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

Paola Spinozzi / Brian Hurwitz (eds.)

Discourses and Narrations in the Biosciences

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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.

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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Interfacing Science, Literature, and the Humanities / ACUME 2

Volume 8

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Paola Spinozzi / Brian Hurwitz (eds.)

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With 2 figures

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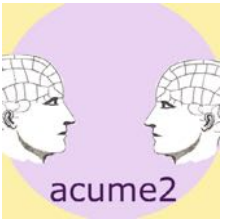

Socrates

This book has been published with the support of the Socrates Erasmus program for Thematic Network Projects through grant 227942-CP-1-2006-1-IT-ERASMUS-TN2006-2371/001-001 SO2-23RETH.

This project has been funded with support from the European Commission. This publication reflects the views only of the author and the Commission cannot be held responsible for any use which might be made of the information contained therein.

Questo volume è stato pubblicato con il contributo del programma Socrates Erasmus per i progetti di reti tematiche – 227942-CP-1-2006-1-IT-ERASMUS-TN2006-2371/001-001 SO2-23RETH.
Il progetto è stato finanziato con il contributo della Commissione europea.
La presente pubblicazione riflette le idee del solo autore e la Commissione europea non può ritenersi responsabile per l'uso che potrebbe essere fatto delle informazioni contenute al suo interno.

Bibliographic information published by the Deutsche Nationalbibliothek

The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available in the Internet at http://dnb.d-nb.de.

ISBN 978-3-89971-831-7

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.
Printing and binding: CPI Buch Bücher.de GmbH, Birkach

Printed in Germany

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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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Paola Spinozzi

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.[1] 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.[2] The

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.[3] 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.[4]

Haunted by a sense of belatedeness, 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.[5] 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'[6] 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.[7]

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

(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 Veel (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 Surrogative 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.[8]

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'.[9] 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.

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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.[10] 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.[11]

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)[12] 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.[13]

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.[14]

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?[15]

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.[16]

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.[17] 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 *satura*, 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'.[18] 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.[19] Metaphor can be found extensively in romance, metonymy in tragedy, synecdoche in comedy, and irony in satire.[20]

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.[21] 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.

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.[22] 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'.[23]

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

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.[24]

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-

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',[25] 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.[26] 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 *Spares* (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,[27] but is now, itself, questioned by a

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 [28]

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.[29]

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',[30] 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,[31] coins the term 'genetic hyperspace',[32] defines a swimming mollusc, Nautilus, as a hi-fi system,[33] 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',[34] minutely explains the conservation of the histone-H4 DNA by using the typist analogy,[35] discusses organic 'primeval soup' theories,[36] devotes a careful explanation to the 'arms races' analogy,[37] and talks of the individual body as 'a survival machine'.[38]

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.[39]

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.[40]

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.[41]

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.'[42]

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,[43] 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'.[44] 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.

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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?*'[45]

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.[46]

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'.[47] 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?'[48] 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'.[49]

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.

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?'[50]

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,[51] while Daniel Candel Bormann has examined Neo-Victorian novels which address but do not revolve around scientific topics.[52]

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.[53]

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:

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.[54]

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 metadiscursivity, 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.[55]

54 Ibid., ivi.
55 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.[56]

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

56 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.[57]

The results produced by Sykes's study of mithocondrial 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-

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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Andrea Battistini

The Antagonistic Affair between Literature and Science

Some liken the alternation between literature and science to moments of collaboration and separation which follow each other in the quadrille, when dancers proceed sometimes in lines and sometimes by intertwining their movements. This chapter will closely examine the steps of this dance.

I. Two Dominions Confronting Each Other

Although cases of effective assimilation remain far too rare in the relationship between the two cultures, it is almost always literature which tries to incorporate scientific discourse. Many scientists are acquainted with literary works, but it is unlikely they will use them professionally in their research, while the influence of science on literature is pervasive, reflecting the latter's openness to the most varied experiences and propensity to welcome Terence's saying: 'homo sum: humani nil a me alienum puto' ('I am a man, and reckon nothing alien to me'). This is why the relationship between the two cultures is generally seen (unfairly) as a one-way movement, from science to literature. This is particularly true of those writers with a fetishist worship of science in certain moments of the eighteenth century, or during Futurism; but it also true when poets reject science categorically, since even an apocalyptic condemnation (by Petrarch, Blake, Leopardi, to name a few instances) proves an interest – even if polemical or confrontational – in the rationale of the other's culture. In any case, the most fruitful attitude is neither worship nor execration, but a critically focused gaze, open to other intellectual territories and ready to re-elaborate.

Literature can infer from science its contents, language, and methods. When one thinks of Dante interpreting Aristotle as an astronomer or a naturalist, or of the eighteenth-century didactic poets rendering in verse Newton's optics or physics, one can appreciate how widely the original messages of the sciences were modified. In such passages a translation is effected, sometimes not consciously, which can take place even where terminology is transposed from sci-

entific to literary vocabulary without any modification. When the univocal terms of science enter the literary field, their meaning becomes filled with emotional nuances. Scientists have developed technical terms in order to concentrate a density of information in the most economical way; on the other hand, literary authors want to retain rich linguistic material to create experimental verbal effects and displacements.

Literature can electrify words with significance and create a *surplus* of meaning. In literature, messages live in echoes, suggestions, atmospheres, around words which can be visualised as dots or as semantic haloes of connotation, conferring on their objects a volumetric dimension in which even what is unsaid contributes to polyphony. When Giambattista Marino, the Baroque Italian poet, employs in his *Adone* (1623) scientific words such as 'atom', 'cartilages', 'telescope', or the lexicon of anatomy, he does so in order to enlarge his vocabulary to reach towards an encyclopaedic level, and to amaze his readers, who find in poetic writings words they would never have expected. As Primo Levi's and Italo Calvino's writings prove, syntactic acquisitions seem to be more pervasive, above all when the scientific attitude expresses a clear, linear narrative, in which trivialities and generalisations are shunned by a taxonomic and rationalistic approach.

