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DEVELOPMENTS AND TRENDS IN THE RHETORIC OF SCIENCE

Science, rhetoric, culture

Centuries of new rhetorical discourse

A quote from Lawrence Prelli's work on the rhetoric of science will help us introduce the perspective of this issue, whose aim is 'to inquire into how the arguments that comprise scientific communication are designed and on what grounds they are and ought to be weighed as scientific claims' (Prelli, 1989: 1). The central interest, therefore, is in the rhetorical dimension of scientific communication as a cultural artefact. The multiple relationships between science and (Western) culture have been explored and discussed at length: this includes analyses of the 'new science' of the seventeenth century and the Enlightenment,[1] as well as a great deal of work on the nineteenth and twentieth centuries when science was finally – and irrevocably – established as an area of knowledge that impregnates everyday life and people's understanding of the world.[2]

If we define 'culture' as 'the acquired knowledge people use to interpret experience and generate behaviour' (Spradley, 1980: 6), it follows that science is one cultural manifestation among others, that it is interwoven with, and not separated from, other cultural fields.[3] Science thus has an impact on these fields, and, in turn, is affected by them. It also follows that we have to think about science in terms of rhetoric, for much of the cultural relevance of science is effected through, and made manifest in, discourse – especially discourse that transcends the specialist language in which scientists communicate amongst each other. We understand rhetoric comprehensively as the ways in which language and, by extension, other media are used to represent science effectively and for specific communicative purposes.

The pedagogy and popularisation of science, for example, has an increasing range of media, genres and styles at its disposal, from didactic texts to museum narratives, from television science shows to science blogs on the World Wide Web.[4] As Carol Berkenkotter notes in her discussion of digital age alterations in journals such as *Science*, traditional genres have become blurred (Berkenkotter, 2012). Analogously, Elizabeth Rowley-Jolivet's 2012 analysis of web-mediated

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laboratory protocols has pointed out the changes that occur when the biological engineering lab protocol migrates to the web, another instance of the current mutations of scientific publishing towards a community-oriented, wiki-type communication mode. Finally, María José Luzón (2013) has investigated the impact that new media and the open space provided by science blogs is having on science communication, both on the way scientists communicate with peers and on the dissemination of science to the lay public. For a much longer time, science has also been a thematic interest of the visual arts and literature, and this interest has found multiple forms of expression. And last but not least, famous 'debates' about science[5] extend from T.E. Huxley and Bishop Wilberforce's heated verbal exchange about Darwin at the meeting of the British Association for the Advancement of Science in Oxford in 1860,[6] to equally excited written exchanges about the 'merits' of science versus literature (and the humanities generally). Think of the controversy between Matthew Arnold and T.E. Huxley in the nineteenth century, and the one engaged with by F.R. Leavis and C.P. Snow in the early twentieth.[7]

As these few instances serve to illustrate, science 'matters' in culture owing to its results as well as its representations and discussions of its significance. Science needs rhetoric in the basic sense of a means of expression in order to inform, persuade or motivate particular audiences in specific situations. Rhetoric inscribes science in specific cultural contexts and determines what can be said about science (and what not). Therefore, the modes of inquiry, logic and argumentation, and the ethos and character of scientific discourse and debates are worth exploring. Disciplinary communication between scientists in the same field has become highly specialised and, in most of the natural sciences, largely unintelligible to outsiders of the specific community – both academic and non-academic. Accordingly, its rhetoric tends to be hermetic: marked by a specialised vocabulary, the use of figures, graphs and formulas, and a data- and/or theory-driven argument.[8] By contrast, where science aims to be 'publicly understood' (see below), it needs to be made penetrable and appear attractive to engage with. Popular science, which has boomed on the cultural market since the late decades of the twentieth century, has to capture the audience's interest and render its subject relevant and aesthetically appealing by virtue of a good, perhaps even gripping, narrative, engaging protagonists and an attractive look (and sound, where applicable).

