Interfacing Science, Literature, and the Humanities / ACUME 2 Vol. 8

Discourses and Narrations in the Biosciences investigates the forms of writing in which scientific claims are formulated. Argumentative strategies, compositional rules, and figurative expressions in communication and narrativization of scientific knowledge are the focus of interdisciplinary contributions by humanities and science scholars. The first part, 'Rhetorical and Epistemological Aspects of Science Writing', addresses how scientific pursuits feed into multi-level texts that generate responses within science, society, and culture. The second part, 'Bioscientific Discourses and Narrations', examines popularizations and fictionalizations of science in relation to diversity, deviancy, ageing, illness, reproduction, the evolution of humankind, mathematical models of biomedical systems, and the myth of the heroic scientist. Assessing the narrative impetus and command of literary and meta-discoursive strategies shown by contemporary science writers enhances understanding of the methods and conventions through which the biosciences produce knowledge.

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Volume 8

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With 2 figures

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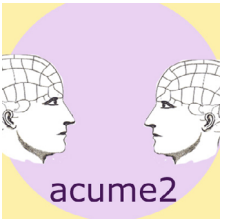

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S C I E N Z A.

DONNA con l'ali al capo, nella deſtra mano tenghi vno ſpecchio, & con la ſiniſtra vna palla ſopra della quale ſia vn triangolo.

Scienza, è habito dell'intelletto ſpeculatiuo di conoſcere, & conſiderar le coſe per le ſue cauſe.

Si dipinge con l'ali, perche non è ſcienza doue l'intelletto non s'alza alla contemplatione delle coſe; onde ſopra di ciò ben diſſe Lucretio nel lib. 4. della natura delle coſe.

Nam nihil egregius quã res diſcernere apertas. A dubijs Animus, quas ab ſe protinus abdit.

Lo ſpecchio dimoſtra quel che dicono i Filoſofi, che *ſcientia fit abſtrahendo*, perche il ſenſo nel capire gli accidenti, porge all'intelletto la cognitione delle ſoſtanze ideali, come vedendoſi nello ſpecchio la forma accidentale delle coſe eſiſtenti ſi conſidera la loro eſſenza.

La palla dimoſtra, che la ſcienza non hà contrarietà d'opinioni, come l'orbe non hà contrarietà di moto.

Il triangolo moſtra, che ſi come i tre lati fanno vna ſola figura, coſi tre

termini

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Cover Image

'Scienza', in Cesare Ripa, *Iconologia, overo Descrittione d'Imagini delle Virtù, Vitij, Affetti, Passioni humane, Corpi celesti, Mondo e sue parti* (Padova: Pietro Paolo Tozzi, 1611, 1st edn 1593), pp. 471 – 472:

DONNA con l'ali al capo, nella destra mano tenghi uno specchio, & con la sinistra una palla sopra della quale sia un triangolo.

Scienza, è abito dell'intelletto speculativo di conoscere, & considerar le cose per le sue cause.

Si dipinge con l'ali, perché non è Scienza dove l'intelletto non s'alza alla contemplatione delle cose; onde sopra di ciò ben disse Lucretio nel lib. 4 della natura delle cose:

Nam nihil egregius quam res discernere apertas. A dubiis Animus, quas ab se protinus abdit.

Lo specchio dimostra quel che dicono i Filosofi, che *scientia sit abstrahendo*, perché il senso nel capire gli accidenti, porge all'intelletto la cognitione delle sostanze ideali, come vedendosi nello specchio la forma accidentale delle cose esistenti si considera la loro essenza.

La palla dimostra, che la scienza non hà contrarietà d'opinioni, come l'orbe non hà contrarietà di moto.

Il triangolo mostra, che si come i tre lati fanno una sola figura, così tre termini nelle propositioni causano la dimostratione, & scienza.

WOMAN with wings on her head, holding a mirror in her right hand and a sphere in her left, with a triangle on the top of it.

Science is the disposition of the speculative intellect towards knowledge and the evaluation of things according to their causes.

It is painted with wings, because it would not be Science, if the intellect did not elevate itself towards the contemplation of things. Lucretius finely observed in book 4 of the nature of things:

For nothing is more excellent than to distinguish things that are clear and plain from those that are doubtful, which the Mind immediately rejects from itself.

The mirror demonstrates what Philosophers maintain, namely that *science is itself through abstraction*, because sense through the understanding of accidents gives knowledge of ideal substance to the intellect; likewise, by seeing the accidental forms of things in a mirror, their essence is opened up to scrutiny.

The sphere demonstrates that science has no contrariety of opinions, as a globe has no contrariety of movement.

The triangle shows that just as three sides make one and the same figure, so too, three terms in propositions produce demonstration, and science.

(Our translation).

For the first English edition see Cæsar Ripa, *Iconologia: or, Moral Emblems. Wherein are Express'd, Various Images of Virtues, Vices, Passion, Arts, Humours, Elements and Celestial Bodies; as Design'd by the Ancient Egyptians, Greeks, Romans, and Modern Italians* (London: Benj. Motte, 1709), p. 67.