The deepest and perhaps most vital contribution of science is on artists' vision of the world, on their capacities as observers and interpreters of phenomena, which extends to the organising of their work and to the final consequences in their methods and poetics. Even when science is not practised professionally, it modifies the way in which reality is perceived, it increases imaginative and interpretative capacities. *Quer pasticciaccio brutto de Via Merulana* (1946), where 'pasticcio' is probably best rendered as muddle or, more literally, cognitive tangle, does not have any scientific contents proper, but Carlo Emilio Gadda would not have been able to write it without his scientific competences; these enabled him to elaborate a chaotic, entropic conception of reality, similar to the uncontrollable trajectories of gas molecules.

One characteristic of writer scientists or 'double talents' who are sensitive to both the sciences and the humanities is a propensity to reflect on their interrelationships and develop a meta-discursive attitude. When cultural conditions live through critical moments, for example, due to accelerations in technological progress, the debate about the connections between the two cultures is extended to all intellectuals. Recently there have been two periods in which writings on literature and science have witnessed a steep rise: in England during the Victorian age and, more widely, after the publication of C. P. Snow's pamphlet on the 'two cultures'.

In the late nineteenth century the confrontation was contained within the limits of constructive dialogue. In 1881 Thomas Henry Huxley, the Darwinist,

made a reasonable proposal for an educational reform which would allow more space for science and technological knowledge, hitherto largely ignored by an educational system unbalanced in favour of *belles lettres* and a sterile and gratuitous aestheticism.[1] In 1883 Matthew Arnold, while recognising the formative value of scientific texts, endowed literature with a guiding role in a final synthesis that would gather together the data of all human knowledge to include aesthetic and emotional features of all disciplines. Only literature could reconcile the sectarian, apparently unrelated knowledge of science, with man's instinct for the good and the beautiful, and highlight those educational and ethical values that could overcome Victorian utilitarianism, determinism, and agnosticism.[2]

The controversy ignited by Snow became virulent in 1959, when F. R. Leavis replied. The terms of the debate are too well known to be detailed here. It is enough to remind younger generations of scholars that on the one hand there was a universal condemnation of humanists, accused of individualism, racism, obtuse and stubborn refusal to acknowledge the intellectual progenies of the Industrial Revolution, simplistic aversion to science and indifference to man's social ills.[3] On the other hand there was an animated defence of the rights of literature, whose office, according to Leavis, was being made all the more essential by a highly technological society.[4] Setting aside the gratuitous personal offences, there was some foundation to Leavis' remark about literature's criticism of science and of societies that make it a fetish. Far from being reactionary, the questioning attitude of literature reveals a concern for what reality is and what it should be. According to the Italian prose writer Claudio Magris

> one of the functions of literature consists in saying no, in defining oneself through negation, in not identifying oneself with the existing order but linking oneself closely to that which is not there yet, which does not exist. This does not entail despising the world, betraying its values, its colours, its smell, its particulars.[5]

So, the union between philosophy (or science) and literature may be compared, as Italo Svevo thought, to a 'legal marriage' where husband and wife are not on good terms but beget very beautiful children. If humanities scholars and com-

1 Thomas Henry Huxley, 'Science and Culture' [1880], in Id., *Science and Culture, and Other Essays* (London: Macmillan, 1882), pp. 1–23; 'Scienza e cultura', in Id., *Scritti pedagogici*, trans. by Giuseppina Di Laghi (Milan – Rome: D. Alighieri, 1904), pp. 79–90 (pp. 83–86).

2 Matthew Arnold, 'Literature and Science', in Id., *Discourses in America* (London: Macmillan, 1894), pp. 72–137.

3 Charles Percy Snow, *The Two Cultures: And a Second Look* (Cambridge: Cambridge University Press, 1959).

4 Frank Raymond Leavis, 'Two Cultures. The Significance of C. P. Snow', *Spectator*, 9 March 1962, pp. 297–303.

5 Claudio Magris, 'L'Europa vista da Trieste', *Lettera internazionale*, 9 (1992), p. 25, my translation.

mentators often express horror at the technological revolution, this is not because they are intrinsically averse to science, but because they want to caution that mere material advancement will lead to the deterioration of life quality, alienation, egoism, intellectual blindness, and the deadening of critical insight.

This debate fostered contributions that have helped to clarify the operative dynamics of science and literature. Amongst the most significant outcomes, there are differences emphasised by Aldous Huxley (Thomas Henry's grandchild) between the nomothetic aspects of science, orientated towards universal and univocal laws, and the idiographic dynamic of literature, which studies the most personal and intimate experiences in order to express life's turmoil, its contradictions, its ineffable aspects. Despite the different approaches, the two branches of knowledge for Huxley are reconciled, as much as for Husserl, in the *Lebenswelt* – the world of life – because both face the same human experiences.[6]

Giulio Preti's research sees in science and literature different scales of values that are virtually complementary. According to Preti, science is founded on morality, with its absolute principles which transcend history and empirical circumstances, its openness being verified by intelligence, in a dialectic process that coincides with liberty. Literature, conversely, is inspired by ethics founded on persuasion, on relativity, on common sense, and on a restricted validity.

Immersed in the Italian cultural tradition, the confrontation between science and literature poses once again the long debate between rhetoric, which focuses on verisimilitude and probability, and logic, which (like science) deals with what is real and has universal value.[7] This highlights a different operative dynamic: scientists must always attempt to (dis)confirm their interpretative hypotheses, following experimental methods which have a long lineage, extending to Aristotle and Ptolemy, Bacon and Galileo, whereas the literary scholar with the poetic text creates a monad that relies on itself. For this reason, a scholar in aesthetics, Galvano Della Volpe, distinguishes between science's 'hetero-verifiability' and literature's 'self-verifiability'.[8]

Having highlighted these differences in the two types of knowledge pertaining to science and literature, there remain differences also in the human resources acting within the two processes, but not so much as to make them as incompatible as they were in the Romantic Age. Thomas Kuhn, who became

6 Aldous Huxley, 'Literature and Science' [1963], in *Aldous Huxley. Complete Essays. Vol. 6: 1956–1963, and Supplement, 1920–1948*, ed., with Commentary, by Robert S. Baker and James Sexton (Lanham, MD: Ivan R. Dee, 2002), pp. 90–151; 'Letteratura e scienza', in Id., *Letteratura e scienza e altri saggi*, trans. by Corrado Pavolini (Milano: Il Saggiatore, 1965), pp. 104-110.