That science needs rhetoric – or rather, many different kinds of rhetoric –, and that these types of rhetoric deserve to be studied, is thus as fresh an issue today as it was when the Royal Society struggled over the 'proper' way in which the (new) science should be articulated. As Thomas Sprat elaborated in his *History of the Royal Society* (1667), the new rhetoric was explicitly meant to replace an older, ornately 'literary' style that allegedly obscured rather than illuminated discoveries and results:[9]

> [The Royal Society] have therefore been most rigorous in putting in execution, the only Remedy, that can be found for this *extravagance*; and that has been, a constant Resolution, to reject all the amplifications, digressions, and swellings of style: to return back to the primitive purity, and shortness, when men

> deliver'd so many *things*, almost in an equal number of *words*. They have exacted from all their members, a close, naked, natural way of speaking; positive expressions; clear senses; a native easiness: bringing all things as near the Mathematical plainness, as they can: and preferring the language of Artizans, Countrymen, and Merchants, before that, of Wits or Scholars.
>
> (Sprat, 1667: 113)[10]

The sober, unadorned rhetoric prescribed here was meant to reflect not only the precision of scientific observation and method, but also its benefit to society: that which can be expressed in the 'natural' language of people whose work is materially profitable to the common weal will appear useful itself.

The contributions to this issue of *EJES* address special areas of the rhetoric of science. In what follows, we will sketch the major lines of research with which these contributions engage.

Developments in the study of rhetoric: from classical to new New Rhetoric

Chaïm Perelman and Lucie Olbrechts-Tyteca's *Traité de l'argumentation. La nouvelle rhétorique* (1958) revived Aristotelian classical rhetoric; the modes of reasoning, or argumentation, in communication have thus acquired new philosophical centrality in twentieth- and twenty-first-century cultural reflections. The treatise has been extremely influential in studies on the role of language in argument construction and persuasion and on the informal logic of speechmaking. Drawing directly from Aristotle's notions of *ethos*, *pathos*, *logos*, the idea that discourse is shaped differently depending on its audience, while at the same time being directed at a 'universal audience', has been a feature of practically all subsequent works on reasoning and argumentation and has become constitutive of literature on genre variation, academic communication and scientific discourse.[11]

In the world of global scientific communication, it is interesting to single out the modes of knowledge transfer and negotiation, and to look at how they vary depending on the epistemology of the various science fields, communities of practice and text types. However, current investigative efforts have to take into account a new complexity: genre boundaries are becoming blurred by *topoi* that are borrowed from different communicative practices (hybridisation); national, cultural and linguistic boundaries have become fuzzy as one language (English) is used as the lingua franca of scientific communication and is grafted onto other linguistic traditions of scientific communication. In this complex scenario, knowledge fields continue to maintain their specialised cultures while also renewing their rhetorical particularities (see Schmied, 2011).

Two articles in this issue directly concern developments in the study of rhetoric and the strategies scientists use to present areas of knowledge and the results of their research. Geneviève Bordet's and Carmen Pérez-Llantada's studies focus on scientific communication in contemporary academic contexts and deal centrally with rhetorical 'patterning'. Bordet combines corpus methodology, genre

theory and a terminological approach to investigate persuasion in scientific discourse. In particular, she refers to the frequency-driven notion of 'collocation' of John Sinclair (Sinclair et al., 2004), to the work of John Swales (see Swales, 1990) and to M.A.K. Halliday's ideas about 'labelling' in scientific discourse (see Halliday, 2004a). She examines two disciplines, Materials Science and the Didactics of Mathematics, and one genre, PhD abstracts, to see how scientific knowledge is communicated in the two fields by native and non-native speakers of English, thus adding a comparative dimension to her work. Her analysis highlights the 'connection between collocational patterns and rhetorical moves' within one genre and the differences caused by writers' varying disciplinary and linguistic origins. Seeing a relationship between collocation and broader discourse structure, Bordet shows that the alternation of specialised terms and a more general scientific lexicon determines textual dynamics and rhetorical patterning. She concludes that native writers master the processes of packing and unpacking nominalised sequences into specialised compound terms, particularly in the 'method section' of Materials Science abstracts, thus reflecting the field's underlying experimental model. By contrast, Didactics of Mathematics uses a wide range of general scientific terms and less complex collocational patterns, which is typical of an argumentative model based on interpretation: this explains the importance of 'contextualisation' (as in Swales, 1990: 141), i.e. establishing the general theoretical and institutional framework.

