



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

Paola Spinozzi /  
Brian Hurwitz (eds.)

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-discursive strategies shown by contemporary science writers enhances understanding of the methods and conventions through which the biosciences produce knowledge.

Paola Spinozzi / Brian Hurwitz (eds.)  
**Discourses and Narrations in the Biosciences**

Discourses and Narrations  
in the Biosciences

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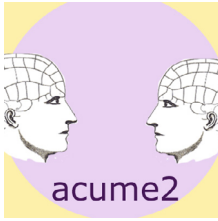
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# **Discourses and Narrations in the Biosciences**

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Socrates

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

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**D**ONNA 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, così tre

termina.

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### Cover Image

‘Scienza’, in Cesare Ripa, *Iconologia, ovvero 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:

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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:



## Representing and Narrativizing Science

### I. Science and Representation

The sciences and the humanities have been differentiated on the basis of distinct modes of researching, acquiring, and representing knowledge. The assumption that literature, and not only science, is a cognitive system which can lead to knowledge, and that science, and not only literature, is a system of representation that offers an account of the world, invites a reappraisal of their demarcations. Science has long offered a vocabulary for literature to appropriate and, in turn, language has provided a loom for scientists to experiment with going beyond a mere referential use.<sup>1</sup> In the twentieth century, forms of knowledge and representation defined as scientific *or* humanistic have been delineated and narrativity claimed as constitutive of both creative and scientific writing.<sup>2</sup> The

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1 See Frederick Bodmer, *The Loom of Language*, ed. by Lancelot Hogben (London: Allen and Unwin, 1943); Norman A. Jeffares, *Language, Literature, and Science. An Inaugural Lecture* (Leeds: Leeds University Press, 1959); *Languages of Nature: Critical Essays on Science and Literature*, ed. by Ludmilla J. Jordanova, Foreword by Raymond Williams (New Brunswick: Rutgers University Press, 1986), in particular Maureen McNeil, 'The Scientific Muse: The Poetry of Erasmus Darwin', pp. 159–203, and Gillian Beer, "'The Face of Nature": Anthropomorphic Elements in the Language of *The Origin of Species*', pp. 207–243; Ronald Schleifer, 'Analogy and Example. Heisenberg, Linguistic Negation, and the Language of Quantum Physics', in Id., *Modernism and Time: The Logic of Abundance in Literature, Science, and Culture, 1880–1930* (Cambridge: Cambridge University Press, 2000), pp. 184–207; Carson Bergstrom, *The Rise of New Science. Epistemological, Linguistic, and Ethical Ideals and the Lyric Genre in the Eighteenth Century* (Lewiston – Lampeter: Edwin Mellen Press, 2002); John Gordon, *Physiology and the Literary Imagination* (Florida: University Press of Florida, 2003); Christine Ferguson, *Language, Science and Popular Fiction in the Victorian Fin-de-Siècle: The Brutal Tongue* (Aldershot: Ashgate, 2006).

2 James J. Bono, 'Contemporary Cosmology and Narrative Theory', in *Literature and Science: Theory and Practice*, ed. by Stuart Peterfreund (Boston: Northeastern University Press, 1990), pp. 91–112; Robert F. Storey, 'What Is Art for? Narrative and the Ludic Reader', in Id., *Mimesis and the Human Animal: On the Biogenetic Foundations of Literary Representation* (Evanston: Northwestern University Press, 1996), pp. 101–131; David Herman, 'Narrative, Science, and Narrative Science', *Narrative Inquiry*, 8, 2 (1998), 279–290; Fritz Kubli, 'Can the

notion that scientific knowledge is narratively represented supports the contention that the writing of science entails techniques of fictionalization.<sup>3</sup> One could attempt an identification and classification of narrative forms – hypothetically from ‘scientific scientific’ to ‘creative scientific’ – and an investigation of why and how science is transformed into narrative. Such a classification could help us to understand how science elicits different modes of reception and interpretation.

Narrative renditions of science, claims Ben Agger, should be viewed in the context of a postmodern framework:

In ‘narrativizing’ science, translating it back into argument made forcefully by an author with views and values, not to mention embodiment, postmodern theorists actually democratize science, opening it to dialogue and debate.<sup>4</sup>

Haunted by a sense of belatedness, bewildered by an all-encompassing relativism, postmodernism may be thought to hold out a ‘frame-within-the-frame’ perspective on science, but self-reflexivity is both too narrow and too vague to shed light on the narrativization of science. To narrativize, applied to scientific theories and practices, does not entail envisioning researchers wrapped up in a vertiginous succession of self-fashionings and -mirrorings. On the contrary, despite claims to self-enclosure, the sciences are exposed systems: how they represent themselves or are represented reflects their inter-connectedness with the world.

In using verbal language to articulate working hypotheses, illustrate methods, describe stages of research, and show results, scientific writers do not only praise neutral, objective language, but also respond to the lure of literariness. Their pursuit of clarity and use of stylistic devices erases the sharp separation between scientific and literary language, denotative and connotative functions, form and content, and invites an assessment of the rhetorical components of scientific discourse.<sup>5</sup> Assessing scientific representation presupposes studying what

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Theory of Narratives Help Science Teachers Be Better Storytellers?, in *Science Education and Culture: The Contribution of History and Philosophy of Science*, ed. by Fabio Bevilacqua, Enrico Giannetto, and Michael R. Matthews (Dordrecht – Boston: Kluwer Academic Publishers, 2001), pp. 179 – 184.

3 *Fictions in Science. Philosophical Essays on Modeling and Idealization*, ed. by Mauricio Suárez (New York – London: Routledge, 2008).

4 Ben Agger, ‘Sociological Selves Write Science Fiction’, in Id., *Postponing the Postmodern: Sociological Practices, Selves, and Theories* (Lanham: Rowman and Littlefield Publishers, 2002), p. 8.

5 See Lawrence J. Prelli, *A Rhetoric of Science: Inventing Scientific Discourse* (Columbia, SC: University of South Carolina Press, 1989); Alan G. Gross, *The Rhetoric of Science* (Cambridge, MA: Harvard University Press, 1990); Marcello Pera, *Scienza e retorica* (Roma: Laterza, 1991), English translation: *The Discourses of Science* (Chicago: University of Chicago Press, 1994); *Persuading Science: The Art of Scientific Rhetoric*, ed. by Marcello Pera and William R. Shea

meaning scientists associate with ‘representation’<sup>6</sup> and how modes of writing science with an awareness of literary and stylistic strategies relate to modes of writing literature with a focus on scientific content.

Charles Darwin was deeply aware of the potentialities of metaphor in scientific explanation. Responding to objections about his presentation of nature as an anthropomorphic entity, he claimed that metaphor was needed to facilitate the comprehension of a scientific concept:

It has been said that I speak of natural selection as an active power or Deity; but who objects to an author speaking of the attraction of gravity as ruling the movements of the planets? Everyone knows what is meant and implied by such metaphorical expressions; and they are almost necessary for brevity. So again it is difficult to avoid personifying the word Nature; but I mean by Nature, only the aggregate action and product of many natural laws, and by laws the sequence of events as ascertained by us. With a little familiarity such superficial objections will be forgotten.<sup>7</sup>

Andrea Battistini has observed that the search for connections between apparently unrelated objects is the primary aim of scientific law and metaphor:

[...] The scientist’s innovative process arises from the novelty of relationships never seen before; without stretching the point too much, scientific law could be equated to

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(Canton: Science History Publications, USA, 1991); Walter R. Fisher, ‘Narrative Rationality and the Logic of Scientific Discourse’, *Argumentation*, 8 (1994), 21–32; Charles Alan Taylor, *Defining Science: A Rhetoric of Demarcation* (Madison: University of Wisconsin Press, 1996), in particular ‘The Rhetorical Construction of Science and Creation Science’, pp. 135–174; *Landmark Essays on the Rhetoric of Science: Case Studies*, ed. by Randy Allen Harris (New Jersey: Robert Erlbaum Associates, 1997); *Reading Science. Critical and Functional Perspectives on Discourses of Science*, ed. by J. R. Martin and Robert Veil (London: Routledge, 1998); Scott L. Montgomery, *Science in Translation: Movements of Knowledge through Cultures and Time* (Chicago: University of Chicago Press, 2000); *Science Communication in Theory and Practice*, ed. by Sue Stocklmayer, Michael M. Gore, and Chris Bryant (Dordrecht – Boston: Kluwer Academic Publishers, 2001); Heather Brodie Graves, *Rhetoric in(to) Science. Style as Invention in Inquiry* (Cresskill, N.J.: Hampton Press, 2005); Michael J. Zerbe, *Composition and the Rhetoric of Science: Engaging the Dominant Discourse* (Carbondale: Southern Illinois University Press, 2007); David J. Tietge, *Rational Rhetoric: The Role of Science in Popular Discourse* (West Lafayette, Ind.: Parlor Press, 2008).