7 Giulio Preti, *Retorica e logica. Le due culture* (Turin: Einaudi, 1968).

8 Galvano Della Volpe, 'Discorso poetico e discorso scientifico', in Id., *Crisi dell'estetica romantica e altri saggi* (Rome: Samonà & Savelli, 1963, 1st edn 1956), pp. 127–135.

popular with his book *The Structure of Scientific Revolutions* (1962), rightly claimed that it is no longer possible to contrast science and literature by means 'of the classic dichotomies between, for example, the world of value and the world of fact, the subjective and the objective, or the intuitive and the inductive'.[9] If up to about half a century ago it could be proclaimed that science proceeds rationally and that literature advances by imagination, today nobody any longer believes in this Manichean vision. After the emergence of structuralism, in particular its psychological version of the Gestalt, a definite schism between two spheres of cognitive activity became no longer tenable. Using a scientific comparison, a process similar to that of electrolysis had occurred: in an electrolytic solution positive ions migrate to the negative electrode and vice versa; in the same way, today literary scholars claim qualities traditionally peculiar to scientists and vice versa.

Nobody believes in the Platonic or Romantic myth of the possessed, instinctive poet, irrationally and mysteriously inspired. It is acknowledged that the inventive freedom enjoyed by a writer or artist, although much wider than that of the scientist, is not unlimited. Gadda, with his habitual irony, helps us understand that

> a xylographer representing a locomotive will certainly not draw it bolt by bolt, such as it is in the three orthogonal projections kept in the Technical Bureau's archives. The xylographer may not see wheels, and instead, wrapped up as he is in the drive to picture the fleeing run, will identify a Homeric nebula. Nevertheless, he will not seek to endow the triumphant machine with square wheels.[10]

Gadda's point is that the ways of reaching knowledge are different, but that even arts and the humanities must follow certain canons and respect certain rules. Traditionally the rational realisation of projects according to a precise design and calculation has been considered peculiar to science, but it applies also to literature. Beyond any mythology, literature is an engineered construction entailing reflection, study, and research; it has to face persistent technical problems which must be resolved in pursuit of its craft. In the same way, the positivist myth of the objective scientific researcher, impassive in photographing reality, with no subjective influence, has faded. Nowadays, science draws nearer to literature's operative code because it has left behind its deterministic and homogeneous system emanating from Newton, founded on the maximum predictability of phenomena and the certainty of results. From this position, science has moved on to a dynamic system that no longer considers chaos to mean the absence of order, but judges positively the richness of a chaotic universe. Dis-

9 Thomas S. Kuhn, 'Comment [on the Relations between Science and Arts]', *Comparative Studies in Philosophy and History*, 11 (1969), 403 – 412 (p. 403).

10 Carlo Emilio Gadda, *I viaggi la morte* (Milan: Garzanti, 1977), p. 77, my translation.

order is no longer a synonym for chance but for an indefinite number of variables out of which structure can be created. Nowadays, Nature is not only observed but has become susceptible to interpretation. Intuition, imagination, fancy are thus judged to pertain also to the scientist. It has been realised that hypotheses are born from an imaginative flight, destined only later to be examined under the lens of logic and science.

If literary metaphor consists in getting close to things thought of as distant, its field of application widens to include aspects of science. The mechanism of metaphor is not intended as a procedure by which a word is substituted merely by another, but as figurative meaning that establishes a dialectic tension with the very term it interacts with, to the point of specifying a variety of multiple connections.[11] When closely scrutinised, metaphor is seen to behave the way scientific rules do, since the latter, also, establish relations between phenomena. According to psychologists, those who wish to understand the relations between natural phenomena do not proceed by conceptual abstractions but by visual images, that is by metaphoric correlations. When Niels Bohr construed a model of the atom as the solar system, he formulated a theory starting from a metaphor, an analogical association. Today, rhetoric is considered a part of science, because scientific research is understood to include debate between different schools of thought that may interpret the same phenomena in different ways.

II. Literature at the Service of Science: Galileo's Example

The works of Galileo reveal how science uses rhetoric and, in a broad sense, literary devices. As long as science operates with a view to a 'normal paradigm', to use Kuhn's terminology, it does not feel the need to reinforce its voice by particular attention to how its message is conveyed (and received). It focuses almost exclusively on *what* to say rather than on *how* to say it. In moments in which science experiences strongly revolutionary periods, anomalies and puzzles are no longer to be solved by using a normal framework; innovative scientists propose solutions in the light of alternative paradigms. In his 1969 *Comment* Kuhn remarks:

> discussing either developmental patterns or the nature of creative innovation in the sciences, [*The Structure of Scientific Revolutions*] treats such topics as the role of competing schools and of incommensurable traditions, of changing standards of value,

11 Umberto Eco rightly thinks that metaphor must be understood as 'an instrument of additive and not substitutive knowledge': see Umberto Eco, 'Metafora', in *Enciclopedia*, ed. by Ruggiero Romano and others, 16 vols (Turin: Einaudi, 1977 – 1984), VI (1980), p. 192.

> and of altered modes of perception. Topics like these have long been basic for the art historian but are minimally represented in writings on the history of science.[12]

Making this central to science involves disavowing that literature can be distinguished from science on that count.