With a similar concern for national and disciplinary styles, Carmen Pérez-Llantada's investigation is centred on non-native English social scientists' argument structures particularly in the well-defined genre of the research article. She examines markers of epistemic modality as rhetorical features at the interface between semantics and pragmatics. By expressing degrees of writers' knowledge, these markers are used to construct an argument. The author compares the frequency data extracted from a corpus of non-native English writers with two comparable samples of native English and native Spanish writers to show that there is a preponderance of standard norms of Anglophone rhetoric. However, through the qualitative analysis of repeated sequences within each corpus, the author highlights divergences in the textual practices of each group as well as transfers of national conventions of scientific argumentation into the English text. What emerges is a hybrid model of persuasion and rhetorical practices in an attempt to 'codify the hybrid features of academic written English*es*'. This demonstrates the complexity of today's glocal scientific rhetoric.

Scientific discourse historically

Today, specialist scientific language is often cryptic to the outsider. Until the nineteenth century, however, there was no gap between scientific expression and other cultured forms of expression. As Marjorie Nicolson (1946) claims in a seminal study, Newton's *Opticks* (1704) inspired so many poets of the eighteenth century not only because it dealt with phenomena of everyday experience such as light and vision, but also because it was written in plain, nontechnical English compared with the far more abstract and mathematical *Principia* (1687). Similarly,

Halliday (2002), amongst others,[12] has praised Darwin's prose for its readability and careful rhetorical construction leading to his theory of evolution, while communicating the writer's confidence in this theory. The following well-known passage from *The Origin of Species* (1859) representing the culmination towards which the 'one long argument' has been building up is an apt example:

> There is grandeur in this view of life, with its several powers, having been originally breathed into a few forms or into one; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being, evolved.
>
> (The Origin of Species, 1985: 459–60)

It is again Halliday who has shown how the language of science represents a diachronic process in which the gradual abstraction and reification of nature is achieved through the nominalisation or 'grammatical metaphor' (Halliday, 2004b). This refers to the shift that occurs at the level of grammar, by which a process that could 'more congruently' be represented linguistically as a verb is turned into a noun. For example, *diamond is kinetically unstable* is a more direct wording than the more abstract nominalised phrasing *the kinetic instability of diamond* (Halliday, 2004b: 76). Such processes of abstraction have contributed to the specialisation of science over time and, in the opinion of some scholars, a dissociation of scientific and everyday educated language. According to John Chapple, this dissociation occurred during the nineteenth century:

> In the early part of the century a literate reader could understand the chemical articles in the *Annals of Philosophy* or in its successor, the more general *Philosophical Magazine*. But chemistry is a clear example of a science which became more quantitative and, in addition, developed a symbolic language, meaningless to the uninstructed.
>
> (Chapple, 1986: 5)

This view applies to some branches of the sciences more than others. As the example of Darwin demonstrates, in the latter half of the nineteenth century evolutionary biology could still be presented in a generally accessible language that was also appreciated for its literary qualities. In this vein, Laura Otis has prefaced her anthology of nineteenth-century literature and science with the premise that 'the notion of a "split" between literature and science, of a "gap" to be bridged between the two, was never a nineteenth-century phenomenon' (2009: xvii).