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Part I:
Epistemological and Rhetorical Elements of Science Writing

Brian Hurwitz / Paola Spinozzi

Science, Discoursivity, and Narrativity

> The primary encounter with any text, be it metaphysics, poetry or biology, is linguistic.
> J. R. R. Christie, 'Introduction. Rhetoric and Writing in Early Modern Philosophy and Science' (1987)[1]

Science writing has evolved in response to changes in methods, stylistic conventions, and rhetorical strategies used to enunciate concepts and findings. The narrative impetus exhibited by contemporary science writers is the focus of this volume, especially in relation to popularization and fictionalisation of scientific discourses. The contributions brought together here reinvigorate scholarly interest in the central role played by figurative elements in bioscience.[2]

I. Writing Science

The inauguration of modern science coincided with energetic attempts to forge a linguistic community and consensus on how seventeenth-century observations, descriptions, and experiments were to be couched and conveyed. Thomas Sprat, one of the founders of the Royal Society and its first historian, in 1667 voiced the distrust in which Fellows of the Society held 'specious Tropes and Figures':

> [The Ornaments of speaking] […] make the *Fancy* disgust the best things […]: they are in open defiance against *Reason.* […] It will suffice my present purpose, to point out, what has been done by the *Royal Society*, towards the correcting of its excesses. […] 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.[3]

1 John R. R. Christie, 'Introduction. Rhetoric and Writing in Early Modern Philosophy and Science', in *The Figural and the Literal*, ed. by Andrew E. Benjamin, Geoffrey N. Cantor, and John R. R. Christie (Manchester: Manchester University Press, 1987), p. 3.

2 This Introduction arises from a shared process of discussion and drafting, with Brian Hurwitz lead author of sections I. Writing Science and III. Science Popularization and Paola Spinozzi lead author of sections II. Narrativizing Science and IV. Figurative Science.

3 Thomas Sprat, 'Part Two, Section XX. Their Manner of Discourse', in Id., *The History of the Royal Society of London for the Improving of Natural Knowledge* (London: Printed by J. R. for

Sprat's preference for pragmatic language, a genuine, unaffected way of speaking, and his praise of mathematics valorise a science grounded in numbers and precision rather than in wrestling with the ambiguity of certain words. He singles out craftsmen and businessmen for their straightforward verbal interactions and efficient communications, for capacities based more on evaluation than on sophisticated vocabulary or refined literacy skills.

The lineage of scientific and medical papers reveals changes in the structure, register, and language in which they are cast.[4] Narratively organised accounts of phenomena and experiments predominantly written in an active register which emphasized witnessing and artful demonstration were gradually replaced by more passive forms of communication, signalling a growing separation of observer from observed and the creation of forms of knowledge purportedly detached from the knower and 'unmarked by prejudice or skill, fantasy or judgment, wishing or striving'.[5]

Today's lattice work of linguistic practices in the sciences includes not only reports of experiments and procedures but also grant proposals, conference abstracts, notebooks, 'research scribblings',[6] measurement records, literature reviews, meta-analyses, and textbooks. Contemporary scientific reports are but the public face of 'lower level' texts which find expression in highly polished arrays of words, symbols, numbers, tabulations, graphs, tracings, drawings, flow diagrams, and images, all orchestrated together in a hierarchy of headings and subheadings. IMRAD, the four-part convention underlying the structure of scientific papers,[7] is often regarded by contemporary science authors as a se-

J. Martyn at the *Bell*, 1667), pp. 112 – 113. See also Marie Boas Hall, 'Oldenburg, and the Art of Scientific Communication', *The British Journal for the History of Science*, 2 (1965), 277 – 290.

4 Peter B. Medawar, 'Is the Scientific Paper a Fraud?', *Listener* 70, 12 September 1963, pp. 377 – 378, republished in Peter B. Medawar, *The Strange Case of the Spotted Mice and Other Classic Essays on Science* (Oxford: Oxford University Press, 1996), pp. 196 – 202; Steven Shapin, 'Pump and Circumstance: Robert Boyle's Literary Technology', *Social Studies of Science*, 14 (1984), 481 – 520; Charles Bazerman, *Shaping Written Knowledge: The Genre and Activity of the Experimental Article in Science* (Madison: University of Wisconsin Press, 1988); Greg Myers, 'The Pragmatics of Politeness in Scientific Articles', *Applied Linguistics*, 10 (1989), 1 – 35; Dwight Atkinson, 'The Evolution of Medical Research Writing from 1735 to 1985: The Case of the *Edinburgh Medical Journal*', *Applied Linguistics*, 13 (1992), 337 – 374; Irma Taavitsainen and Paivi Pahta, 'Conventions of Professional Writing: The Medical Case Report in a Historical Perspective', *Journal of English Linguistics*, 28 (2000), 60 – 76; Brian Hurwitz, 'Form and Representation in Clinical Case Reports', *Literature and Medicine*, 25, 2 (2006), 216 – 240.

5 Lorraine Daston and Peter Galison, *Objectivity* (New York: Zone Books, 2007), p. 18.

6 Hans-Jörg Rheinberger, 'Discourses of Circumstance', in *Scientific Authorship. Credit and Intellectual Property in Science*, ed. by Mario Biagioli and Peter Galison (New York: Routledge, 2003), pp. 309 – 323.