In a phase of turbulence and epistemological conflict, in which the old paradigms appear obsolete because they are incapable of solving odd anomalies and the new ones, as yet, are without objective and sure demonstrations, science tends to take advantage of rhetorical and literary tools, in order to make its accounts and reasonings more captivating and pleasing. Galileo is fully aware of this when he confides to his friends that he wishes to take special care of 'the ceremonial introduction and the cues to my dialogues even though they are rhetorical and poetical, rather than strictly scientific'.[13]

In his revolutionary works Galileo does not only worry about demonstrating by physical experiments and astronomical observation the truthfulness of the Copernican heliocentric hypothesis, but searches for the most elegant and effective way in which to present his beliefs. To revert to old terminology, the contents of science are melded with the forms of literature.

Science does not disdain to take care of the aesthetic qualities of its formulations – one often hears of some mathematical demonstrations being more 'elegant' than others – and makes good use of the hedonism of certain formulas which explain, with the greatest simplicity and economy, a chaotic group of elements. However, these are to be seen as tools. They may be determining ones, as in the case of Galileo, who made himself heard through the sheer beauty of his prose, but the critical aim of science is the explanation (and prediction) of phenomena.[14]

Science's rhetorical or literary dimension has definite relevance because, as we have seen, its results are always presented to a community which must examine and share them. In particular, Galileo's audience required a special approach. Rather than writing for the academic world composed mainly of peripatetic scholars, he wanted to be accessible to educated intellectuals, passionate about science, but without any professional interest, amateurs lacking the exclusiveness typical of the university establishment. It is for this reason that he chose Italian instead of Latin and the dialogue instead of the treatise form,

12 Kuhn, 'Comment', p. 403.

13 Galileo Galilei, Letter to Federico Cesi, 24 December 1629, in Id., *Opere*, ed. by Antonio Favaro, 20 vols (Firenze: Barbèra, 1890 – 1909), XIV, p. 60, my translation.

14 If science is enjoyed for the beauty of its results, these acquire an aesthetic value. When two German physicists used fractals not to calculate real objects but to create abstract figures, their drawings became works of art, shown in an exhibition. See Heinz-Otto Peitgen and Peter-Hans Richter, *The Beauty of Fractals: Images of Complex Dynamical Systems* (Berlin – New York: Springer Verlag, 1986).

which was the genre usually used by scientists. The *Dialogo sopra i due massimi sistemi del mondo* (1632) is based on the gnoseological model of Plato's Socratic dialogues, while structure and argument reveal the schema of Cicero's *De Oratore*, which no longer presents the dialogue between a teacher and a pupil, but three characters, not simple doctrinal voices but people, not larvae but men. In this way abstract theories are identified by particular persons, assuming a concreteness well beyond the ordinary. Scientific research is not only a duel between Nature and the scientist who interprets and questions it, with the aid of a method, but a game with three players: scientist, Nature, and audience which, while posing questions, develop a discourse.[15]

Galileo's epistemology, instead of being presented by philosophical disquisitions, is transmitted by means of the literary instruments of the apologue[16] and the story. Typical, amongst many, is the short story by the investigator of the nature of sound, included in his *Saggiatore*, which thereby acquired the allure of a novel. Upon a closer look, scientists, when observing Nature, are rather like *picaros* who, following their explorative instinct, enrich speculative investigation with a sense of adventure, of itinerant quest, which fits well within the structure of *romance*. Scientists share with travellers a progressive unfolding knowledge of the route traversed, a chronotopos of encounters and surprises. The metaphor of the investigator of sounds enables Galileo to explain that scientific research follows the same diegetic logic of the novel. Thanks to his apologue, Galileo shows that science demands not only wit and curiosity, which correspond to the rational and experimental moments, but also pathos and intellectual anxiety, derived from a consciousness of the infinity of Nature.

III. Science at the Service of Literature: Primo Levi's Example

Only a narrow, old fashioned view of literature would presume to be able to do without science. Italo Calvino has said that by now we must 'ask of literature more than mere knowledge of a time or mimesis of aspects of objects or of the interiority of the human soul. From literature we must have a cosmic image'.[17] In

15 Marcello Pera, *Scienza e retorica* (Rome – Bari: Laterza, 1991), p. x.

16 An apologue is a fable-like story with a didactic purpose. Galileo adopts this form of discourse at the start of the dialogues in order to place before readers puzzling vignettes, composed in everyday familiar terms, about the complex nature of motion to which he promises solutions.

17 Italo Calvino, 'La sfida al labirinto' [1962], in Id., *Saggi 1945 – 1985*, ed. by Mario Barenghi, 2 vols (Milan: Mondadori, 1995), I, pp. 105 – 123 (p. 123), my translation.

the same way Primo Levi has given voice to the will for a 'mutual enthrallment'[18] which widens the capacity for observation, typical of the technician and the scientist, from the world of Nature to the world of men. By personal and direct experience Levi, who wrote a sort of autobiography based on the periodical system of elements, was able to claim that the 'patrimony of mental habits deriving from chemistry and its environs' can easily find greater applications, which means writers will never 'remain indifferent to whatever chance makes them come across'. Human beings themselves can become samples, specimens in a sealed packet, to be recognised, analysed, and weighed.[19]

The possibility of analysing 'formidable sources of literary inspiration' dispels, according to Levi, a type of 'voluntary blindness' which loses the measure of our universe, 'impregnated by technology and science'. An ethical connotation comes to the fore again, that of 'humility', a keyword often recalled by Levi, inasmuch as it is the expression of a recognition given to metiers (crafts) that cannot avoid integrating extra-sectorial experiences. The continuous transit from one culture to the other is the manifestation of

> the humility of looking around and noticing that the figure of the soothsayer artist, voice of a God fountain of truth, is no longer valid: next to him a new culture was born and is growing vertiginously. The poet better make room for the physicist, the economist, the psychologist; he will find himself in good company and perhaps will have all the more to say.[20]

It is even better if all these variegated competences coexist in the same person, according to an ideal that Levi identifies with the heuristic figure of the centaurs. The balance between their double natures is certainly not stable, but as long as these are united, the centaur can amount less to a paranoid splitting than to a perceptive fullness. His soul, Levi said, is one without welding, and two souls are too many. So 'there is not a contradiction between the condition of a chemist and the condition of a literary writer. On the contrary there are reciprocal reinforcements'.[21] That is why, in one of his last collections of writings, called *L'Altrui Mestiere* (1985, *Other People's Trades*), Levi adopted a geological metaphor to protest against the absurdity of the 'crevice' that has opened between literature and science. What makes us wonder today about the fracture diagnosed by Levi is certainly not the exhortation to throw a bridge over the abyss caused by the philistine vocation to flee any threat of traumas and conflicts.