6 See *Philosophy of Science*, 71, 5 (December 2004), Proceedings of the 2002 Biennial Meeting of the Philosophy of Science Association, Part II: Symposia Papers, in particular Ronald N. Giere, ‘How Models Are Used to Represent Reality’, 742–752; Mauricio Suárez, ‘An Inferential Conception of Scientific Representation’, 767–779; Andrea I. Woody, ‘More Telltale Signs: What Attention to Representation Reveals about Scientific Explanation’, 780–793; Bas C. van Fraassen, ‘Science as Representation: Flouting the Criteria’, 794–804. See also Gabriele Contessa, ‘Scientific Representation, Interpretation, and Surrogate Reasoning’, *Philosophy of Science*, 74, 1 (January 2007), 48–68, and Bas C. van Fraassen, *Scientific Representation: Paradoxes of Perspective* (Oxford: Oxford University Press, 2008).

7 Charles Darwin, ‘Chapter IV. Natural Selection; or the Survival of the Fittest’, in Id., *On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life* (London: John Murray, 1866, 4th edn), p. 92.

metaphor, which for Aristotle (*Rhetoric*, III, 11) and for Baroque poets consists in connecting things which are far from each other. Therefore, science, too, makes use of imagination and proceeds according to its own aesthetics.<sup>8</sup>

The utilization of tropes in science writing draws attention to the coexistence of epistemological and aesthetic aspects. Ilse N. Bulhof stresses that scientific language must be also rhetorical-literary, as the reporting of facts and the transfer of information requires persuasive strategies and even poetic abilities. The presence of literary elements in innovative scientific texts bears evidence to researchers' awareness that 'reality is not once and for all "what it is" in a univocal manner, but is multivocal like a literary text, coming to be in interactions with its readers'.<sup>9</sup> The literary quality of scientific writing is the starting point from which Bulhof develops a hermeneutical ontology. Questioning what may sound restrictive in the notion that science is the product of social construction, she proposes to study how the ontological specificities which pertain to different modes of understanding the world are expressed through the creative power of language.

Figures of speech are used in scientific discourse to enhance verbal translatability of abstract concepts. By going beyond the referential use of language, tropes move meaning from a literal to a non-literal plane. However, while they make scientific theories representable verbally, and in writing, they also add semantic facets, engendering multiple processes of signification.

Scientific and literary concepts travel between scientific and literary representation. Scientificity and literariness intermingle when a scientific text seeks to achieve aesthetic qualities and a literary text tackles a scientific topic. Creative writers who choose to discuss scientific theories in their fictional works and scientists who display an awareness of rhetorical strategies will be inclined to think and talk about their own hermeneutic tools and modes of representation. The double focus on knowledge as an object of representation and on the representability of knowledge recognizes that science writing is inherently epistemological and meta-discursive.

Language allows knowledge to be represented, but different forms of knowledge are represented by different linguistic codes. The extensive use of the verbal medium and the elaboration of specific verbal modes of scientific representation call for further investigation.

8 Andrea Battistini, 'Introduzione' to *Letteratura e scienza*, ed. by Id. (Bologna: Zanichelli, 1977), pp. 1–13 (p. 2), my translation.

9 Ilse N. Bulhof, 'Chapter I. Purpose of This Study', in Id., *The Language of Science: A Study of the Relationship between Literature and Science in the Perspective of a Hermeneutical Ontology, with a Case Study of Darwin's The Origin of Species* (Leiden: Brill, 1992), pp. 3, 8.

Thirty years ago Hayden White put forward a persuasive claim for the value of narrativity in the representation of reality.<sup>10</sup> It is time to assess the significance of narrativization in forms of knowledge and representation which are designated science. Instead of attempting to classify narrative models, a deeper insight into scientific discourses could be gained by examining the narrative and fictional modes adopted by scientists and creative writers to articulate epistemological and meta-discursive issues.

## II. A Theory of Science Narrativization

Language represents and construes knowledge, describes, supplements, translates, and expands on it. The languages of sciences are notoriously technical and arcane. Because of their degree of specialization, they may appear to function as closed systems of communication. Framed discourses also abound among humanities scholars, who may pride themselves in having developed a fine and highly ductile style, a claim rooted in the long-standing assumption that the gift of eloquence has been bestowed primarily upon the *studia humaniora*. The differentiation between restricted and open linguistic latticeworks invites a closer inspection of scientific and humanistic citizenships and the supposedly exclusive benefits associated with one or the other. What needs to be investigated is the assumption that the humanities possess the best critical equipment for talking *about themselves*. Historically, the sciences have not aroused attention for their inclination to display a self-reflexive attitude; yet it is a significant one which requires systematic investigation, judging by the rhetorical abilities scientists show when they choose themselves as objects of investigation, when they talk about science as a system of representation.<sup>11</sup>

The assumption that narrative elements are necessary to the creation of scientific discourse constitutes the foundation of a theory of scientific narrativity. When the sciences represent knowledge in the shape of theories, discoveries, and data, they are – like every other form of representation – subject to narrativization.

The notion of explanation and the form that it takes stands out as a paramount example of the theoretical challenge faced by scientists as well as by

10 Hayden White, 'The Value of Narrativity in the Representation of Reality', *Critical Enquiry, On Narrative*, 7, 1 (Autumn 1980), 5–27, republished in Id., *The Content of the Form: Narrative Discourse and Historical Representation* (Baltimore and London: The Johns Hopkins University Press, 1987), pp. 1–25.

11 Peter B. Medawar, 'Is the Scientific Paper a Fraud?', *Listener*, 70, 12 September 1963, pp. 377–378, republished in Id., *The Strange Case of the Spotted Mice and Other Classic Essays on Science* (Oxford: Oxford University Press, 1996), pp. 196–202.

historians in the twentieth century. The deductive-nomological model introduced by Karl Popper in *Logik der Forschung* (1934; *The Logic of Scientific Discovery*, 1959) was strongly supported by Carl G. Hempel in 'The Function of General Laws in History' (1942)<sup>12</sup> and further elaborated by Richard B. Braithwaite in *Scientific Explanation* (1953), Patrick L. Gardiner in *The Nature of Historical Explanation* (1959), and Ernest Nagel in *The Structure of Science: Problems in the Logic of Scientific Explanation* (1961). Among the advocates of the nomological-deductive assumptions and the proponents of alternative models of scientific explanation, Hempel remains in the foreground also by virtue of a further elaboration of his theory. In 'Explanation in Science and History' (1962) he extended the applicability of his model to disciplines which infer laws by following different procedures:

[...] the nature of understanding, in the sense in which explanation is meant to give us an understanding of the empirical phenomena, is basically the same in all areas of scientific inquiry; and [...] the deductive and the probabilistic model of nomological explanations accommodate vastly more than just the explanatory arguments of, say, classical mechanics: in particular, they accord well also with the character of explanations that deal with the influence of rational deliberation, of conscious and subconscious motives, and of ideas and ideals on the shaping of historical events. In so doing, our schemata exhibit, I think, one important aspect of the methodological unity of all empirical science.<sup>13</sup>

His view of science as thriving on the study of the physical causes of events and of history as focusing on the beliefs and visions underlying them has aroused diverse responses. Here it is important to highlight that for Hempel the modes of articulating an explanation are key to understanding the *modus operandi* of both science and history.