Laurence Talairach-Vielmas's contribution to this issue directly concerns the nineteenth-century scientific discourse. Like Otis, she claims that this discourse was not so removed from that of literature and romance; on the contrary, nineteenth-century palaeontologists and geologists made use of imaginative language to develop a visual rhetoric that helped them to communicate new scientific theories to their peers and the lay public. Talairach-Vielmas's interest is in the role that

analogies and metaphorical language in palaeontology play in promoting the emerging scientific discipline and negotiating controversial issues such as those linked to evolutionary thought. Thanks to a close reading of texts written by prominent palaeontologists and geologists of the time, including Georges Cuvier, Rev. H.N. Hutchinson and Gideon Mantell, the author leads the reader through a series of 'contaminations' of scientific ideas by metaphorical language, and referential descriptions of nature by romantic tales. This leads her to Charles Dickens's representation of extinct species in the novel *Bleak House* (1852–1853) and larger ideological concerns of the Victorian era.

Popularisation of science

This well-researched area in the Public Understanding of Science aims to study the interrelationships between science (including technology) and public society, and the sociology of knowledge.[13] This popularisation of science has taken many forms and ranges from didactics for the novice to those for the general public[14] and those for children (and women).[15] Popular science books and articles were staple items on the nineteenth-century's book and periodicals market. The *Penny Magazine* was published by the Society for the Diffusion of Useful Knowledge. But more entertaining magazines such as Dickens's *Household Words* also included articles on many aspects of science and natural history and were important vehicles for the wide circulation of important scientific discoveries such as, for example, the chemistry of a candle as explained by Michael Faraday before an audience at the Royal Institution Christmas Lectures (see *Household Words* from 3 August 1850: 439–44). In 1845, *Scientific American* was founded, which is still a major platform for the diffusion of scientific knowledge in the current market, much like *New Scientist*, which has been published since 1956.

More recently, several bestselling, nonfiction science books have filled an ever-increasing market. A well-known example is Stephen Hawking's *A Brief History of Time* (1988), which was also made into a cinema film. Borrowing its plot and characterisations from fiction, its rhetoric is aimed at making science as exciting as possible by presenting it as a quest and a struggle that can end in personal satisfaction or tragedy. Another example is Dava Sobel's *Longitude* (2005), whose subtitle, *The True Story of a Lone Genius Who Solved the Great Scientific Problem of His Time*, betrays its narrative strategy.[16] It is immediately obvious why this book could be successfully adapted into a television mini-series. Or, take Deborah Cadbury's *The Dinosaur Hunters* (2000; paperback 2001). As a television science producer, Cadbury knows how science can be successfully presented and marketed. In this case, too, the subtitle of her book, *A Story of Scientific Rivalry and the Discovery of the Prehistoric World*, signals a suspenseful and humanly engaging story about the history of prehistory. Not only does Cadbury borrow techniques from fictional storytelling, but she also uses images to illustrate her narrative, and even the book's design aims at attractive presentation. The paperback cover depicts the book's protagonists and chief scientific rivals, Gideon Mantell and Richard Owen; a circular hole allows the reader (buyer) to glimpse the head of a dinosaur, which is part of a full-page colour illustration, thus tempting her or him to enter the book.

Science documentaries on TV are challenged to use new formats to interest over-saturated audiences,[17] and the development of such innovations is furthered by events such as the annual Sundance Science-in-Film Initiative in the USA.

Venla Oikkonen's contribution in this issue is specifically concerned with popular science books. The author studies the evolutionary psychological and sociobiological debate about human sexuality as represented in two major books, Niles Eldredge's *Why We Do It* and Nancy Etcoff's *Survival of the Prettiest*. Through extensive analysis of the linguistic and rhetorical strategies employed by the two scientist writers, she convincingly shows that such popular books work to establish their scientific authority as compared to pseudoscience. Specifically, she argues that Eldredge's critique of evolutionary psychology is achieved, first, through the strategic use of the subject pronoun *we* as a distancing device (us = evolutionary biologists), and, second, through repetitions of the *topos* of comparing argumentative clarity and simplicity to the supposed impenetrability and hence potential fraudulent nature of bad science. While claiming the value of clarity and dismissing non-science, Etcoff relies on a large number of references and other disciplines to support her argument for evolutionary psychology. Oikkonen concludes that popular science books represent a powerful form 'of public outreach among practising scientists' that influences public opinion and affects institutional priorities and funding.