18 Primo Levi, 'L'altrui mestiere' [1985], in Id., *Opere*, ed. by Marco Belpoliti, 2 vols (Turin: Einaudi, 1997), II, pp. 629 – 856 (p. 632), my translation.

19 Levi, 'I sommersi e i salvati' [1986], in Id., *Opere*, II, pp. 995 – 1153 (p. 1102).

20 Levi, *Conversazioni e interviste 1963 – 1987*, ed. by Marco Belpoliti (Turin: Einaudi, 1997), pp. 173 – 174, my translation.

21 Levi, 'Storie naturali' [1966], in Id., *Opere*, I, pp. 399 – 567 (pp. 505 – 516).

What really counts is rather his belief that the cracks between the territories of science and literature are not the inevitable result of a natural tectonic process, of an objective incompatibility of the subjects, but the result of prejudice against knocking on a neighbour's door.

Levi identifies the common denominator in a dominion made precarious for both cultures by the absence of certainties, even without conceding to scepticism. This is a thesis that has become most topical today after Ilya Prigogine, Nobel prize winner for chemistry, published a book on *The End of Certainty* (1997), which is an obituary to the determinism underpinning Newtonian and classical mechanics, formulated at the cost of simplifications that transform the universe into a discreet and perfect machine. We now understand this to be rather nearer chaos and entropy, which the fluctuating rates of probability are best suited to represent.

Even in these circumstances, the claim is that of a realistic utopia in which everyone shares a tension requiring not only challenge and strife, but also involvement. The boundaries between these different jurisdictions are thus doomed always to be tested, although by different moves. Scientific procedure is of a centripetal sort, because it aspires to bring all that is unknown and at first sight particular and inexplicable within the container of already proven universal laws of behaviour. Literature and the arts, instead, with a centrifugal attitude, aspire to drive out what is known and familiar, or even trivial, to the territories of the unforeseeable. Through a process that Russian Formalists called estrangement, one can be brought towards deviation and the limit even when reality is homely and day-to-day. There derives a logic Levi is fully aware of, when he brings to mind his amusement in 'watching the world under unusual light, inverting the instrumentation, and visiting techniques with a literary eye, and literature with a technical one'.[22] This proposal by Levi still offers a productive beginning to interfacing sciences, literature, and the humanities.

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22 Levi, 'L'altrui mestiere', p. 631, my translation.

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Brian Hurwitz

Narrative [in] Medicine

> Everywhere one looks in the academy these days, theory is out and stories are in.
> J. D. Arras, 'Nice Story, But So What? Narrative and Justification in Ethics' (1997)[1]

In this chapter, I shall argue that Narrative Medicine is a practice and an intellectual stance which enables physicians to look beyond the biological mechanisms at the centre of conventional approaches to medical practice, towards domains of thought and ways of telling that focus on language and representation, on the emotions and relationships which illuminate health care practice.[2] Narrative offers a great deal more than efficient information capture, processing, and transmission, communicational competencies which dominate how the clinical consultation today is understood and taught.[3] Narrative [in] Medicine implies representation, a construal with shape, tone, and emphasis, which encompasses temporal change, character, character development, personality, predicament, and the hues and layers of feelings, thoughts, and suffering.

Narrative Medicine does not constitute a new paradigm in medicine that supersedes or licenses physicians to reject or dispense with scientific medicine. Rather, Narrative Medicine arises from recognition that the objective, impersonal, and universal view to which science aspires does not alone – even when supplemented by nods towards ethics, social sciences, and history – provide

1 John D. Arras, 'Nice Story, But So What? Narrative and Justification in Ethics', in *Stories and Their Limits*, ed. by Hilde Lindemann Nelson (New York: Routledge, 1997), pp. 65 – 88.

2 Brian Hurwitz, 'Narrative and the Practice of Medicine', *The Lancet*, 356, 9247, 16 December 2000, pp. 2086 – 2089; Brian Hurwitz, 'Medicine, the Arts and Humanities', *Clinical Medicine, Journal of the Royal College of Physicians*, 6 (2003), 497 – 498; *Narrative Research in Health and Illness*, ed. by Brian Hurwitz, Vieda Skultans, and Trisha Greenhalgh (Oxford: Blackwell Publishing, BMJ Books, 2004).

3 Martin von Fragstein, Jonathan Silverman, Anne Cushing, Sally Quilligan, Helen Salisbury, and Connie Wiskin on behalf of the UK Council for Clinical Communication Skills Teaching in Undergraduate Medical Education, 'UK Consensus Statement on the Content of Communication Curricula in Undergraduate Medical Education', *Medical Education*, 42 (2008), 1100 – 1107, <http://www.bris.ac.uk/medical-school/staff/tomorrowsdoctors/commcurricme.pdf> [accessed 14 June 2011].

sufficient foundation on which to forge all-purpose understanding of clinical encounters.