The nexus between explanation and narration can be elucidated by comparing their respective functions. An explanation presents a logical exposition of concepts or facts, a narration recounts them. Clearly information and elucidation are essential to what is explained, but are also relevant to what is narrated:

12 Carl G. Hempel, 'The Function of General Laws in History', *Journal of Philosophy*, 39 (1942), 35–48; Carl G. Hempel and Paul Oppenheim, 'Studies in the Logic of Explanation', *Philosophy of Science*, 15 (1948), 135–175.

13 Hempel, 'Explanation in Science and History', in *Frontiers of Science and Philosophy*, edited by Robert G. Colodny (Pittsburgh: The University of Pittsburgh Press, 1962), pp. 7–33 (p. 31). See also Hempel, 'Aspects of Scientific Explanation', in Id., *Aspects of Scientific Explanation and Other Essays in the Philosophy of Science* (New York: Free Press, 1965), pp. 331–496; W. W. Bartley III, 'Achilles, the Tortoise, and Explanation in Science and History', *The British Journal for the Philosophy of Science*, 13, 49 (May, 1962), 15–33; John Passmore, 'Explanation in Everyday Life, in Science, and in History', *History and Theory*, 2, 2 (1962), 105–123.

intelligibility is a shared aim. J. David Velleman suggests that narrative may be described as a genre of explanation:

When the police invite a suspect to 'tell his story', they are asking him to explain the blood on his shirt or his absence from home on the night of the murder; and whether he is judged to have a 'good story' will depend on its adequacy as an explanation. Can we account for the explanatory force of narrative with the models of explanation available in the philosophy of science? Or does narrative convey a different kind of understanding, which requires a different model and perhaps even a term other than 'explanation'?

This question arises for various disciplines in which narrative comes into play. For historians, it is the question of whether narrating historical events conveys understanding over and above that conveyed by subsuming the same events under the generalizations of economics, political science, or sociology. For clinical psychologists, it is the question of whether fitting symptomatic behaviors into a life-story adds to the understanding gained by fitting them into diagnostic categories.<sup>14</sup>

A form of verbal communication based on the dual act of recounting and clarifying can thus be plausibly classified as narrative explanation. The identification of a new discursive mode evidences the need to devise novel typologies which fuse genres previously kept separate. Science writing requires a definition which encompasses standards of accuracy, precision, linguistic inventiveness, and formal elegance. It is worthy of notice that scientific narrativity is the expression employed by the historian Michel de Certeau to define a form of writing characterised by functional and fictional components. In an essay published in 1991 he develops a sophisticated classification of travelogues and explains:

As scientific narrativity, [travel literature] refers to modes in which an account 'represents' technical operations (observations, controls, rules, procedures) and their results. At once a staging (fiction, in the English sense of the term) and an ordering (discourse), travel narratives offer to analysis various combinations between the practices of scientific investigation [...] and their figurations in a literary space-time. In order precisely to establish the status of this scientific writing, I will particularly investigate: a) the narrative description of the series of operations that characterize a study (in comparing these accounts with other 'histories' of scholarly, medical, chemical discoveries, and so on); b) the imaginary, the beliefs and the ideologies that a rationality postulates, produces, or critiques; c) the relation of these representations of itineraries [...] to the systems of figuration of the period [...]. How, under the name of travel narratives, were these fictions, at once models and representations of scientific operations, produced?<sup>15</sup>

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14 J. David Velleman, 'Narrative Explanation', *The Philosophical Review*, 112, 1 (January 2003), 1–25 (p. 1).

15 Michel de Certeau, 'Travel Narratives of the French to Brazil: Sixteenth to Eighteenth Centuries', *Representations*, 33 (Winter 1991), Special Issue: The New World, 221–226 (p. 223).

After having situated the travelogue within a discursive net, de Certeau defines how its woven texture expands by attaching its threads to other threads. Because the act of reporting travel is an interactive work in progress that involves numerous itinerant stages and points of reference, it requires the contribution of manifold forms of knowledge. In the twentieth century it has become apparent that the collection, study, interpretation, and exposition of data are dynamic processes in which a rigorous separation of subjective from objective parameters, though often claimed rhetorically, cannot be maintained. The very idea of objectivity has been questioned. Definitions of knowledge based on accuracy, neutrality, and transparency have been revised to encompass imaginative and ingenious components. Investigations of diegetic techniques employed in historical texts have shaken the paradigms of reliability associated with the reporting of facts, producing waves which have uncovered new conceptual territories.

The views developed by Hayden White in the decades since the 1960s are founded on the idea that the reconstruction of past events requires the construction of a rhetorical apparatus. By declaring that the enunciation of historical facts involves a creative process, he has questioned the objectivity of knowledge acquired through access to primary historical sources and has deconstructed assumptions about the impartiality of historiography by focusing on the 'gap-filling' process historians must perform when the primary sources are fragmentary or inconsistent. The writing of history poses complex epistemological problems as it raises questions about the nature and limits of man's comprehension of the past and draws attention to the historian's interpretative process and point of view.

While exploring the narrative structures underlying the rendition of historical events, White has raised more than a few eyebrows in his respondents. In 'Interpretation in History' (1973) he points out how 'readability' of the past depends on the hermeneutical method of the historian and is affected by the varying reliability of the sources:

On the one hand, there are always more facts in the record than the historian can possibly include in his narrative representation of a given segment of the historical process. And so the historian must "interpret" his data by excluding certain facts from his account as irrelevant to his narrative purpose. On the other hand, [...] the historian must inevitably include in his narrative an account of some event or complex of events for which the facts that would permit a plausible explanation of its occurrence are lacking. And this means that the historian must 'interpret' his materials by filling in the gaps in his information on inferential or speculative grounds.<sup>16</sup>

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16 Hayden White, 'Interpretation in History', in *New Literary History*, 4, 2 (Winter 1973), On Interpretation: II, 281–314, republished in Id., *Tropics of Discourse. Essays in Cultural*



Historical texts offer varied and even divergent versions of events which result from different modes of reporting evidence, advancing hypotheses, proposing interpretations, and expressing ideological stances.

White draws attention to the plot-structures or archetypal stories identified by Northrop Frye in 'New Directions from Old' in 1963.<sup>17</sup> Frye's narrative models are redefined as modes of emplotment and associated with specific modes of explanation. The plot of *romance* entails an idiographic process which charges events with symbolic values. Great deeds are emblematic; reread by posterity as special or representative moments in history, they become archetypes. The ideological matrix of romance is anarchic: a description of events set outside a definite temporal context and underlying universal principles is offered as an alternative to the status quo. *Comedy* unfolds through a series of events leading towards a solution and is correlated to organicist modes of explanation. It involves a conservative view of human institutions, as it presupposes that controversies can be settled without resorting to radical changes. *Tragedy* presupposes a mechanist principle; events are ruled by laws of causality and the past is envisioned as a play where man is a *dramatis persona* in the theatre of history. The corresponding ideological matrix is radical thought, which thrives on the idea that society can be healed through palingenetic events. *Satire* genealogically derives from *satira*, or medley, in which the coexistence of diverse components generates an elusive effect. Writers in the mode of satire utilize a contextualist explanatory strategy which focuses on a complicated, heterogeneous setting.