Science and literature

Literature as a sense-making practice has produced numerous works relating to science, from celebrations to critiques. Apart from poetry[18] and plays,[19] fiction has addressed science with particular frequency (see Amrine, 1989). Some novels use scientific theories to explore wider issues in human life. For instance, Jeanette Winterson's *Gut Symmetries* (1997) draws on the controversial 'Grand Unified Theories' of particle physics. Other novels explore scientists' minds and dilemmas, such as John Banville's *Kepler* (1981). Usually, research on literary treatments of science focuses on thematic issues and on ethical issues in particular. Yet the language of science has also influenced writers: in his work of Victorian novelists, Greg Myers (1985) has argued that the rhetoric of social prophecy was inspired by writings about thermodynamics; Gillian Beer (1983) has likewise shown how scientists have 'borrowed' from literature. Analogously, many authors have explored the 'affinities and distinctions of science and fiction',[20] as was recently done anew by Laura Otis (2009) in an anthology of nineteenth-century literature and science.[21] The genre of science fiction was specifically created in order to explore and comment on the human and social consequences of science.[22]

The final article in this issue discusses one literary example of the rhetoric of science as represented by William Gibson's cyberpunk, a sub-genre of science fiction. In her article Dalia Staponkutė explains how Gibson's cyberpunk and Alphonso Lingis's philosophical work represent alternative forms of resisting what she attests is the ubiquity of scientific discourse. In particular, cyberpunk displays a dystopian rhetoric that criticises the disembodiment of language through the 'technological turn', while making use of this very language for literary purposes.

Conclusion

As a totality, the contributions to this issue demonstrate that examining the rhetoric of science functions as a powerful heuristic approach to scientific reasoning as well as a strategy for negotiating science in (Western) culture. This approach extends far beyond the mere presentation of facts and results. Rather, it emphasises that representations need to make science meaningful for diversified audiences from different academic backgrounds and cultures. Globalised communication in the twenty-first century seems to be evolving towards a 'new' New Rhetoric of science. What the articles in this issue have in common is the centrality of the text and the discursive practices that are typical of presentations of scientific knowledge, whether they are specialised or popular or are presented in fictional contexts. The essays make an effort to go beyond the mere formalisms and argumentative circularity that characterise some linguistic analysis, while at the same time avoiding the subjectivism and lack of empirical foundation that mark certain cultural approaches to science. Pursuing an interest in interdisciplinary scholarship,[23] we hope that this issue will suggest a promising way of engaging with English Studies.

Notes

1. See Battistini (2000), Jones (1930), Nate (2001), Nicolson (1946, 1960), Stark (2009), and Vickers and Struever (1985) for treatments of the seventeenth and eighteenth centuries.
2. See Brantlinger (1989), Chapple (1986), Christie and Shuttleworth (1989), Martin and Veel (1998), and Myers (1985) for discussions of the nineteenth and twentieth centuries.
3. See Levine's refutation of C.P. Snow's influential idea that science and culture, or, more specifically, science and literature, form 'two cultures'. As Levine writes in his 1987 introductory essay to *One Culture*, 'it is possible and fruitful to understand how literature and science are mutually shaped by their participation in the culture at large – in the intellectual, moral, aesthetic, social, economic, and political communities which both generate and take their shape from them' (5–6).
4. One notes the long-lived BBC natural history documentaries by David Attenborough, as well as the growing popularity of platforms like ted.com, used to disseminate scientific knowledge on a global scale.
5. See the 10 controversies discussed by Hellman (1998) and those in Harris (1997).
6. Wilberforce famously ridiculed Darwin's theory, culminating in the question as to whether Huxley claimed his descent from a monkey through his grandfather or his grandmother. For Huxley's version see Leonard Huxley (2012: 268). For a general discussion of Huxley's rhetoric and the popularisation of Victorian science, see Block (1989).
7. See Huxley, 'Science and Culture' (1880) and Arnold's response in 'Literature and Science' (1882); Snow's 'The Two Cultures' (Rede Lecture, 1959); Leavis's reaction appeared in the *Times Literary Supplement* in 1962.
8. On graphs and figures in scientific argument and more generally on the language of mathematics, see Bastide (2001) and O'Halloran (2005).