The thesis I want to put forward is that Narrative Medicine complements and counterbalances the explanatory drive of clinical science, which is 'to molecularize': to account for the medically complex in terms of the simple, to collapse experience and predicaments of ill health into the quantified and quantifiable. The physician-philosopher Raymond Tallis has argued that intractable moral and epistemological difficulties arise from accepting that 'a discolouration of one's days, a pruning of one's future and a loss of hope', in the case of someone suffering from renal disease, translates into a blood urea concentration of 50mmol/l. As Tallis puts it, the experience and human significance of illness 'are simply not science shaped'.[4]

Narrative Medicine recognises that illness experience, which is at the heart of diagnosis, calls forth conversation and history (re)construction fed not only by observation – a primary skill in Clinical Medicine – but also by snippets of storied information. Narrative Medicine fosters a double vision: an eye to the monitoring of raised urea, creatinine, and potassium levels, on the lowered glomerular filtration rates characteristic of diseased kidneys, and minute attention to the idiomatic accounts of human experience. Understanding renal physiology *and* the biographical and existential elements of a person living with kidney disease contribute to taking account of the nature and quality of a life lived with this sort of illness. Although these are two quite different sorts of apprehensions and understandings, both enter into clinical practice, and both are represented in Narrative Medicine.

In *Midstream* (1990), a memoir of her mother's last illness, Le Anne Schreiber wrote of what was most lacking in her mother's care:

> Doctors are specialists trained to intervene at moments of crisis, to cut, to radiate, to alter chemistry, then to move on to the next patient. But why is there no place in this elaborate medical system for sustained care of the human being who continues to feel the effects of the doctors' knives and beams and chemicals?[5]

During his own last illness, Anatole Broyard, the critic and novelist, wrote:

> Now that I know I have cancer of the prostate, the lymph nodes, and part of my skeleton, what *do* I want in a doctor? I would say that I want one who is a close reader of illness and a good critic of medicine […]. To most physicians, my illness is a routine incident in their rounds while for me it's the crisis of my life. I would feel better if I had a doctor who at least perceived this incongruity. […] I see no reason why [my doctor] has to stop being a doctor [to] become an amateur human being. Yet many doctors sys-

4 Raymond Tallis, 'Medicine and Human Nature', paper delivered at The Arts and Humanities Research Board seminar on *The Medical Humanities*, University of Edinburgh, July 2005.

5 Le Anne Schreiber, *Midstream* (New York: Viking, 1990), p. 138.

> tematically avoid contact […]. I do expect some willingness to make contact, some suggestion of availability. I would also like a doctor who enjoyed me. I want to be a good story for him, to give him some of my art in exchange for his.[6]

Perhaps it should not surprise us that the novelist and critic each yearn for a doctor with readerly skills, who is prepared to enter into, become a participant in, the drama and tragicomedy of patients' lives, whilst also maintaining disciplined, medical and scientific focus on health care needs. In her book on *Narrative Medicine* (2006) Rita Charon remarks:

> As a living thing, narrative has many dimensions and powers. The novelist values its creative force; the historian relies on its ordering impulses, the autobiographer redeems its link to identity […]. What is clear is that narrative does things for us, perhaps things that cannot be done otherwise. Narrative structures, such as novels, newspaper articles, and letters to friends enable us to recount events, to depict characters, to suggest causes for events, to represent the passage of time, to use metaphor to convey meanings otherwise elusive. As an instrument for self-knowledge and communion, narrative is irreplaceable.[7]

As the epigraph to this chapter indicates, focus on narrative and narrative studies within the academy is relatively recent. I am struck by the absence of the term narrative in Michael Balint's *The Doctor, His Patient and the Illness* (1957), a study of some 50 accounts of relationships between doctors and patients.[8] Arguably story does much of the work in Balint's text that narrative performs in medical discourse today. Yet there is no entry for narrative in the first edition of Raymond Williams's influential work *Keywords*, subtitled *A Vocabulary of Culture and Society* (1976).[9] If one were forced to offer a starting date for interest in narrative, and for the growth of narrative studies in the West, perhaps a relatively early point of origin would be the work of the Russian Formalist Vladimir Propp, whose *Morphology of the Folk Tale* in 1928 claimed to have reduced all folk tales

6 Anatole Broyard, 'Doctor, Talk to Me', in *On Doctoring*, ed. by Richard Reynolds and John Stone (New York: Simon & Schuster, 1991), pp. 175 – 181.

7 Rita Charon, '3. Narrative Features of Medicine', in *Narrative Medicine. Honoring the Stories of Illness* (New York: Oxford University Press, 2006), pp. 39 – 40.

8 Michael Balint, *The Doctor, His Patient and the Illness* (London: Churchill Livingstone, 1957). Starting in 1949, a group of general medical practitioners met regularly at the Tavistock Clinic in London with the Hungarian psychoanalyst Michael Balint, his wife Enid Balint and other psychiatrists to discuss reactions to, and relationships with, their patients. Over many years, the group focused on the emotional dynamics of continuing doctor-patient relationships and this volume analyses fifty clinical cases discussed within that setting.

9 Raymond Williams, *Keywords: A Vocabulary of Culture and Society* (London: Fontana/Croom Helm, 1976). However, the second edition carried an entry for narrative. See Raymond Williams, *Keywords: A Vocabulary of Culture and Society* (New York: Oxford University Press, 1983), pp. 210 – 212.

to 7 'spheres of action' and 31 fixed elements or 'functions'. This work prefigured by some 30 years interest in narrative by Structuralist thinkers.[10]

In the 1960s and 70s, accounts by literary theorists of the properties and framing capacities of narratives[11] paralleled growing interest on the part of social scientists and anthropologists in the elaborately storied structure of lay accounts of illness.[12] Narrative, today, has a key place in philosophical accounts of personal identity,[13] and has come to signal human self and selfhood, something more than mere fleeting brain processes. The penumbra of terms associated with narrative include: 'tale', 'account', 'story', and 'history'. Dr Johnson in his 1755 Dictionary referred to Dryden on 'the tattling quality of age which is always narrative'. For Johnson, tattling meant 'to talk idly; to use many words with little meaning'. Later editions of the Dictionary explicate 'Life' as 'a narrative of a life past' and define narrative as 'an exact resemblance', 'giving an account' of 'the course of things'.[14] If one takes only a cursory look at its use in announcing medically related works at the time, one finds, for example:

