse, death, a storm) were more or less the same for all observers, regardless of the epistemological framework they possessed. Although of course, in terms of complexity, it is

quite different to explain an eclipse or a tree, the motion of a pendulum or that of a horse. But with the parallel introduction of microscope and telescope, a new problem of scale emerged: the scientist now had access to objects that were beyond the human scale, a scale about which literature, the arts and the humanities have most to say. Thus, beside the break in method and language, from the 17th century onwards (and this was to become even more extreme in the following centuries), a basic division occurred regarding the subjects and interests of science, literature and other forms of knowledge. Science moved on to deal with what was immense and what was minute; it moved away from the human scale (and complex problems). This meant that astronomy and micro-science became exclusive spheres of scientific knowledge and a large part of reality became inaccessible to the arts and the humanities. In this way, the (supposedly) subjective was restricted almost exclusively to the sphere of literature and the arts and the (supposedly) objective to the sphere of science.

2. A long crossing of the desert

On the one hand, both the method and the language adopted by science from the 17th century onwards were to establish a radical break with other forms of knowledge. The method and language not only establish the way in which knowledge is obtained and codified (or transmitted), they also define the object of study. Mathematical language establishes that only what can be measured or expressed in mathematical terms is liable to be studied scientifically. The motion of falling bodies fits into this category while the study of feelings does not. In this way, the scientific method determines the object of study; the need to perform experiments in controlled conditions and to ensure that these can be repeated excludes from scientific knowledge a large part of complex problems such as those that have to do with human behaviour and feelings.

On the other hand, as we mentioned in the previous section, the incorporation by science of scientific instruments has enabled it to access a world that is vastly greater than the one our senses can perceive. A world that remained inaccessible for other forms of knowledge. The objects of study became even more polarised during the following centuries with the incorporation of new scientific equipment and the discovery of new phenomena. Electricity and magnetism, the theory of relativity, quantum physics and nuclear forces intensified this polarization and made dialogue between science and the humanities practically impossible.

The authority of science as the only way to acquire true knowledge has gradually been reinforced since its modest beginnings in the 17th century. The arts in general, and literature in particular, had practically nothing to contribute to subjects such as astronomy, physics or chemistry. This meant that they were consigned to the insubstantial (from a scientific viewpoint) task of describing human feelings; something that science was unable to deal with given that the complexity of these problems didn't allow for a reductionist approach. The gap that separated feelings and thoughts became deeper and deeper. Strangely enough, at the same time as modern science emerged with Galileo, Bacon and Descartes, literature also reached certain heights with William Shakespeare in England and Miguel de Cervantes in Spain; two authors through which modern theatre and the modern novel were born. Perhaps anticipating the great divide, or perhaps (more probably) because it was what it knew how to do best, 17th century literature focused on essential aspects of the human condition.

During the 18th and 19th centuries, literature witnessed the gradual fading of its power as a privileged form of knowledge, in favour of science. This provoked fierce reactions from many writers and artists and gave rise to what would later be known as "romanticism." In clear opposition to rationalism and positivism, romantic writers proposed a reassessment of the personal, the subjective and the emotional. All this widened even further, if possible, the gap between science and literature by reinforcing epistemological stereotypes; leaving

the natural world in the hands of science and the human condition in the hands of literature.

Did all this mean that there was no contact between science and literature? Was there any way, although it was unpremeditated or unconscious, in which ideas and concepts were exchanged? We must not forget here that both literature and science are fuelled by (at the same time as they themselves fuel) a common social imaginary. An imaginary that changes in each period and with each culture, but that in a certain way demarcates what can be thought at any time and in any place. Regardless of the explicit relationship between literature and science, there are, and always have been, underground communicating vessels that "connect" both disciplines. There is a series of general concepts and profound ideas that literature and science have shared, without even being aware of it, during all this time: the search for beauty in symmetry, the ideas of linear time and of progress, horizons of expectations. Science and literature, even without realising it, shared (and share) many of the ideas and concepts that make it possible to construct worldview.

3. A light at the end of the tunnel

The 19th century represents a turning point in the relations between literature and science. On the one hand, writers emerged who greatly admired scientific knowledge and deliberately included aspects of this field in their work. On the other hand, the problems of science once again began little by little to focus on the human scale as biology, experimental medicine, the theory of evolution, genetics, anthropology or psychoanalysis emerged.