9. See also Atkinson (1999) on how science discourse in the *Philosophical Transactions* has changed over time.
10. For a discussion of the Royal Society's ideas about language, thought and style see Hüllen (1989).
11. See, for example, Berkenkotter (2007), Campagna et al. (2012) and Swales (1990) on genre; Hyland and Bondi (2006) on academic discourse; Fahnestock (1999), Freddi (2011), Gross (1990; 2006; 2011), and Miller and Charney (2007) on scientific communication.
12. See also Campbell (1997) and, for a lexical analysis of *The Origin of Species* and *The Descent of Man*, Freddi (2008).
13. See, for example, Calsamiglia (2003), Halliday and Martin (1993), Martin and Veel (1998), Myers (1990), and Shinn and Whitley (1985).
14. See Freddi's (2011) analysis of analogical reasoning in Richard Feynman's lectures on physics.
15. In his study of historical examples, Myers (1989) has highlighted the use of dialogue for didactic purposes, as in Maria Edgeworth's *Harry and Lucy*, which uses a fictionalised teaching scenario and stages its characters as representing 'ignorance and knowledge: the learner who knows nothing, and the teacher who knows everything' (174). On the forms of science popularisation, see also Moirand (2003) and Myers (2003).
16. See Charney (2003) and Montemayor-Borsinger (2012) for analyses of its popularising strategies.
17. See, for instance, the digitised *Walking with Dinosaurs* series and the six-part *Space* series with actor Sam Neill as presenter; both are BBC productions. On early BBC science broadcasts, see the recent article by Jones (2012).
18. See poems collected in Bush's (1962) and in Heath-Stubbs and Salman's (1984) anthologies. Verse was even used by scientists themselves: Erasmus Darwin presented his ideas in poems such as 'The Botanic Garden' (1792).
19. See, for instance, Michael Frayn's *Copenhagen* (1998), which manages to render the difficulties of quantum physics and the uncertainty principle by translating it into a human issue. Consisting mainly of dialogues between Bohr and Heisenberg, the play even plays with the notion of a sober language of science when the two scientists decide to explain everything to Margrethe 'in plain language'. Bohr: '… You know how strongly I believe that we don't do science for ourselves, that we do it so we can explain to others … / Heisenberg: In plain language. / Bohr: In plain language. Not your view, I know – you'd be happy to describe what you were up to purely in differential equations if you could – but for Margrethe's sake …' (38).
20. See, for instance, Evans (1954), works by Carlisle (1980), Cosslett (1982), Davie (1963), Eastwood (1961) and Ingersoll (1992).
21. The relations of literature and the arts to the sciences and technology are investigated by specialised platforms such as *Configurations: A Journal of Literature, Science, and Technology*. Founded in 1993, the journal promotes interdisciplinary research on the interplay between arts and humanities and sciences.
22. Given the range of literary ways to speak about science, it is unsurprising that a vast amount of research on literature and science has accumulated. See Schatzberger, Waite and Johnson's 1987 bibliography; in particular, research has explored the impact of science on literature: see Jones (1966) and Nicolson (1946) on the impact of Newton in the eighteenth century; Beer (1983),

Cosslett (1982) and Levine (1988) on the impact of Darwin in the nineteenth century; other aspects of Victorian science and its reception in literature have been discussed by Brantlinger (1989) and Myers (1985); finally, Shaffer 1998 is a collection of essays on literature and science.

23. For an example of this type of work see also Barbara Korte and Christian Mair's 2010 publication on linguistics and cultural studies.

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