7 Luciana B. Sollaci, William Enneking, and Mauricio G. Pereira, 'The Introduction, Methods, Results, and Discussion (IMRAD) Structure: A Fifty-year Survey', *Journal of the Medical Library Association*, 92, 3 (2004), 364 – 371.

verely limiting architecture, but one that nevertheless sets down a positively challenging grid to aspiring authors. Respect for the rules of science communication and demands for originality coexist antagonistically, generating metadiscoursive comments such as those of John Skelton in 'English as she is wrote':

> We must recognise just how rigorous these conventions are and what a constraint on literary skill they impose. The organising principle of the contemporary medical paper no longer has the simple force of chronology, but undertakes a ritual dance through Introduction, Methods, Results, and Discussion.[8]

The ability to impress a clearly defined rhythmical pattern on to scientific reporting creates a bioscience posture in regard to constructing and communicating findings. But as already noted, scientific papers are fed by abstracts, notebooks and research scribblings – the notes of 'night science', as the Nobel laureate, François Jacob, so evocatively termed these less visible practices, habits and mentalities undergirding and driving the public discourse of science:

> […] night science wanders blind. It hesitates, stumbles, recoils, sweats, wakes with a start. Doubting everything, it is forever the building material trying to find itself, question itself, pull itself back together. Night science is a sort of workshop of the possible where what will become building material of science is worked out. Where hypotheses remain in the form of vague presentiments and woolly impressions. Where phenomena are still no more than solitary events with no link between them. Where the design of experiments has barely taken shape. Where thought makes its way along meandering paths and twisting lanes, most often leading nowhere.[9]

At the 'embryonic' stage a multitude of bookkeeping texts is generated, which the historian Hans-Jörg Rheinberger wants to see investigated as records of the primary written processes of science:

> These traces reach from jotting down ideas to drawing sketches of experiments, recording data, arranging data, processing data, interpreting experimental results, trying out calculations, and designing instrumentation. All these and many more comparable activities circumscribe a space that lies *between* the materialities of the experimental systems and the various written communications that are eventually released to the scientific community.[10]

The communications of science reaching public scrutiny tend to erase the subjective, unruly elements within the disparate texts belonging to the 'workshop' of the enterprise, but it is at this level of activity that scientists first press

8 John Skelton, 'English as she is wrote', *The Lancet*, 346, 9 December 1995, p. 1568.

9 François Jacob, 'Beauty and Truth', in Id., *Of Flies, Mice and Men* (Cambridge, Mass.: Harvard University Press, 1998), p. 126.

10 Rheinberger, 'Discourses of Circumstance', p. 314. See also Gianfranco Marrone, *Corpi sociali. Processi comunicativi e semiotica del testo* (Torino: Einaudi, 2001), p. XXVI.

their work into written form in preparation for later inscription into high level scientific papers.

In an observational study devoted to the dynamics of laboratory life Latour and Woolgar portray the activities of the neuroendocrine laboratories at the Salk Institute in the USA as a hub of incessant action, reaction, and counteraction to statements, counter-statements, endorsements, and rebuttals:

> A laboratory is constantly performing operations on statements; adding modalities, citing, enhancing, diminishing, borrowing and proposing new combinations. Each of these operations can result in a statement which is either different or merely qualified. Each statement, in turn, provides the focus for similar operations in other laboratories. Thus, members of our laboratory regularly noticed how their own assertions were rejected, borrowed, quoted, ignored, confirmed, or dissolved by others.[11]

The knowledge bioscience produces (and confutes) appears in tactically positioned claims and crafted literary inscriptions addressed to many audiences.[12] This form of writing makes peculiar and heavy demands on authors. Manuals offering advice on the composition of scientific reports stress the importance of plain language, concision, lucidity, and controlled variation of sentence structure in the service of an embedded narrative of discovery. According to Jacob, in bioscience publishing 'reason proceeds along a high road that leads from darkness to light with not the slightest error, not a hint of a bad decision, no confusion, nothing but perfect reasoning. Flawless'.[13]

Given the less than perfect activities taking place at the workshop level of science, which find public expression only through the super ego processes of peer review and journal editing, it is not surprising that manuals and web sites offering meticulous models of how to write, edit, and proofread a scientific manuscript have flourished. Advice revolves around careful selection of the journal to submit work to, attention to the central arguments a paper mounts, the importance of explicit relationships between data collection, analyses, findings, and conclusions, and the imperative of avoiding over-claiming.[14] Peter J. Feibelman acknowledges that:

11 Bruno Latour and Steve Woolgar, *Laboratory Life. The Social Construction of Scientific Facts* (Princeton: Princeton University Press, 1986, 1st edn 1979), pp. 86 – 87.

12 Latour, 'Literature', in Id., *Science in Action* (Cambridge, Mass.: Harvard University Press, 1987), pp. 21 – 62.

13 Jacob, 'Beauty and Truth', p. 125.

14 Jean-Luc Lebrun, *Scientific Writing* (New Jersey: World Scientific Publishing Co.Pte.Co., 2010).

> Virtually everyone finds writing the introduction to a paper is the most difficult task […]. My solution to this problem is to start thinking about the first paragraph of an article when I begin a project rather than when I complete it […].[15]

There can be few clearer indications of the constitutive role that discourse plays in scientific work. Compositional strategies for conveying theories and discoveries to diverse audiences reveal that, while pursuing clarity and precision, science writers are sensitive, also, to form and to style.

II. Narrativizing Science

In *The Faber Book of Science* (1995)[16] John Carey alights on 'a new kind of twentieth-century literature, which demands to be recognized as a separate genre, distinct from the old literary forms, and conveying pleasures and triumphs quite distinct from theirs'.[17] Carey samples these works and finds that they fit 'into one of two modes, the mind-stretching and the explanatory'.[18] Readers' minds can be stretched through a sense of wonder and awe akin to the aesthetic category of the Sublime, whereas the explanatory mode revolves around the act of searching and the moment of finding. Carey's preference for science writing that emphasises the epiphanic aspect is clear: his anthology prizes 'the feeling of enlightenment that comes with a piece of evidence being correctly interpreted, or a problem being ingeniously solved, or a scientific principle being exposed and clarified'.[19]

Popular science writing hardly hints at the written hinterland of 'night science', valuing instead puzzles and their solutions technically, intellectually, and in terms of imaginative steps.[20] In *The Cambridge Introduction to Creative Writing* (2007) David Morley has no doubts about the imaginative and technical skills qualifying writers of popular science:

> Popular science writing […] *is* creative nonfiction, and the skill with which it is composed has been responsible for melting many of the falsehoods that have iced up between the arts and sciences, not least the idea that scientists cannot write […].