In 'Analysing the Discourse of History' (1990) Stephen Bann points out that White has introduced 'Northrop Frye's notion of "emplotment" to explain, not the "self-contained" character of the historical work, but its relation to a limited number of archetypal "plots", such as tragedy and comedy'.<sup>18</sup> Bann also notices that White identifies four rhetorical effects in order to strengthen his hypothesis about the rhetorical patterning on which historical texts are built.<sup>19</sup> Metaphor can be found extensively in romance, metonymy in tragedy, synecdoche in comedy, and irony in satire.<sup>20</sup>

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*Criticism* (Baltimore and London: The Johns Hopkins University Press, 1978), p. 51. See also White, 'The Question of Narrative in Contemporary Historical Theory', *History and Theory*, 23, 1 (February 1984), 1 – 33, republished in Id., *The Content of the Form*, pp. 26 – 57, and Id., *Metahistory: The Historical Imagination in Nineteenth-Century Europe* (Baltimore and London: The Johns Hopkins University Press, 1973).

17 Northrop Frye, 'New Directions from Old', in Id., *Fables of Identity. Studies in Poetic Mythology* (Harcourt: Brace & World – New York: Burlingame, 1963), pp. 52 – 66.

18 Stephen Bann, 'Analysing the Discourse of History', in Id., *The Inventions of History. Essays on the Representations of the Past* (Manchester: Manchester University Press, 1990), pp. 33 – 63 (p. 42).

19 Ibid., p. 43.

20 White, 'Interpretation in History', pp. 73 – 74.

The contention that history, and not only literature, shows aspects of creative writing was deemed to blur the boundaries between different disciplines. The focus on modes of verbalisation was seen as betraying a lack of confidence in the accuracy and truthfulness of historiographical methods. For historians White's theories are invalidated by relativism, for literary theorists they are made vulnerable by formalism. Wanting to defend the rank of history as a discipline, authoritative representatives retaliated with sharp ripostes.<sup>21</sup> The debate evidences the resistance to deconstructing the long-lasting divide between the pursuit of objectivity attributed to historians and the élan towards subjectivity shown by literary authors. Nonetheless, the separation has been undermined, and nowadays history is studied as a rhetorical discourse and historical writing is examined as a genre.

Transdisciplinary migration of emplotment as an organising principle and of narrative as a genre of explanation demonstrates that a critical method belonging to literary or philosophical theory can be extended well beyond its original field of pertinence. Not only fictional and historical texts, but also verbal representations of scientific concepts or theories can be seen as emplotted. The study of narrative elements in non-narrative writing, developed mainly with regard to history, and of narration as a form of explanation can be productively directed to scientific texts and to creative texts tackling science. Focusing on narrativization of science proves helpful in understanding the origin of new epistemic representations generated by cross-fertilizations in the discourses of the sciences and the humanities.

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21 F. R. Ankersmit, 'Hayden White's Appeal to the Historians', *History and Theory*, 37, 2 (May, 1998), 182–193 (p. 185): 'Since the publication of White's *Metahistory*, historians – from Gertrude Himmelfarb at one end to Carlo Ginzburg at the opposite end of the spectrum of historical writing – have fulminated against White and condemned his views as a dangerous and irresponsible caricature of what historical writing actually is. [...] In 1995 Arthur Marwick [...] wrote an essay in the *Journal of Contemporary History* which certainly marked an absolute low in the perennial battle of the historical discipline against the scourge of theory'. See also Arthur Marwick, 'Two Approaches to Historical Study: The Metaphysical (including 'Postmodernism') and the Historical', *Journal of Contemporary History*, 30 (1995), 1–35; Hayden White, 'Response to Arthur Marwick', *Journal of Contemporary History*, 30 (1995), 233–245; Wulf Kansteiner, 'Hayden White's Critique of the Writing of History', *History and Theory*, 32, 3 (October 1993), 273–295; Richard T. Vann, 'The Reception of Hayden White', *History and Theory*, 37, 2 (May, 1998), 143–161.

### III. Narratives of Science and Popular Science

Forms of scientific representation vary according to the intended audience. The writings of science and on science by scientists and creative writers invite an assessment of language as the medium adequate to such representation. The circulation of scientific theories and practices is based on oral, written, and e-interactive communication. Although scientific language tends to specialization, it can also pursue accessibility. The transposition of scientific data into intelligible, widely accessible notions entails acts of translation from specialized to non-specialized knowledge. Popularization of science conventionally defines prose writing in which scientific knowledge is made available to non-specialist readers. Popular science often adopts techniques of fictionalization, while literature that talks about science incorporates scientific concepts into the fictional context.

A prototypical text that presents scientific topics in a literary form is Kepler's *Somnium* (1634), the first tale of a scientific journey to the Moon, followed by Francis Godwin's *The Man in the Moone: or a Discourse of a Voyage thither by Domingo Gonsales* (1638), a detailed account of a utopian lunar journey. Both fictional descriptions draw upon contemporary astronomical treatises about the same subject, namely *Astronomia Nova* (1609), where Kepler includes references to terrestrial attraction and to the varying force of gravity depending on mass, and *Sidereus Nuncius* (1609), where Galileus offers a description of the lunar ground. In the description of the interplanetary journey the category of the wonderful is interwoven with meditations on pseudo-scientific hypotheses and the discoveries of the new science. Scientific discoveries were tackled in hybrid texts not easily classifiable either as critical or creative writing. *Ignatius His Conclave* (1611) by John Donne is a treatise hinting at the possibility of other inhabited worlds, but shows a sceptical attitude towards the new science. The *Anatomy of Melancholy* by Robert Burton (1621) has a section devoted to the exposition of contemporary scientific knowledge. Newton's *Principia* (1687) finally detaches from conjectures and marks the beginning of modern lunar theories. Early modern literature shows that creative writers have constantly responded to science of the future: the lunar journey could be envisioned because in the seventeenth century the moon was being observed thanks to technological advancements in the field of optics.

Science began to reside conspicuously in literature in the nineteenth century, when the principle of evolution by selection was forged into a system of belief able to encompass previous theories of origin, development, and progress, apparently without the requirement of a Prime Mover. The impact of evolutionary theories on society, culture, and literature has been studied promptly after the publication of Darwin's works. While the reception of evolutionary laws has

been extensively explored in realistic novels, mutations of mankind and its environment caused by the evolutionary process have been conjectured about in literary utopias and science fiction.

Evolutionism, positivism, and religion were constantly addressed by Victorian writers.<sup>22</sup> Social Darwinism, according to which peace was an illusion of the weak and survival was only for morally and physically superior beings, challenged natural law theories and humanitarian ideals, and influenced the Marxist concept of class struggle. It also fuelled the national-popular idea of an eternal antagonism among populations and nourished the newly emerging ideology of the conflict among the races. Samuel Butler's views about evolution are expressed in numerous critical and creative writings. In the novel *Erewhon; or Over the Range* (1872) he provokingly maintains that all living species, even the most basic ones like plants or vegetables, know how to struggle to survive:

Even a potato in a dark cellar has a certain low cunning about him which serves him in excellent stead. He knows perfectly well what he wants and how to get it. He sees the light coming from the cellar window and sends his shoots crawling straight thereto: they will crawl along the floor and up the wall and out at the cellar window; if there be a little earth anywhere on the journey he will find it and use it for his own ends. [...] 'He that is stronger and better placed than I shall overcome me, and him that is weaker I will overcome'.<sup>23</sup>

By offering a hyperbolic example of the survival of the fittest, Butler highlights how the belief in the 'natural' supremacy of the strongest race fuelled imperialistic ideologies: it was Great Britain's predisposition to explore, lead, and rule that legitimated its world expansion.

Butler questions the notion that national identity results from nature and biological evolution. By identifying the basic equipment of an Australian aboriginal and the opulent paraphernalia of a Victorian bourgeois, he argues that the biological features of human beings are shaped by the geographical location and socio-cultural context in which they happen to live:

By the institutions and state of science under which a man is born it is determined whether he shall have the limbs of an Australian savage or those of a nineteenth-century

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22 See Lionel Stevenson, *Darwin among the Poets* (Chicago: The University of Chicago Press, 1932); Leo Justin Henkin, *Darwinism in the English Novel, 1860–1910. The Impact of Evolution on Victorian Fiction* (New York: Russell & Russell, 1940); Conway Zirkle, *Evolution, Marxian Biology, and the Social Scene* (Philadelphia: University of Pennsylvania Press, 1959); Gillian Beer, *Darwin's Plots: Evolutionary Narrative in Darwin, George Eliot, and Nineteenth-Century Fiction* (Cambridge: Cambridge University Press, 1983); George Lewis Levine, *Darwin and the Novelists: Patterns of Science in Victorian Fiction* (Cambridge, Mass. – London: Harvard University Press, 1988); Id., *Dying to Know: Scientific Epistemology and Narrative in Victorian England* (Chicago – London: University of Chicago Press, 2002).