During the second half of the 19th century, naturalism arose. This artistic style (primarily a literary movement) was aimed at studying and reproducing reality with as much rigor and objectivity as possible. The founder and leading representative of naturalism was the French author, Émile Zola. Naturalism was strongly influenced by two kinds of determinism: the mechanistic determinism of Newtonian physics, and the genetic determinism based on biological inheritance; let's not forget that this movement appeared at the same time as Charles Darwin's and Alfred Wallace's theories of evolution. Auguste Comte's positivism and Jeremy Bentham's and John Stuart Mill's utilitarianism also influenced this trend. In a clear attempt to imitate the scientific method, naturalism researched, in a materialist and mechanistic perspective, the laws that govern human behaviour in order to explain social problems and conflicts. From the naturalists' point of view, the human condition is subject to three factors: genetic inheritance, social problems (poverty, alcoholism, prostitution, etc.) and each individual's social context. This mechanistic description of the human condition left little room for free will or psychology, and towards the end of the 19th century naturalism began to burn out as a literary form (and as an attempt to reproduce reality) as many writers began to focus on the inner world of their characters, giving rise to the psychological novel. This is the case of great writers like Virginia Woolf, James Joyce and Arthur Schnitzler whose interests converged with those of the scientific research of their time: Sigmund Freud in psychology or Santiago Ramón y Cajal in neurology. The naturalist movement can be considered to be a turning point between the escapism proposed by romanticism and the more intimate, mundane vision of reality that was to characterise modern literature from the early 20th century onwards. A common factor shared by naturalism and what we could call "psychologism" is that they emerge at the same time as anthropology and psychoanalysis; in a certain respect, literature and science once again began to take an interest in the same problems.

During the 19th century, science continued to reinforce itself as the best (and for many the only) way to acquire reliable knowledge about the world. From its beginnings in the early 17th century, modern science was to add to the study of natural philosophy (what we would now call physics) new fields of study that gradually increased the complexity of its objects of study. This led to the emergence of fields such as chemistry, biology, anthropology, sociology or economics.

Science was no longer merely devoted to studying the motion of (heavenly or earthly) bodies but was to gradually take a closer look (sometimes awkwardly, for example: phrenology) at problems that had more to do with man and the human scale. Although 19th century science and literature didn't use the same methods or the same language, they did at least start to show some signs of convergence as far as their objects of study were concerned. At the start of the century, Mary Shelley explored, in her novel *Frankenstein, or the modern Prometheus*, the use of electricity to bring inanimate matter to life. In this way, literature began to put forward hypotheses about the use of scientific knowledge and question the moral responsibility of scientists. A few years later, Edgar Allan Poe successfully appropriated the scientific method. Indeed, he constructed some of his short stories around the solving of police cases through meticulous analysis and logical deduction. This was a real innovation for both literature and for the police (Schwartz, 2014). But the important thing here is that certain scientific ideas and concepts were reaching literature and could now be considered in a new way. Literature and science were linked once again.

As we mentioned earlier, Zola's naturalism can be considered as a kind of literary counterpoint to 19th century anthropology; both erred in their methods, but talked about the same problems. Another interesting example of how literature and science can tackle the same issue from different perspectives is provided by the study of personality. Robert Louis Stevenson in his famous novel *The Strange Case of Doctor Jekyll and Mr. Hyde* explores ideas that Freud was to develop towards the end of the century regarding the functioning of the psyche. It is most likely that these ideas were already "floating" in the atmosphere and in the collective imaginary of the period, and that both Stevenson and Freud channelled them in the way that each considered to be most appropriate. To a certain extent, Stevenson's book and Freud's theories are two different representations of a single phenomenon: human behaviour.

4. Rapprochement

Although it is true that the natural sciences continued to specialise in the early 20th century, with physics reaching its peak with the formulation of quantum theory and the theory of relativity, it is no less true that certain sciences (biology, medicine, psychology, neurology) began, in parallel, to deal with problems that had more to do with the human sphere and which had traditionally been dealt with by the so-called humanities. The sciences thus began to venture into the difficult terrain of the human condition, that until then only literature and art had dared to make incursions into.