15 Peter J. Feibelman, *A PhD Is Not Enough! A Guide to Survival in Science* (New York: Basic Books, 1993), p. 45.

16 Michael R. Lynn, *Popular Science and Public Opinion in Eighteenth-Century France* (Manchester: Manchester University Press, 2006).

17 John Carey, 'Introduction' to *The Faber Book of Science*, ed. by Id. (London: Faber and Faber, 1995), pp. xiii-xxvii (p. xiv).

18 Ibid., p. xv.

19 Ibid., p. xvi.

20 Simon Schaffer, 'What is Science?', in *Companion to Science in the Twentieth Century*, ed. by John Krige and Dominique Pestre (London and New York: Routledge, 2003), pp. 27 – 41.

> [Scientists] prize imagination, energy of expression, style, and understand their own process of creativity.[21]

The focus on the creative talent of scientific writers is evident in *The Oxford Book of Modern Science Writing* (2008),[22] in which Richard Dawkins explores 'the romance of science' in a selection of papers which revolves around the act of glimpsing as the fulcrum of scientific discovery. For Dawkins, the glimpse is a gnostic form of sight, an insight penetrating the structure and inner workings of the universe. It can be conjured up and conveyed in lucid prose that celebrates the intelligibility of Nature and recognises its transcendent value in the face of a vast and complex universe.[23]

The expressive values of science writing are the focus of humanities and science scholars contributing to *Discourses and Narrations in the Biosciences.*[24] The discoursive modes and rhetorical strategies used to convey theories and discoveries in science to specialist and non-specialist audiences are the core of Paola Spinozzi's consideration in 'Representing and Narrativizing Science'. Clarity, efficacy, and rigour are not the only concerns of scientific writers: sensitivity to literariness is also a prominent feature shared with creative writers. Popular science challenges the classification of scientific language as denotative, and literary language as connotative, by showing that the use of figures of speech can indeed enhance understanding of scientific theories. Tropes go beyond a referential use of language and transport concepts from a literal to a non-literal plane; they also add layers of meaning requiring complex hermeneutic acts. The assumption that a scientific essay complies with strict compositional rules drawing on a specialised glossary still applies, but meta-discoursivity has also become essential to the public understanding and narrativization of science. Science writers who talk about themselves as writers raise questions about the meanings they attach to representation, and how epistemology and aesthetics intersect in communication, popularizations, and fictionalisations of science.

Rhetorical and discoursive engagements shared by science and literature are examined in 'The Antagonistic Affair between Science and Literature', in which Andrea Battistini deconstructs the Manichean idea – firmly maintained until

21 David Morley, 'Chapter Ten. Writing in the Community and the Academy', in Id., *The Cambridge Introduction to Creative Writing* (Cambridge: Cambridge University Press, 2007), pp. 234 – 257 (p. 242).

22 *The Oxford Book of Modern Science Writing*, ed. by Richard Dawkins (Oxford: Oxford University Press, 2008).

23 Peter R. Dear, *The Intelligibility of Nature* (Chicago and London: University of Chicago Press, 2006).

24 See for example *A Bedside Nature. Genius and Eccentricity in Science 1869 – 1953*, ed. by Walter B. Gratzer (London: Macmillan magazines, 1996), and *Vintage Papers from The Lancet*, ed. by Ruth Richardson (London: Elsevier, 2005).

half a century ago – that science proceeds rationally and literature advances by imagination. Both activities, he finds, draw on vision and creative capabilities, as hypotheses are always generated by an imaginative flight which at a later stage is subjected to rules of logic and empirical tests.

When literature interacts with science, it incorporates, responds to, and addresses a rich interplay of concepts, images, reasoning, and practice.[25] Novelists, poets, and dramatists elaborate on scientific concepts by forging images, metaphors, and figures that 'go beyond reality [and] turn reality into song',[26] amplifying, intensifying, and even satirising, the symbolic influence which the sciences wield. In some areas of overlap, porosity rather than impermeability describes the relationship. In *Neurology and Literature, 1860 – 1920* (2007) Anne Stiles investigates the common cultural reference points and rhetorical strategies shared by neurologists and literary authors:

> Whilst late-Victorian […] novelists like Émile Zola and George Moore employed the scientific method in their minute observations of daily life, medical writing took a decidedly narrative turn with longer "novelistic" case studies, culminating in Freud's extensive explorations […]. At times, the resemblances between case studies and literary works were striking enough to obscure the line between fact and fiction. French psychologist Théodore Flournoy's best-selling case study of a patient with multiple personality disorder, *From India to the Planet Mars* (1900), was read as a case study and as a novel when it first appeared. […] Silas Weir Mitchell's fictional account of an amputee suffering from phantom limb syndrome, presented in the short story "The Case of George Dedlow" (1866), was taken for reality by many who read the tale in *The Atlantic Monthly* […]. Money was collected in several places to assist the unfortunate man, and benevolent persons went to 'The Stump Hospital' in Philadelphia, to see the sufferer and offer him aid.[27]

Clearly, the creative writer's ability to achieve verisimilitude can blur the boundaries between science and fiction, showing that clinical case reports can be forged by exploiting acknowledged notions of objectivity and meticulousness.