23 Samuel Butler, *Erewhon; or Over the Range* (London: Trübner, 1872), p. 192.

Englishman. The former is supplemented with little save a rug and a javelin; the latter varies his physique with the changes of the season, with age, and with advancing or decreasing wealth. If it is wet he is furnished with an organ which is called an umbrella [...]. His watch is of more importance to him than a good deal of his hair [...]; besides this he carries a knife, and generally a pencil case. His memory goes in a pocket book.<sup>24</sup>

Like his father William Rathbone Greg, Percy Greg was actively involved in the Victorian debate on oligarchy, eugenics, and evolutionism. His long utopian novel *Across the Zodiac* (1880) anticipates H. G. Wells's *The War of the Worlds* (1898) in portraying Mars as a threatening planet. The debate on the scope of epistemological research on atheistic, anti-humanistic Mars is clearly related to the nineteenth-century dispute over scientific agnosticism aroused by T. H. Huxley. Greg's attempts to fit Nature into the utopian paradigm of order and transparency include the erection of a great observatory on an artificially extinct volcano, the eradication of epidemic diseases, and the practice of euthanasia. Greg gives vent to the growing late-Victorian ambivalence towards scientism and its epistemological creed: the scientific exploitation of natural resources enhances technological progress but does not secure a fuller understanding of the vital impulse. Although the progress of knowledge in the fields of logic, biology, and physics claims disengagement from religion or spirituality, the search for the innermost in human nature challenges a positivist, empiricist approach. Natural laws, inferences from facts, and logical deductions are overcome by hope in a fulfilling after-world. The author's utopian response to the Victorian bipolarity of science and religion is an attack on the belief that sensation is the only form of knowledge and a poignant revival of gnosticism.

In *Three Hundred Years Hence; or, A Voice from Posterity* (1881) William Delisle Hay recounts how during the universal emigration into the Cities of the Sea the water surface was divided into 60 States and the dry land became common property for rent. In 2180 the world map comprises submarine towns of white koralla within huge aerated domes on the Ocean bed, supermarine towns like Aquamarina or cities like Londinova, and hypogeic states with cities of metal buildings. Wild and useless animal life is extinct; Nature has been equalised and balanced by bioengineering. Basilico-magnetism and zodiacal electricity provide new forms of energy. Agriculturalists – the Bucolics – and scientists – the Zodiacists – are equally highly ranked.

By suppressing the structural elements of plot and characterisation, Hay develops his narrative like a treatise on sociology, politics, and anthropology: nineteenth-century arguments on Malthusianism and T. H. Huxley's ethno-

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24 Samuel Butler, *Lucubratio Ebria* [From the *Press*, 29 July, 1865], in *The Note-Books of Samuel Butler*, Selections arranged and edited by Henry Festing Jones (London: Jonathan Cape, 1926), p. 51.

logical theories are skilfully validated by statistics and turned into axioms on race development and means of living. Since it is the blood power of the white man which mainly determines the intermingling of nationalities, the selection of the species will lead to the predominance of the Xanthocroi, the fair white, over the Xanthomelanoi, that is the Yellow Race, the Melanochroi, the Melanoi, and the Ulotrichi, that is the Black. By envisioning ‘the steam-plough at work on English farms bordering the river Jordan’,<sup>25</sup> Hay connects Teuton-centrism with evolutionism: the Anglicisation of both South Europe and the East proceeds regardless of human relations, enhanced by technology, untroubled by religious beliefs.

Science fiction is a genre in which a fundamental thematic component, namely the pursuit of deeper insight into the life and death of human organisms, stems from the authors’ capacity to anticipate advancements or even breakthroughs in scientific knowledge. More significant than the degree of verisimilitude in the notions expressed by the novelists is their power of intuition and penchant for prediction. Sci-fi writers imagine novelties in the domains of science and technology without eluding rationality, because unrestrained imagination would land in the domain of pure fantasy.<sup>26</sup> Whatever occurs in the alternative world must be plausible: imaginative leaps originate from reality and do not lose connection with it, even when extraordinary changes are envisioned, as in H. G. Wells’s non-fiction work *Anticipations of the Reaction of Mechanical and Scientific Progress upon Human Life and Thought* (1902). His description of future developments in social interactions, economic assets, means of transport, and urban planning blends scientific data, statistics, and futuristic visions. The writer’s intuition, far from wandering freely, detached from the social and cultural context, picks up and thrives on heated scientific topics. Science fiction is simultaneously situated and far-sighted: while Wells in *The Island of Dr Moreau. A Possibility* (1896) explores opposite stances regarding organ transplantation, vivisection, and blood transfusion, Michael Marshall Smith in *Spare* (1996) and Kazuo Ishiguro in *Never Let Me Go* (2005) respond to the latest advancements in molecular biology and genetics by delving into the uncanny core of post-humanity.

Darwin created one of the great master narratives which replaced, or at least challenged, the master narrative of the Bible,<sup>27</sup> but is now, itself, questioned by a

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25 William Delisle Hay, *Three Hundred Years Hence; or, A Voice from Posterity* (London: Newman and Co., 1881), p. 116.

26 Darko Suvin, *Metamorphoses of Science Fiction: On the Poetics and History of a Literary Genre* (New Haven: Yale University Press, 1979), p. 63: ‘SF is distinguished by the narrative dominance or hegemony of a fictional “novum” (novelty, innovation) validated by cognitive logic’.

27 Roger Ebbatson, *The Evolutionary Self: Hardy, Forster, Lawrence* (Sussex: Harvester Press,

post-Darwinian frame of mind involving an oscillation between permanence and provisionality of paradigms. The multiple scientific perspectives which support contemporary narratives of evolution draw attention to intricate connections between epistemology and aesthetics.

The 1991 edition of Richard Dawkins's *The Blind Watchmaker* (1986) includes excerpts from numerous reviews in which content and form are seen as equally significant. Journalists and scholars from different disciplines highly praise his rhetorical ability:

Brilliant exposition, tightly argued but kept readable by plentiful recourse to analogies and examples [...]. *The Blind Watchmaker* shows what a convincing scientific argument looks like; it is popular science at its best.

*The Times*

An astonishingly lucid exposition of Darwinism [...] Dawkins is a born writer with an unmatched gift for the brilliant metaphor, the inspired syntactic switch, and the relevant zoological detail.

Francisco J. Ayala, Professor of Genetics,  
University of California<sup>28</sup>

In the 'Preface' Dawkins himself talks about the rhetorical components of scientific discourse, stressing his preference for direct persuasive strategies which stimulate strong emotional responses:

You can explain something so that your reader understands the words; and you can explain something so that the reader feels it in the marrow of the bones. To do the latter, it sometimes isn't enough to lay the evidence before the reader in a dispassionate way. You have to become an advocate and use the tricks of the advocate's trade. This book is not a dispassionate scientific treatise. Other books on Darwinism are, and many of them are excellent and informative and should be read in conjunction with this one. [...] in parts this book is written with a passion which, in a professional scientific journal, might excite comment. Certainly it seeks to inform, but it also seeks to persuade and even – one can specify aims without presumption – to inspire.<sup>29</sup>

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1982); Margot Norris, *Beasts of the Modern Imagination: Darwin, Nietzsche, Kafka, Ernst, and Lawrence* (Baltimore – London: Johns Hopkins University Press, 1985); James Krasner, *The Entangled Eye: Visual Perception and the Representation of Nature in Post-Darwinian Narrative* (New York – Oxford: Oxford University Press, 1992); Joseph Carroll, *Evolution and Literary Theory* (Columbia: University of Missouri Press, 1995); *Philosophy and the Darwinian Legacy* (Rochester: University of Rochester Press, 1996); *The Literary Animal: Evolution and the Nature of Narrative*, ed. by Jonathan Gottschall and David Sloan Wilson, Forewords by E. O. Wilson and Frederick Crews (Evanston: Northwestern University Press, 2005).