> *A Narrative of the Effects of a Medicine, Newly Discovered, by Mr. Keyser […] That Cures the Venereal Disease in its Most Inveterate and Malignant State […] Consisting of Translated Extracts from Medicinal Journals […]. To Which is Prefixed, a Preliminary Discourse on the Disease and Remedy, by James Cowper.*[15]

> *A Narrative of the Extraordinary Effects of a Medicine Well Known All Over Europe, by the Name of Le Lievre's Baume de Vie; To Which Is Prefixed, an Account of Its Nature and Operation, by Le Lievre.*[16]

10 Vladimir Propp, *Morphology of the Folktale* (Austin: University of Texas Press, 1928). For excerpts from a 1968 translation supervised by the American Folklore Society and Indiana University see <https://docs.google.com/viewer?url=http://homes.dico.unimi.it/~alberti/Mm10/doc/propp.pdf> [accessed 14 June 2011].

11 See Raymond Barthes, 'Introduction to the Structural Analysis of Narratives', in Id., *Image-Music-Text*, Selected, Translated and Edited by Stephen Heath (Glasgow: Fontana/Collins, 1979), pp. 79–124; Gérard Genette, *Narrative Discourse* (Oxford: Blackwell, 1980); Hayden White, 'The Value of Narrativity in the Representation of Reality', *Critical Enquiry*, *On Narrative*, 7, 1 (Autumn, 1980), 5–27.

12 Gareth Williams, 'The Genesis of Chronic Illness: Narrative Reconstruction', *Sociology of Health and Illness*, 6 (1984), 175–200.

13 See Alasdair MacIntyre, *After Virtue: A Study in Moral Theory* (London: Duckworth, 1981) and Charles Taylor, *Sources of the Self: The Making of Modern Identity* (Cambridge: Cambridge University Press, 1989).

14 Samuel Johnson, *A Dictionary of the English Language* (London: J. and Knapton, 1755), <http://drjohnsonsdictionary.wordpress.com/?s=narrative> [accessed 14 June 2011], and Samuel Johnson, *Johnson's Dictionary, Improved by Todd*, ed. by Henry John Todd (Boston, Mass: Charles J. Hendee, 1836), pp. 199, 226, 335.

15 London: Mrs. Cooper; Mr. Owen; Mr. Woodfall; Mr. Robson, 1760.

16 London: Printed for W. Nicoll; Becket and De Hondt; Richardson and Urquhart; and W. Flexney, [1780?].

The City Remembrancer; Being Historical Narratives of the Great Plague at London, 1665; Great Fire, 1666; and Great Storm, 1703, […] With Historical Accounts of the Most Memorable Plagues, Fires, and Hurricanes; Collected from Curious and Authentic Papers Originally Compiled by the Late Dr. Harvey […] and Enlarged with Authorities of a More Recent Date, by Gideon Harvey.[17]

The Interesting Narrative of the Life of Olaudah Equiano, or Gustavus Vassa, the African. Written by Himself.[18]

Narrative here promises not only an account of the course of things, but some insight into the causes and interconnections between episodes in a life story. Nineteenth-century medical reports parallel such usages, narrative denoting a long or unusual clinical case,[19] straddling two quite different sorts of linguistic portraits, composed of elements of biographical memoir,[20] and the log (or catalogue), which picks out sequences of significance answering to another realm, one couched in the language of medical, explanatory, and diagnostic terms.[21]

Long before the terms Narrative Medicine or Narrative Based Medicine were coined,[22] clinicians prized the ability to reconstruct the history of a complaint: 'The most important difference between a *good* and an *indifferent* clinician lies in the amount of attention paid to the story of the patient' wrote the Oxford Professor of Medicine Sir Farquhar Buzzard in *The Lancet* in 1933.[23] 'History-taking is the greatest art in medicine. Generations of clinical teachers have acknowledged its importance and have tried to pass on the art to their pupils',[24] wrote Robert Platt in the same journal in 1947, since when its pivotal position in

17 London: Printed for W. Nicoll, in St. Paul's Church-yard, 1769.

18 London: T. Wilkins, 1789.

19 J. W. Ogle, 'On a Proposed Remedy (a Species of Gallium) for Epilepsy and Other Spasmodic Affections: Narrative of Two Visits to the Hospital for Epileptics at Tain, in France', *The Lancet*, 79, 2019, 10 May 1862, pp. 482 – 483. See also John Hoare and W. H. Colston, 'Extraordinary Narrative', *The Lancet*, 18, 449, 7 April 1832, pp. 20 – 21.

20 Brian Hurwitz, 'Form and Representation in Clinical Case Reports', *Literature and Medicine*, 25 (2006), 216 – 240.

21 Brian Hurwitz, 'Clinical Cases and Clinical Case Reports: Boundaries and Porosities', in *The Case and the Canon. Anomalies, Discontinuities, Metaphors between Science and Literature*, ed. by Gabriella Morisco, Giorgio Turchetti, Alessandra Calanchi, and Gastone Castellani (Göttingen: Vandenhoeck & Ruprecht Unipress, 2011), pp. 45 – 57.

22 *Narrative-based Medicine: Dialogue and Discourse in Clinical Practice*, ed. by Trisha Greenhalgh and Brian Hurwitz (London: BMJ Books 1998); *Narrative Research in Health and Illness*; *Narrative Medicine*.