The attention narrative has received in clinical circles since the 1990s is the focus of Brian Hurwitz's 'Narrative [in] Medicine'. A role for narrative in medicine has been recognised for much longer, arising from the confluence of psychodynamic thinking, structuralism, descriptive sociology, and literary

25 Geoffrey Sill, *The Cure of the Passions and the Origins of the English Novel* (Cambridge: Cambridge University Press, 2001); T. W. Laqueur, 'Bodies, Details, and the Humanitarian Narrative', in *The New Cultural History*, ed. by Lynn Hunt (Berkeley: University of California Press, 1989), pp. 176 – 204.

26 Gaston Bachelard, *L'Eau et les Rêves* (Paris: Gallimard, 1942), p. 23.

27 Anne Stiles, 'Introduction' to *Neurology and Literature, 1860 – 1920*, ed. by Ead. (Basingstoke: Palgrave Macmillan, 2007), pp. 1 – 23 (p. 12).

studies in relation to medicine. Nonetheless, its adjectival usage – as in Narrative Medicine – is novel, referring to the pervasive presence of storied transactions in the medical realm. Hurwitz calls on physicians to look beyond, without devaluing, the biological mechanisms at the centre of conventional approaches to disease and diagnosis, to turn to domains of thought and forms of communication which extend the scope of clinical work. Over and above listening, diagnosing, treating, and informing, a new remit is emerging in medicine, which grants a primary value to multiple and nuanced ways of story-telling.

In '"Disease is a crime; and crime a disease now unknown": Changing Views of Crime in Nineteenth- and Twentieth-century Culture' Maurizio Ascari examines the powerful narratives which substantiate the study of criminal behaviour in individuals and society. In the nineteenth century crime could still be viewed as a sign of punishment from God, manifest as mental and physical disease. Systematic studies of degeneration introduced a paradigm shift in the conception of crime, which came to be classified as a degenerative behaviour requiring specific societal remedies, such as eugenics and euthanasia, to prevent birth of degenerate creatures and to kill off those who do appear. The rise of criminal anthropology as a discipline was marked by theories of human behaviour allegedly founded on universalistic principles such as the influence of heredity. In contemporary age criminography and criminology seek to avoid absolute parameters for assessing and sanctioning crime by situating human nature in a pluralistic perspective that contemplates diversity.

How deviancy became entwined with genius can be assessed by retracing the mutation of the artist, whom the Romantics prized as a mediator of divine, affective powers and Cesare Lombroso in *Genio e follia* (1864) labelled as an abnormal individual doomed to degeneration. Mary Kemperink's 'Physiognomies of Genius: Norm and Deviation in Nineteenth-century Literary and Scientific Writings' shows how, one by one, the Romantic features of genius were translated into medical terms and stripped of blessed connotations.

Normality, abnormality and exceptionality acquired new meanings in the last decades of the nineteenth century. In '"I lost my Body in an experiment': Reshaping the Human in Edward Page Mitchell's Short Stories' Alessandra Calanchi examines how the American writer contributed to the popularization of science and to the 'scientification' of fiction by exploring (im)materiality, time and space, the relationship between movement, heat, and electricity, the wave and electromagnetic field theory, and envisioned the future of humankind by anticipating technologies of the body and artificial intelligence. Mitchell's stories show that science and literature energize each other in the overlapping territories of science fiction, fantasy, and the supernatural.

Human evolution is the unifying theme of the 'Today and Tomorrow Series' edited by Charles K. Ogden and published between the 1920s and 1930s. Aline

Ferreira's 'Mechanized Humanity: J. B. S. Haldane, J. D. Bernal, and Their Circle' shows that the technological advancement in computer science, biotechnology, and nanotechnology, foreseen by scientists and intellectuals in the first decades of the twentieth century, was aimed at overcoming human limitations and biological death. Futuristic scenarios in which the human species has undergone radical mutations still abound in contemporary literature, demonstrating that, although rarely optimistic, speculations about how nonbiological components will modify humanity are intrinsically human.

Narrativization of scientific topics considered from a comparative perspective is the core of '"Extravagant Fiction Today, Cold Fact Tomorrow". The Theme of Infertility in Science Fiction'. Clare Vassallo, a literary theorist, carefully explains the origins and distinctive features of the genre for the benefit of readers with a scientific background, while Victor Grech, a paediatrician, is mainly concerned with scientific rigour and authoritative bibliographical sources. These different authorial approaches prove complementary when the literary potential and value of sci-fi novels are discussed in relation to factual inaccuracy or counterfactuals.

Vita Fortunati and Claudio Franceschi's 'The Quest for Longevity and the End of Utopia' engages powerfully with interdisciplinarity and medical humanities. Narratives of old age show that humanistic disciplines are struggling to assess the social and cultural impact of recent theories of ageing as a form of remodelling and to assimilate new notions of human lifespan. The history of ideas has been marked by persistent stereotypes which chastise old age as a vile degeneration of mind and body. While rejection of decrepitude and obsession with mortality have permeated western representations of old age since classical antiquity, Darwinian theories have directed the health sciences towards understanding ageing as a post-reproductive process which may not have been selected for throughout successive stages of human evolution. Such profound differences suggest that the scientists' endeavours are directed towards the immediate future, while humanities scholars, attentive to the past, locate their views in a diachronic continuum. As geneticists gain deeper insight into why and how extended lifespan is achievable, philosophers, anthropologists, and literary scholars need to deconstruct biases and preconceptions established at earlier stages of history, when scientific knowledge worked within different paradigms. Sci-fi writers appear to be better equipped to meld a dynamic response to ageing, as Ursula K. Le Guin proves by claiming that the sense of identity can not only be retained with old age, but can also develop and expand in unexpected ways.