28 Richard Dawkins, *The Blind Watchmaker. Why the Evidence of Evolution Reveals a Universe Without Design* (London: Penguin Books, 1991, 1st edn 1986), p. iv.

29 Dawkins, 'Preface' to *The Blind Watchmaker*, p. xiv.

Not only does Dawkins update Darwinism by contending that ‘non-random reproduction, where there is a hereditary variation, has consequences that are far-reaching if there is time for them to be cumulative’,<sup>30</sup> but he also incessantly acts as a narrator and name-giver: he mentions tree-like shapes, evokes weeping willows, cedars of Lebanon, Lombardy poplars, and seaweeds,<sup>31</sup> coins the term ‘genetic hyperspace’,<sup>32</sup> defines a swimming mollusc, Nautilus, as a hi-fi system,<sup>33</sup> becomes lyrical when he announces that ‘It is raining DNA outside’ and promptly adds that ‘That is not a metaphor, it is the plain truth’,<sup>34</sup> minutely explains the conservation of the histone-H4 DNA by using the typist analogy,<sup>35</sup> discusses organic ‘primeval soup’ theories,<sup>36</sup> devotes a careful explanation to the ‘arms races’ analogy,<sup>37</sup> and talks of the individual body as ‘a survival machine’.<sup>38</sup>

His rhetorical strategies are made manifest in the virtual dialogue which involves Darwin, William Paley, and himself:

The watchmaker of my title is borrowed from a famous treatise by the eighteenth-century theologian William Paley. His *Natural Theology – or Evidences of the Existence and Attributes of the Deity Collected from the Appearances of Nature*, published in 1802, is the best-known exposition of the ‘Argument from Design’, always the most influential of the arguments for the existence of a God. [...] Paley drives his point home with beautiful and reverent descriptions of the dissected machinery of life, beginning with the human eye, a favourite example which Darwin was later to use throughout this book [...]. Paley compares the eye with a designed instrument such as a telescope, and concludes that ‘there is precisely the same proof that the eye was made for vision, as there is that telescope was made for assisting it’. The eye must have had a designer, just as the telescope had.<sup>39</sup>

Paley’s comparison between the eye and the telescope and the metaphor of the watchmaker are instrumental in historicizing Darwinism and supporting the scientific validity of the evolutionary model:

[Paley’s] hypothesis was that living watches were literally designed and built by a master watchmaker. Our modern hypothesis is that the job was done in gradual evolutionary stages by natural selection.<sup>40</sup>

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30 Ibid., p. xv.

31 Ibid., p. 59.

32 Ibid., p. 77.

33 Ibid., p. 85.

34 Ibid., p. 111.

35 Ibid., p. 123.

36 Ibid., ‘Chapter VI. Origins and Miracles’, pp. 139–166.

37 Ibid., ‘Chapter VII. Constructive Evolution’, pp. 169–193.

38 Ibid., p. 192.

39 Ibid., pp. 4–5.

40 Ibid., p. 37.



The ‘watchmaker’ that is cumulative natural selection is blind to the future and has no long-term goal.<sup>41</sup>

The opposition between creationism and evolutionism, on which Dawkins founds his ‘representation’ of evolution, is fictionalized by A. S. Byatt in ‘Morpho Eugenia’ (1992). Paley’s and Darwin’s views resonate in the dialogues between the Reverend Harald Alabaster and the atheist entomologist William Adamson. Byatt herself openly refers to Darwin’s reception of Paley:

‘Now, Darwin, in his passage on the *eye*, does seem, does he not, to allow the possibility of a Creator? He compares the perfecting of the eye to the perfecting of the telescope [...] and he goes on to remark that *if we compare the forces that form the eye to the human intellect “we must suppose that there is a power always intently watching each slight accidental alteration in the transparent layers.”* Mr Darwin invites us to suppose that this intently watching power is inconceivable – that the force employed is blind necessity, the law of *matter*. But I say that in the matter itself is contained a great *mystery* – how did it come to be at all – how does organisation take place – [...]? Darwin himself writes that his transparent layers form “a living optical instrument as superior to one of glass, as the works of the Creator are those of man.”’

‘So he does. And it is easier for us to imagine the patient attention of an infinite watcher than to comprehend blind chance.’<sup>42</sup>

Dawkins and Byatt narrativize Darwinism by emphasising the dichotomy between biology and theology, evolution and creationism; both create narratives of evolution.

‘Morpho Eugenia’ recounts the discovery of reproductive practices performed by social insects in the behaviour of an extended Victorian family, a beehive that does everything to protect the queen bee. Beneath the first narrative level, based on the relationships between genetic heredity and incest, entomology and sociology, the core of the novella is to be found in Byatt’s enquiry into scientific representation. Far from parodying or mocking Victorian discourses of science,<sup>43</sup> she reproduces the lofty rhetoric with which evolutionary or creationist views were defended in order to underpin ‘the post-structuralist tenet that cognition, and any literary artefact that is its product, is linguistically mediated’.<sup>44</sup> While highlighting the discursive practices of Victorian speakers in the antithesis between atheism and Christian faith, epistemology and theology, she suggests that scientific paradigms of origins cannot dissolve ontological concerns. How to apprehend reality, gain an insight into the categories of being, and grasp the ultimate aim of existence remain unsolved issues.

41 Ibid., p. 50.

42 Byatt, ‘Morpho Eugenia’, in Ead., *Angels & Insects. Two Novellas* (New York: Random House, 1992), pp. 35–36.

43 A. S. Byatt, ‘Ancestors’, in Ead., *On Histories and Stories* (London: Vintage, 2001), pp. 65–90.

44 Celia Wallhead, *The Old, the New and the Metaphor. A Critical Study of the Novels of A. S. Byatt* (Atlanta – London: Minerva, 1999), p. 38.

For Adamson the belief that the Creation does not have a Creator, that Nature is red in tooth and claw is supported by the knowledge he has acquired in the Amazon jungle. While its luxuriance arouses a sense of wonder, the voracity and deterioration shown by flora and fauna lead him to think that they have been generated by a mindless natural force. For Alabaster the seism caused by Darwin's theories has engendered an overpowering sense of impermanence:

"The world has changed so much, William, in my lifetime. I am old enough to have believed in our First Parents in Paradise, as a little boy, to have believed in Satan hidden in the snake, and in the Archangel with the flaming sword, closing the gates. I am old enough to have believed *without question* in the Divine Birth on a cold night [...]. All the music and painting, all the poetry and power is so much illusion. I shall moulder like a mushroom when my time comes, which is not long. It is likely that the injunction to love each other is no more than the prudent instinct of sociability, of parental protectiveness, in a creature related to a great ape. I used to love to see paintings of the Annunciation [...]. And now all that is as it were erased, and there is a black backcloth on an empty stage, and I see a chimpanzee, with puzzled eyes and a hanging brow and great ugly teeth, clutching its hairy offspring to its wrinkled breast [...].