The quantum and relativity theories represent the high point of Newtonian physics. Although they are able to explain both subatomic and astronomical phenomena with hitherto unknown accuracy, they are still a natural extension of Newton's laws. The laws of mechanics (from Newton to Einstein, and including Bohr, Heisenberg and Schrödinger), with all their predictive power, are still an explanation of relatively simple phenomena. The real paradigmatic change of the 20th century was to occur with the introduction of the sciences of complexity. From Galileo right up to the 20th century, modern science has always wrestled with simple problems, following two strategies: 1) ignoring complex problems, claiming that they were not matters of scientific interest; or 2) reducing the complexity of these problems until they could be fitted into the conceptual frameworks of each period. Over the last four centuries, modern science has gradually added the study of certain complex problems to its corpus, but at the cost of reducing these to simple problems. In some cases (as for example solid-state physics or thermodynamics) this strategy has worked relatively well; nevertheless, many complex problems (climate, earthquakes, ecosystems, consciousness, societies) are usually irreducible and therefore require a new epistemological strategy.

From the mid-20th century onwards, science began to study problems that it had put aside (through inability or ignorance) for centuries. It was then that science began to study genetics,

human behaviour, mental illnesses, the brain, the emotions, and so on. In fact, the two great scientific projects of the last few decades have been precisely the "Human Genome Project" and the "Human Brain Project." The complexity of some of these problems is sometimes concealed by their apparent "mechanical" nature. For example, genetics, which might seem to be the most "mechanical" of the aforementioned problems, is not as mechanical as it might seem at first sight. Epigenetics has shown that the way in which genes are expressed (and even if they are or not) depends not just on the genetic code but also on certain environmental factors. As if it were a great novel, the reading of the genetic code doesn't have a single interpretation and depends on the context. To paraphrase Heraclitus, we could say that (in some cases) "no one reads the same code twice."

5. New times

Many of the problems that concern us today are so complex that they cannot be dealt with properly by only using the tools of science. These problems cover almost all the range of human activities, from behaviour, memory or the emotions, to the functioning of societies, economy or climate, education, health or the environment. All these subjects have not formed part of the interests and/or possibilities of science for centuries; either because the problem didn't exist (we weren't able to see it) or because science couldn't deal with it (it was impossible to deal with it mathematically or to systematise it). However, many of these subjects (behaviour, the emotions, society) have been dealt with at length in the literature of each period. Far removed from the eagerness with which science attempts to systematise things, literature provided a different way to explore the human condition. Its holistic vision of reality enabled it to see things that become blurred in a reductionist analysis; nevertheless, its lack of systematic, methodical analysis prevented its acquisition of more profound and accurate knowledge.

Although the method and language used by science and literature are still quite different today, their objects of study have once again become the same (in some cases at least); after centuries of divide, literature and science are dealing with the same problems again. It is quite obvious that each discipline also explores problems that are exclusive to it; science continues to study the elementary particles or the Big Bang and literature continues to explore certain aspects of the human condition that are a long way from scientific research. However, the important thing is that the boundaries between literature and science have begun to fade and that the point where they intersect, that is, the set of problems that can be tackled from a cross-disciplinary perspective, is gradually and continually increasing. Even methodological disparity, far from becoming an obstacle, may be considered to be an advantage, as an appropriate combination of holism and reductionism could establish a new epistemological paradigm.

6. A new epistemological strategy

New problems often require new strategies, and given that certain complex problems can be tackled from a wide variety of perspectives, a cross-disciplinary approach appears to be a good epistemological option for studying them. We are not talking here about mixing literature and science just for the sake of it; there are subjects that clearly form part of the fields of science or literature, but there are others, that we have already mentioned, that do not exclusively belong to a field. So what we are talking about here is proposing a hybrid approach between science and literature; not to combine and standardise them, but to produce an alternative approach somewhere between homogeneity and heterogeneity, between holism and reductionism, between the general and the particular. It is not a matter of rejecting disciplines, but of appreciating that their boundaries are quite arbitrary and are not always suitable for the historical period or the problems that concern us.