Striking in contemporary science fiction is the intricacy of the interplay, in construction of lifespan, between the role of genetic inheritance, technological intervention, and Darwinian thought. When sci-fi renditions of the quest for immortality are examined by a scientist rather than by a literary critic, the focus

tends to be on ways in which the technologies devised by the novelist to extend life beyond its natural limit, or to reactivate it after its end, stretch scientific notions of longevity. Life extension may well be in the making but, as Stefano Salvioli persuasively argues in 'Sci-fi Quests for Longevity and Immortality', it proves difficult for it to emerge without the help of mythic or ironic musings on mortality.

Ana Gabriela Macedo compares the attitudes of novelists towards writing and of biologists towards their experiments in 'A. S. Byatt's Storytelling Ancestors and Narrations of Science'. Rejecting the notion that telling stories may be regarded as a primitive, unrefined form of representation, Byatt argues it remains essential because it reproduces biological time. The antithesis between the atheistic views of an explorer and the creationist beliefs of a clergyman, the clashing forces of instinct, sexual drive, and desire that traverse the novella 'Morpho Eugenia' (1992) converge towards a subtler argumentation concerning the claim that beauty and perfection are features of the natural world order rather than of a divine plan. Scientific themes can work as antidotes to existential crisis, as scientists eschew speculation about purely abstract notions.

The narrativization of a bioscience accomplished by Byatt in 'Morpho Eugenia' matches the mathematization of a bio-narrative formulated by Gastone Castellani and Enrico Giampieri in 'Modelling Bistabilities that Link Macro and Microscopic Biological Phenomena'. By contending that the behaviour of social insects in Byatt's novella can be described through mathematical models similar to the ones used to study population dynamics or the firing of neural networks, the authors illustrate the biophysical equations developed to define the fundamental laws underlying the structure, functioning, and evolution of living systems. The method adopted by the biophysicists raises questions such as 'What is the significance of different models?' 'How testable are these competing hypotheses?' and 'Might the hypotheses be wrong?'

Discussion of population dynamics within the framework of modern bio-evolutionary theory shows how much such equations are dependent on discourse in order to supply explanation and justification. A key issue is whether such formulae should be understood as descriptive, prescriptive, or – as they mostly aspire to be – nomic. Empirical observation and controlled experiment would be needed to decide which mathematical model applies to different sorts of populations and network structures under which circumstances, with what tolerance of variation and measurement error: mathematical equations stand for narration and, in the process, narrations assume scientific form.

Biomedical discourses carry the responsibility for stimulating cultural and artistic representations of diseases. In 'The Plague Years. Borderland Narratives on AIDS in the '90s' Nicoletta Vallorani explores paradoxes grounded in the ambiguity of the pathology itself as well as in the processes through which it has

affected and infected Western culture as a virus and a text. Demarcated by the language of medicine and unleashed through artistic creativity, AIDS has proliferated into borderland narrations of physical and social death. Precisely because the significance of AIDS takes and changes shape through language, discourses of science and the humanities can together foster or reject conceptualizations of the disease aimed at punishing deviant and shameful sexual practices through marginalization and isolation.

III. Popular Science

Public interest in knowledge has acquired many new forms ranging from documentary television series presented by science historians to daring theatrical representations of scientific concepts. Knowledge is shaped not only by the procedures through which it is presented in the forms of papers, letters, reports, or chapters, but also by scientists' practices and performances, as Pino Donghi emphasises in 'Science Popularization and Performativity'. A scientific work cannot be explained to a broader audience simply by dissecting articles published in high impact factor journals. Its meaning and significance instead are illuminated by retracing the history of the discovery and by unfolding what may be habitually hidden. The quality of a scientific paper is judged, as Skelton wryly explains, on the basis of the writer's ability to persuade the reader that the argument is robust, exact, and untainted by assertiveness:

> the chaotic hit and miss of much real experimentation (the questionnaire the cat ate, the missing notes, the dropped test tube) [is] […] suppressed in favour of an account of seamless perfection. […] The draining of life from the scientific drama is part of the convention of authorial anonymity […]. In a medical journal today you must, unless you are very famous, present yourself as a humble faceless servant in pursuit of truth. This on occasion may mask a monstrous ego […].[28]

Public understanding of science requires that such cleansing operations are replaced by the retrieval of paratexts.[29] Popularization and dissemination involve understanding the differences between scientific and other types of discourse: science can be communicated by selecting materials which within an article would certainly be redundant. For Donghi it could be important to know that it was a small mammal – the cat – that ate the questionnaire.

28 John Skelton, 'English as she is wrote', p. 1568.

29 The critical role of such paratexts is highlighted, for example, in Fred Pearce, 'The five key leaked emails from UEA's Climatic Research Unit', *The Guardian*, Climate Wars, Guardian Special Investigation, Wednesday 7 July 2010, <http://www.guardian.co.uk/environment/2010/jul/07/hacked-climate-emails-analysis> [accessed 25 June 2011].