[...] I end [my life] like a skeleton leaf, to be made humus, like a mouse crunched by an owl, like a beef-calf going to the slaughter [...]. And then, I think, no brute beasts could have such thoughts. No frog, no hound even, could have a vision of the Angel of the Annunciation. *Where does it all come from?*<sup>45</sup>

As a narrator, Byatt is intrigued by Darwinism because it is a narrative of human origins and destiny which has ungrounded the foundations of western thought. In *Ancestors* she examines how contemporary novelists, including herself, respond to evolutionism and quotes a passage from John Fowles's *The French Lieutenant's Woman* (1969), in which it is made clear that the deconstruction of the biblical tale and the challenge posed to the idea of transcendence are remarkable effects of Darwin's theories, but an even more important outcome is the questioning of human capacity for self-determination. Ethical values elevated to universal guiding principles have been shackled by determinism:

Darwinism, as its shrewder opponents realised, let open the floodgates to something more serious than the undermining of the Biblical account of the origins of man; its deepest implications lay in the direction of determinism and behaviorism, that is, towards philosophies that reduce morality to a hypocrisy and duty to a straw hut in a hurricane.<sup>46</sup>

Byatt's views about knowledge and representation are expressed in the feverish activity of Adamson, who studies the variety of species and their mutations in

45 Byatt, 'Morpho Eugenia', pp. 59 – 60.

46 John Fowles, *The French Lieutenant's Woman* (London: Cape, 1969), p. 119, and Byatt, 'Ancestors', pp. 76 – 77.

order to taxonomize them. Observation, interpretation, and classification support his quest for truth: 'He had sat alone under a roof woven of leaves in an earth-floored hut, and scribbled descriptions of everything'.<sup>47</sup> Adamson firmly believes he has truly known and is able to represent what he has known, but will discover that representation of knowledge is construction of knowledge, and, as such, exposed to deconstruction. What is known requires to be represented, but what is represented derives from *a* mode of representing *a* form of knowledge.

How to elaborate and express concepts is an overarching question in 'Morpho Eugenia': 'I am afraid,' said Miss Crompton carefully, 'that it is too didactic. That there is too much *message*. Did you find that there was too much message?'<sup>48</sup> Miss Crompton's question in 'Things Are Not What They Seem', the story within the story, synthesizes Byatt's enquiry into the referential and symbolic use of language. Name-giving always has a creative, mythopoietic value. Names validate knowledge; more than one name can be given, but each indicates something unique, which cannot be conveyed by any other name. What cannot be named vanishes; concepts and thoughts exist when words are found which represent them:

'I am the Recorder of this Garden [...]. A relation of mine, in another world, was one of the great Namegivers, one of the great historians of this garden. It was he, indeed, who named Elpenor and Vinula, and their names are like delightful poems, you know. I got into a poem myself – "Little Miss Muffet" my poem is entitled – but it is a garbled thing, associating me with spiders, it is true, but suggesting that I, the cousin of the author of *Theatrum Insectorum sive Animalium Minimorum* might be *afraid* of a spider, when I am in fact a recorder of their names and natures, and their good friend.'  
[...]

[...] Names, you know, are a way of weaving the world together, by relating the creatures to other creatures and a kind of *metamorphosis*, you might say, out of a *metaphor* which is a figure of speech for carrying one idea into another'.<sup>49</sup>

Miss Mouffet, the Recorder of the Garden, attends to the creation of a name and classification in relation to other names. Byatt's reference to *Theatrum Insectorum* (1589, published 1634) by Thomas Mouffet and *Systema Naturae* by Linnaeus (1753) evokes the sense of wonder engendered by discovery and creation:

'My question is: What is my name?'

And many names murmured together in his mind, names of fairies and goddesses, and monsters too, like the sound of waters in his ear. And he could not choose. So he was dumb.

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47 Byatt, 'Morpho Eugenia', p. 12.

48 Ibid., p. 141.

49 Ibid., pp. 131 – 132.

‘You must speak, Seth. You must name me.’

‘How can I name you, who have more names than all the creatures, when they have so many each, and Elpenor is Elephant, Hawk, Pig, Twilight Lover and Sphinx and he is only one tiny rosy moth? How can I name you, when you are hidden behind a veil, and you spin your hiding-place, and make your own light? What would any name I choose be, to you?’<sup>50</sup>

*Theatrum Insectorum* and *Systema Naturae* become part of the fictional world conjured up in the tale: have all known insects been correctly named and how are new species to be named? Metaphors are needed, because the act of naming the world consists in fabricating names that are both referential and creative. The name-giver is both a recorder and an inventor of words. The significance of tropes in the construction of a scientific discourse reverberates in conversations between a naturalist and a reverend with an interest in natural history. Darwinian and creationist theories are restaged and employed to address the philosophical issues of nominalism. Is there an arbitrary, conventional relationship between a word that labels and the labelled thing, or is there a natural connection between them? Do words suit the things they signify or do they ‘exceed’ them, superimposing meanings? *Things Are Not What They Seem* extensively addresses inter-textual and meta-textual components of discourse.

While the conversations between Adamson and Alabaster recreate the Victorian evolutionary debate, the story within the story unfolds Byatt’s response: humans are the decoders and creators of the world, and their quest for modes of representation is a search for models. Models and paradigms indicate that knowledge must be validated by representation. Knowledge entails representation and representation entails construal.

The prominence of science in contemporary historical fiction, particularly in neo-Victorian novels, has led critics to revise the canonical classification of literary genres: Sally Shuttleworth has introduced the term ‘natural history’ to define novels in which the epistemological issues debated in the Victorian age are the major topic,<sup>51</sup> while Daniel Candel Bormann has examined Neo-Victorian novels which address but do not revolve around scientific topics.<sup>52</sup>

A theory of writing in which the notion of genre is not restricted to literature but opens up to a trans-disciplinary perspective can tackle how the sciences are represented, enabling contemporary popular science to be assessed along with other literary forms. Rhetorical strategies, narrativity, fictionalization, and a

50 Ibid., p. 138–139.

51 Sally Shuttleworth, ‘Natural History: The Retro-Victorian Novel’, in *The Third Culture: Literature and Science*, ed. by Elinor S. Shaffer (Berlin: W. de Gruyter, 1998), pp. 253–268.

52 Daniel Candel Bormann, *The Articulation of Science in the Neo-Victorian Novel: A Poetics (and Two Case Studies)* (Bern – Oxford: Peter Lang, 2002).

meta-discursive attitude constitute and qualify creative as well as scientific writings.

How to make science work like a play is a major aim of the archaeologist Steven J. Mithen in *The Prehistory of the Mind: A Search for the Origins of Art, Religion, and Science* (1996). In the first two chapters, 'Why Ask an Archaeologist about the Human Mind?' and 'The Drama of Our Past', he develops an elaborate meta-fictional discourse in which he explains that the study of cognitive development conducted by an archaeologist can be better comprehended by accepting a metaphorical premise. The evolution of the human mind can be compared to an extraordinarily long and complex dramatic piece played by diverse actors who have constantly succeeded each other on an ever-changing stage:

Six million years is a vast span of time. In order to begin to comprehend it, to grasp its salient pattern of events, it helps to think of those events as constituting a play, the drama of our past. A very special play, for no one wrote the script: 6 million years of improvisation. Our ancestors are the actors, their tools are the props and the incessant changes of environment through which they lived the changes of scenery. But as a play do not think of it as a 'whodunit', in which action and ending are all. For we already know the ending – we are living it. The Neanderthals and the other Stone Age actors all died out leaving just one single survivor, *Homo sapiens sapiens*.

Think of our past not as a novel by Agatha Christie or Jeffrey Archer but as a Shakespearean drama. Think of it as a story in which prior knowledge of the dénouement enriches enjoyment and understanding. For we need not worry about *what* is going to happen. Instead we can be concerned with *why* things happen – the mental state of the actors. We don't watch Macbeth to find out whether or not he will murder Duncan [...]. Similarly, in this book our interest is not so much with what our Stone Age ancestors did or did not do, as with what their actions tell us about their mentality.<sup>53</sup>

While arousing the interest of the readers through references to multiple settings and unpredictable twists and turns, Mithen enunciates his methodological principles. The metaphor of the play featuring our ancestors thus becomes a meta-discursive statement about the contents and the form of his book. Why, rather than how, primitive men developed physical and cognitive skills is the core of archaeological investigation. This specification signals that it would be misleading to draw similarities between Mithen's narrative and detective fiction. The events he recounts are certainly akin to drama, and because the timescale of evolution escapes human comprehension, the most effective way of encompassing 6 million years is by conjuring up a stage on which four acts are represented:

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53 Steven Mithen, 'Chapter 2. The Drama of Our Past', in Id., *The Prehistory of the Mind: A Search for the Origins of Art, Religion, and Science* (London: Phoenix, 1998, 1st edn 1996), pp. 14–15.