However hybridisation cannot take place in all fields; not all boundaries are equally

fertile. Where then is hybridisation possible? Which fields are amenable to it? Here we return to the question of scale. We have mentioned earlier that the division between science and the humanities occurred (among other reasons) when the introduction of instruments into science meant the latter abandoned the human scale, when a part of reality became inaccessible to the humanities. It is therefore reasonable to think that the most productive forms of hybridisation may occur precisely on this scale, where there are numerous complex problems that cannot be dealt with only by science or only by the humanities; this is where we must try and find possible forms of hybridisation, where science and literature can establish a dialogue and interact. This is one of the possible roads towards what is now called "the new humanities."

When science and literature tackle the same problems, the similarities are greater than the differences. In 1944, Jorge Luis Borges published his short story «Funes, el memorioso» (Borges, 1994) and a few years later the Russian neurologist Alexander Luria published a clinical case study called *A little book about a vast memory. The mind of a mnemonist* (Luria, 2009). Both were interested in the same problems: memory, abstraction and thought; but one of them simply tackled these through literature and the other through science. The interesting thing about this case is that the boundaries between literature and science have become so blurred that we could include Borges's story as just another case study in Luria's work without anyone noticing; or we could take any of Luria's cases and present them separately as fictional stories. Both writer and scientist are talking about the same thing; both are asking themselves the same questions; both are trying to understand how the human mind works.

More and more often over the last hundred years, literature and science have been tackling the same problems from different perspectives. Up to now, this coincidence has been the result of a collective imaginary or of cultural emergencies rather than of the intention of achieving cross-disciplinary integration. It has been a matter, so to speak, of epistemological contingency. I think the time has come to deliberately encourage this kind of interaction that will enable us to tackle certain complex problems. We must start to think in terms of problems and not of disciplines; that is, what are the problems we want to solve and what are the tools that will enable us to do it. A transdisciplinary approach isn't opposed to disciplines, nor does it conflict with them, it is complementary, and fuelled by them (Nicolescu, 1996). It's not about eliminating or breaking up disciplines but about establishing a new level of reality that makes it possible to explore borderline areas and deal with problems that transcend traditional disciplines. In this respect, science and literature share a vast area in which a transdisciplinary approach may be possible and productive.

7. Conclusions

In this article we have analysed the epistemological reasons that led to literature and science moving apart from the 17th century onwards. Apart from their differences in method and language, that partly define their potential objects of study, we also need to consider the introduction into the scientific sphere of observational instruments such as the telescope and the microscope. These three factors meant that science and literature didn't deal with the same subjects and their interests gradually diverged to such an extent that it made any communication between different fields of knowledge virtually impossible. Nevertheless, in the last century this trend has been reversed; the process through which science began to drift away from literature in the 17th century seems to have begun to unravel. For the first time in centuries, science and literature share subjects and objects of study. However there is still a long way to go; we need to find common methodologies and languages that enable us to establish a cross-disciplinary epistemology, so that transdisciplinarity is no longer just a possibility but becomes a reality that makes it possible to expand the boundaries of knowledge and our understanding of the world.

Bibliographical references:

BORGES, Jorge Luis (1994): «Funes, el memorioso», in *Ficciones*. Buenos Aires, Emecé.
GOSSIN, Pamela (2002): *Encyclopaedia of Literature and Science*. London, Greenwood Press.
HEWIIT, Rachel (2007): «Eyes to the blind: Telescopes, theodolites and failing vision in William Wordsworth´s landscape poetry», *Journal of Literature and Science*, 5-23.
LEVINE, George (1989): «One Culture: Science and Literature», in *One Culture.* Madison, University of Wisconsin Press.
LURIA, Alexander (2009): *Pequeño libro de una gran memoria. La mente de un mnemonista*. Oviedo, KRK Ediciones.
NICOLESCU, Basarab (1996): *La transdisciplinariedad: manifiesto*. [On line: <http://www.ceuarkos.com/manifiesto.pdf> consulted on the 02/06/2014].
SCHWARTZ, Gustavo Ariel & Jaume Navarro (2015): «Imágenes del nano-mundo», in Andoni Ibarra & Ekai Txapartegi (eds.), *Hacer mundo(s) en arte, ciencia y tecnología.* Leioa, Servicio Editorial de la UPV/EHU (submitted for publication).
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