Popularization involves viewing science as a social process constrained as well as energized by audience, convention, and language. Donghi regards stage performance as a mode of telling which can both articulate and disarticulate discourses. He invites science to do the same, to expose the practices that give it its meaning. Even the most abstract mathematics can be staged without bending science to the constraints of the mise-en-scène, or transforming a play into a visually appealing explanation of scientific rules. Donghi praises a mode of dramatic expression through which scientific concepts can be performed on stage without being reduced to a play.

Patrick Parrinder's 'Satanism and Genetics: From Frankenstein to J. B. S. Haldane's *Daedalus* and Beyond' presents an inter-textual reading of *Daedalus; or, Science and the Future* (1924), the influential essay in which J. B. S. Haldane first prophesied the separation of sexual life from pregnancy through ectogenesis, an extra-uterine process of human fertilisation. Parrinder shows why this remarkable futurological sketch of genetics, with its potentially profound capacity to remould social relations along scientific lines, has to be understood not only as an exercise in the popularization and fictional translation of a nascent science, but also as a mytho-poetic expression of society's relations with science and the power of scientists, which gives rise to science fiction and dystopian literature.

'Stem Cells: Heroes with a Thousand Faces' shows there to be an intriguing outcome to choosing a mythological narrative style to articulate scientific arguments which ordinarily rely on secure foundations and clear, linear patterns of argumentation. Jorge S. Burns exemplifies and parodies an extraordinarily persistent myth about heroic science and scientists. The first-person narrative featuring 'our hero' emphasises affiliation to audience, a surrogate for the public to which it makes its appeal. The character presupposes emotional closeness with a readership gagging to know more and encouraging him on to bigger and greater deeds. Most strikingly, although many voices make an appearance in the discovery minutely reported, this story symbolically signifies that 'our hero' stands in for all scientists, and readers are left wondering what all the members of the investigative team thought about the project, how they contributed to its realization, interacted, and dealt with disagreement and dissent.[30]

30 The scientist's modes of self-representation have been explored by Simon Pickvance, '"Life" in a Biology Lab', *Radical Science Journal*, 4 (1976), 11–28; Soraya de Chadarevian, 'Memoirs of a Scientist-Historian', *Isis*, 87, 3 (September 1996), 507–510; 'Oral History of Science Collections and Projects', compiled by Simone Turchetti as an appendix to *The Oral History of Science in Britain: A Scoping Survey* for National Lifes Stories, September 2007, <http://www.bl.uk/aboutus/stratpolprog/oralhist/oralhistprojapp1.pdf> [accessed 25 June 2011]; Giuliano Pancaldi, 'The Case and the Canon in Laboratory Life', in *The Case and the Canon. Anomalies, Discontinuities, Metaphors between Science and Literature*, ed. by Ales-

Though presenting a case study, Burns does not become lost in translation, or locked in the narrative; he offers reflection which merges exemplification and meta-discoursivity, seriousness and enjoyment. Viewed from the perspective of literary criticism, the blend of sensational and pedagogical elements in the life history of the omniscient scientist-narrator and the empathic interaction he wants to create with his audience locate the narrative mode in the nineteenth century rather than in contemporary science storytelling. Questioned, revised, reversed, rewritten after the end of the Renaissance, parodied by Cervantes, Laurence Sterne, Henry Fielding, and William Thackeray, the model of the heroic narrative continues to surface and to work.[31]

Burns's chapter raises the issue of utilitarianism in science writing. Demands for simplifications, claims to secrecy and the rules of competition in science publishing, misinterpretation of others' work, manipulations of the refereeing and funding systems are all processes habitually encountered in scientific circuits.[32] The need to secure funds predisposes to a 'bang for the buck' style that may highlight a particular research project as relevant not only for the field, but also for the whole scientific community and ultimately for society. A proposal put forward in a utilitarian manner frequently includes a closing sentence in which posited therapeutic uses associated with the discovery are speculatively foreseen.

IV. Figurative Science

Discussions about the impact of tropes on the understanding of scientific theories have not died out.[33] A major reason, already evidenced in the early modern period, is the ambivalence intrinsic to the use of rhetoric in science. In a chapter focusing on the passage from alchemy to chemistry in the Renaissance Kenneth

sandra Calanchi, Gastone Castellani, Gabriella Morisco, and Giorgio Turchetti (Göttingen: Vandenhoeck & Ruprecht Unipress, 2011), pp. 261 – 281.

31 Roslynn D. Haynes, *From Faust to Strangelove: Representations of the Scientist in Western Literature* (Baltimore – London: Johns Hopkins University Press, 1994); *Telling Lives in Science: Essays on Scientific Biography*, ed. by Michael Shortland and Richard Yeo (Cambridge: Cambridge University Press, 1996); Freeman J. Dyson, *The Scientist as Rebel* (New York: New York Review Books, 2006).

32 G. Nigel Gilbert and Michael Mulkay, *Opening Pandora's Box: A Sociological Analysis of Scientists' Discourse* (Cambridge: Cambridge University Press, 1984); David Locke, *Science as Writing* (New Haven: Yale University Press, 1992).

33 Theodore L. Brown, *Making Truth: Metaphor in Science* (Urbana: University of Illinois Press, 2003); Ken Baake, *Metaphor and Knowledge: The Challenges of Writing Science* (New York: State University of New York Press, 2003); Elizabeth Parthenia Shea, *How the Gene Got Its Groove: Figurative Language, Science, and the Rhetoric of the Real* (New York: State University of New York Press, 2008).