So look upon this short chapter as the play's programme notes. Different producers – the writers of archaeological textbooks – stress different versions even of the main events, which is why a few comments on the alternative versions have been added. I have divided the drama into four acts, and provide below a brief summary of the action, as well as 'biographical details' for the actors, and notes about the props and scene changes. These may be read either now or used as a source of reference later in the book. The changes of lighting I refer to reflect the variable quality and quantity of our knowledge about each of these acts of prehistory. And when I refer to 'he' or 'his', and 'she' or 'her' I am adopting these on an arbitrary basis simply to avoid the inelegant he/she and his/her. There is no implication that either of the sexes was necessarily more important than the other at any time in our past.<sup>54</sup>

The metaphor allows Mithen to clarify that the variations emerging from studies of cognitive evolution conducted by different archaeologists are similar to the modifications introduced by different producers of the same play. An explanatory chapter is thus necessary to clarify not only the author's aims and methods, but also the specific narrative form adopted to make them accessible to a wider audience. By merging seriousness and levity, exemplification and meta-discursivity, Mithen puts forward a form of writing which hosts scientificity and creativity. His dramatization of the past achieves its climax in the description of the four acts, in which emphasis is laid on stage effects:

ACT 1

6 – 4.5 million years ago

A long scene of little action.

To be watched virtually in total darkness.

ACT 2

4.5 – 1.8 million years ago

This has two scenes which together last just over 2.5 million years.

They should be lit only by a flickering candle.

ACT 3

1.8 million-100,000 years ago

Two scenes, which have an exciting start at around 1.8 – 1.5 million years ago, but which lapse into utter tedium. The lighting is still poor, although it improves slightly for the second scene.

ACT 4

100,000 years ago-present day

A much shorter act, into which are squeezed three scenes packed with more dramatic action than in all the rest of the play.<sup>55</sup>

<sup>54</sup> Ibid., *ivi*.

<sup>55</sup> Ibid., pp. 15 – 20.

Far from adopting the neutral, strictly referential language conventionally associated with scientific writing, Mithen assumes the role of a meticulous playwright who offers stage directions. His invitation to appreciate the chapters as if they were written for the theatre is meant to entice readers, but also shows that storytelling and staging are regarded as expressive and representational apparatuses to be employed by creative writers as well as by scientists.

In *The Seven Daughters of Eve* (2001) Bryan Sykes exhibits his meta-discursive attitude in the 'Prologue', where the scientific results obtained through the study of ancient DNA are presented as the outcome of epic deeds. While retracing the origins of the human species, geneticists follow adventurous paths marked by suspense and thrill. The first pages present a carefully developed rhetorical structure, beginning with a series of negations which clarify why genes do not deteriorate like other materials, followed by strong statements about why they are valuable and how their study can contribute to identify our ancestors. After having highlighted the vast scope of the enterprise recorded in the book, Sykes adopts the first-person narration to focus on his own role as a scientist, drawing upon the myth of the hero trained to face trials and hazards and eager to test his talents:

Our DNA does not fade like an ancient parchment; it does not rust in the ground like the sword of a warrior long dead. It is not eroded by wind or rain, nor reduced to ruin by fire and earthquake. It is the traveller from an antique land who lives within us all.

This book is about the history of the world as revealed by genetics. It shows how the history of our species, *Homo sapiens*, is recorded in the genes that trace our ancestry back into the deep past, way beyond the reach of written records or stone inscriptions. These genes tell a story which begins over a hundred thousand years ago and whose latest chapters are hidden within the cells of every one of us.

It is also my own story. As a practicing scientist, I am very lucky to have been around at the right time and able to take an active part in this wonderful journey into the past that modern genetics now permits. I have found DNA in skeletons thousands of years old and seen exactly the same genes in my own friends. And I have discovered that, to my astonishment, we are all connected through our mothers to only a handful of women living tens of thousands of years ago.

In the pages that follow, I will take you through the excitement and the frustrations of the front-line research that lies behind these discoveries. Here you will see what really happens in a genetics laboratory. Like any walk of life, science has its ups and downs, its heroes and its villains.<sup>56</sup>

Since a hero is measured by the strength of his enemies, in the chapter entitled 'We Are Not Amused' Sykes introduces formidable opponents in the shape of two renowned population geneticists, the Italian Luigi Luca Cavalli Sforza and the

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<sup>56</sup> Bryan Sykes, 'Prologue' to Id., *The Seven Daughters of Eve* (London – New York: Bantam Press, 2001), pp. 15 – 16.

German-born British Walter Bodmer. The more radiant and commanding the stature of the senior scientists, the more praiseworthy the victory of the young Sykes, a veritable rising star who skilfully anticipates, fends off, and boldly responds to the potent blows struck by his adversaries in the public arena:

Professor Luigi Luca Cavalli-Sforza is a man whose eminence is matched only by his elegance. Erect of posture, even in his late seventies, his silver hair always immaculately groomed, he is equally at home in the busy conference rooms of the academic circuit by day and the exclusive restaurants that welcome the most distinguished delegates by night. His contributions and influence in the field cannot be over-estimated. [...] It was Luca who first formulated the theory which had come to dominate European prehistory over the preceding quarter-century. According to this theory [...].

[...] I decided to present our work at the Second European conference on Population History, held in Barcelona in November 1995. I knew very well that the main proponents of the 'wave of advance' theory would be there, so at least what I had to say would be noticed. I was given a twenty-minute slot. The conference room was vast, with four hundred delegates and room for many more. I was introduced by the convenor, Sir Walter Bodmer, Fellow of the Royal Society, a long-time associate of Luca Cavalli-Sforza and co-author with him of two influential textbooks on genetics. Walter is not known for his conciliatory remarks, but I did think 'And the next speaker is Bryan Sykes who is talking about mitochondria. I don't believe in mitochondria' was a less than gracious introduction. I began to lay out the basis for the revision of European prehistory.<sup>57</sup>

The results produced by Sykes's study of mitochondrial DNA have indeed enhanced our understanding of population dynamics in ancient and modern times. While appreciating the relevance of his methods, it is important to notice that population geneticists calibrate DNA evidence using data from other scientific fields, such as archaeology, anthropology, linguistics, and even fossil records. It is a comparative process showing that genetic data must be situated also in a trans-disciplinary context. Clearly not only genetics, but all the sciences are faced with the challenge of interrelatedness.

Creative writers intrigued by science fictionalize it and, while giving a literary shape to scientific ideas, draw attention to the medium of communication. They appropriate scientific concepts, representing them for their own purposes in a particular form and language. In literary representations of science, multiple forces work together dynamically: the fictional and narrative one, made manifest through the plot and the characters, and the explanatory and argumentative one, conveyed through the exposition of scientific methods and theories. Literature thriving on science consciously employs language both creatively and instrumentally in order to mould scientific knowledge according to the requisites of literary writing.

Scientists rely on language to formulate, fix, and convey assumptions, hy-

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57 Sykes, 'Chapter 11. We Are Not Amused', in *Ibid.*, p. 190.



potheses, and methods. Writing of science searches for aesthetically accomplished ways of expressing scientific concepts. Because scientific notions are mediated by language, they are constantly exposed to new forms of verbalization which disclose new meanings.

Translating in accessible or creative ways what has been defined in scientific terms proper entails actively taking part in the production of and response to scientific knowledge. Multiple forces work together dynamically: the exposition of scientific methods and theories through explanation and argumentation; narrativization and fictionalization through different modes of emplotment and reference to characters; self-reflexivity and meta-discourse, evidenced in a conscious use of language as a medium that transforms scientific knowledge in representation.

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