Knoespel showed how attention to narrative was maintained and encoded: 'the thematic interest in purification so obvious in alchemical narratives [did] not disappear but [became] condensed in the metaphor of purification found in eighteenth-century chemistry'.[34] Figures of speech surpass referentiality and, while transporting scientific concepts beyond the literal plane, add layers of meaning to them.

The results of an experiment conducted by Paul H. Thibodeau and Lera Boroditsky and published in *PLoS ONE* in February 2011 further indicate that metaphors not only facilitate, but also guide the processes through which judgements are formed. The two psychologists studied how people's opinions about social policy on crime are influenced by the description of criminal behaviour as a virus or a beast and whether variations in prospective solutions could be directly related to the different metaphoric contexts. Participants did not attribute any importance to the metaphor, maintaining that the aspect of the crime report they found most influential in their reasoning was the crime statistics. As all reports presented the same statistical data, but half of them described crime as a contagious disease and the other half as a dangerous wild animal, the psychologists concluded that different metaphors generate different conceptualizations.[35] Metaphor should not be regarded merely as a skilful prop or witty trick, but needs to be seen to have the power of shaping thought and interpretation in ways we are not aware of. The semantic ductility of metaphors is still largely ignored but could be recognized and comprehended if the subtleties of language were more widely shared.

The experiment provoked immediate responses, above all owing to its social implications, as shown in the article by the science writer and journalist Philip Ball in a paper that echoes the concerns voiced by Bishop Thomas Sprat in the seventeenth century. 'A Metaphor Too Far', published in *Nature News* in February 2011, launches a warning against the dangers of metaphors, defined as distracting, equivocal elements in the conceptualization of science. While scientific concepts evolve, metaphors remain and can be extremely persistent, if their evocative value is high: 'Thibodeau and Boroditsky give us new cause to be wary, for they show how unconsciously metaphors colour our reasoning'[36] and how pervasive their action can be not only in culture and politics, but also in

34 Kenneth J. Knoespel, 'The Mythological Transformations of Renaissance Science: Physical Allegory and the Crisis of Alchemical Narrative', in *Literature and Science as Modes of Expression*, ed. by Frederick Amrine (Dortrecht: Kluwer Academic Publishers, 1989), pp. 99 – 112.

35 Paul H. Thibodeau and Lera Boroditsky, 'Metaphors We Think With: The Role of Metaphor in Reasoning', *PLoS ONE*, 6, 2 (2011), e16782, 1 – 11 (pp. 1, 2, 3).

36 Philip Ball, 'A Metaphor Too Far', *Nature News*, 23 February 2011, pp. 1 – 8 (p. 2), <http://www.nature.com/news/2011/110223/full/news.2011.115.html> [accessed 25 June 2011].

scientific contexts. Metaphor has never been an undemanding presence in science and today, almost three hundred and fifty years after Sprat's eloquent defence of unornamented speech, science writers are still haunted and intrigued by its multi-faceted nature:

> But the need for metaphor in science stands at risk of becoming dogma. Maybe we are too eager to find a neat metaphor rather than just explain what is going on as clearly and honestly as we can. We might want to recognize that some scientific concepts are "a reality beyond metaphor", as Nobel laureate David Baltimore, a biologist at the California Institute of Technology in Pasadena, has said of DNA. At the very least, metaphor should be admitted into science only after strict examination. We ought to heed the warning of pioneering cyberneticists Arturo Rosenblueth and Norbert Wiener that "the price of metaphor is eternal vigilance".[37]

Ball's message is that the threat posed by metaphor is proportional to its beguiling power, so the attention it attracts is acceptable as long as it does not eclipse the 'real' object, science. His belligerent attitude is strengthened through quotations from authoritative voices, but his own pronouncements acquire hazardously strong timbres when he exhorts to clarity and honesty, implying that dishonest use of metaphor has become a feature of communication in science. An assessment of metaphor that includes ethical parameters is thought-provoking, but it requires in-depth arguments which only a critic prepared to incur the more than impending peril of generalization would present in a journal article. Nonetheless, whenever a writer chooses to explain a scientific concept metaphorically, appropriateness, precision, and caution should be primary concerns.

Scientists constantly adopt lexemes which draw on already existing words from other contexts and infuse them with highly specialised meanings. 'The book of life' is an anthropomorphic concept, 'transcription' and 'code' evoke a medieval scriptorium or a Latin codex, the biological notion of 'self' and 'not-self' is related to the ancient debate between 'being' and 'non being' in ontological terms. These expressions have acquired specific scientific meanings, but their etymologies hark back to very different scenarios. Words borrowed from one semantic field and exposed to re-signification in another field accrete additional semantic layers, a process not unique to science. When scientists learn that much of the lexicon they employ arises from other disciplines, and that from the outset their own coinages are imbued with meanings remoulded from other branches of knowledge, they may feel simultaneously humbled and stimulated. Terms derived from different semantic fields enter laboratories and clinics, where initially they are kept secluded, becoming more audible on moving into classrooms, appearing in journals, and reaching a wider media audience. As

37 Ibid., p. 3.

physicians and scientists leave their data collection settings and wander out of the hospital and lab, the words they have borrowed and reutilised of course accompany them.

In a laboratory or on a hospital ward round, 'where does that word come from?' may seem an irrelevant question, but it becomes intriguing and boundlessly suggestive when related to the communication and narrativization of scientific knowledge. Following rigorous criteria, the pursuit of significant metaphors shared by the writers of science enables the metamorphoses and reconceptualizations which keywords have undergone to be retraced in reaching their current status within discourses and narrations of the biosciences.

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