23 Farquhar Buzzard, 'Preparation for Medical Practice', *The Lancet*, 222, 5745, 7 October 1933, p. 820.

24 Robert Platt, 'Two Essays on the Practice of Medicine', *The Lancet*, 250, 6470, 30 August 1947, pp. 305 – 307.

diagnosis has been confirmed.[25] Contemporaneous with John Arras's remark cited as the epigraph to this chapter, David Sackett, one of the doyens of evidence-based medicine, wrote in the *Oxford Textbook of Medicine:*

> Our first moments with a patient are packed with visual, auditory, tactile and sometimes olfactory information […]. Of all the diagnoses that ever will be made, most are made during the history […]. Even when patients are referred to specialist centres […], attention is appropriately refocused on the key clinical enactment: the patient's 'story' and the physical examination.[26]

So Narrative Medicine can make no claim to *early* notice of the place of narrative in Clinical Medicine. However, Narrative Medicine does take *new account* of it, by linking medical practice to other fields of enquiry such as narratology, psychology, ethnography, oral history, and communication studies.[27]

Until recently, theorists of narrative focused their attention predominantly on its fictional form, rather than on its many other morphisms, such as biography, memoir, news story, obituary or clinical case report. As already mentioned, Rita Charon in *Narrative Medicine* develops a reading theory of the clinic, analogising the patient to a complicated teller or text, and the clinician to a sensitive listener-reader who deploys a 'narrative competence'. By 'narrative competence', Charon means a capacity to apply 'the narrative skills of recognizing, absorbing, interpreting, and *being moved by* the stories of illness' (my emphasis).[28] Notice the affective and relational components here: Narrative Medicine for Charon is not just a cognitive set of abilities but a moral, emotional responsiveness, an atunement enabling health carers to contact and to sympathise with their patients, which contributes to clinical effectiveness. It is an atunement shared as much by the clinician as by the oral historian or skilled ethnographer.

Although Charon is all too aware of the communicational dynamics of clinical encounters – its gestural, facial-postural, and bodily aspects – the metaphor of close reading (however unruly a text may turn out to be) does a great deal of work in her version of Narrative Medicine:

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25 John R. Hampton, M. J. G. Harrison, J. R. A. Mitchell, J. S. Pritchard, and Carol Seymour, 'Relative Contributions of History Taking, Physical Examination and Laboratory Investigation in Diagnosis and Management of Medical Outpatients', *British Medical Journal*, 2 (1975), 486 – 489.

26 David Sackett, 'History', in *Oxford Textbook of Medicine*, ed. by David J. Weatherall, John G. G. Ledingham, and David A. Warrell, 3rd edn (Oxford: Oxford University Press, 1996), p. 15.

27 Gareth H. Williams and Phillip H. Wood, 'Common Sense Beliefs about Illness: A Mediating Role for the Doctor', *The Lancet*, 328, 8521 – 8522, 27 December 1986, pp. 1435 – 1437; Kathryn Montgomery, *How Doctors Think* (Oxford: Oxford University Press, 2006), p. 13.

28 Charon, '1. The Sources of Narrative Medicine', in *Narrative Medicine*, p. 4 (my emphasis).

> When doctors or nurses listen to patients in this way, related to what psychiatrists call 'listening with the third ear', they will ask themselves readerly questions: 'Why is she telling me this *now?* How come I'm feeling irritated or distracted or sad as I listen to her? How come she started with the end of the story and told it backward? Why did she leave out the chest pain until the very end? Why has she included her sister's accident in the story of her bellyache?'[29]

Listening and questioning between the lines allows the telling of relations between body, mind, self and others to be better heard and interpreted.[30]

An example of what is involved in this sort of approach is a discussion of a bioethics case by Tod Chambers and Kathryn Montgomery:

> Suppose a colleague approaches you and says, 'We have a patient who came for a prostatectomy, and as he was getting prepped, the nurses noticed that he wouldn't talk about his family. Really odd. Then, after the surgery, he tells us that his wife and children – even his secretary – all think he's away on a business trip, and he doesn't want us to contact them. Now Mr. Kaufman's bleeding, and we just took him back to the OR….[31]

This story, they argue, 'could be said to be the plain sequence of events':

> (1) a man learns he needs surgery, (2) he tells his family he is away on a business trip, (3) after the surgery he tells the health care professionals about the deception, (4) he suffers a complication of surgery.[32]

But their colleague's story, as initially related to them, was emplotted quite differently, for it *began* with the surgery and featured the nurses' observation *prior* to surgery – the meaning of which was understood perhaps only retrospectively – that he would not talk about his family. In the first way the story was recounted this element is presented as a clue: the man harbours a secret. He has undergone a surgical procedure entirely alone, without the advice, support or knowledge of family or a network of friends or colleagues. This fact could be grounded in some other secret. In the second, more linear way the story unfolds, the moral issue seems confined simply to one of confidentiality: it is possible the patient wants to protect his family from worrying about him; it is possible he fears impotence as a consequence of the procedure and that he has not discussed this with his wife or partner; it is possible he is living a double life; and it is possible he wants this degree of secrecy for no clear reason at all, which the common law respects.

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29 Charon, '4. Telling One's Life', in Ibid., p. 66.

30 Ibid., ivi.

31 Tod Chambers and Kathryn Montgomery, 'Plot: Framing Contingency and Choice in Bioethics', in *Stories Matter: The Role of Narrative in Medical Ethics*, ed. by Rita Charon and Martha Montello (New York and London: Routledge, 2002), pp. 77–84.

32 Ibid., ivi.

But in the original story as (re-)told by Chambers and Montgomery, the man is bleeding, and the story's audience surmises that the questions on the tips of his carers' tongues – which may not be untinged by sentiment – are not only 'How serious has the situation now become?', 'What is to be done if the bleeding complication cannot be resolved?', 'Who, if anyone, should be informed?' but, additionally and equally importantly, 'What *sort* of a person is this man?' 'What are his values, in what does he believe?' 'What does he think he is doing?' Answers to these urgent questions cannot be inferred without further biographical information, without knowing more about the man's personal narrative, which might reveal something of his life, life style, character, deviousness, predilections, support group, loneliness, and ties.

Montgomery and Chambers comment that, of the two ways in which the story so far has been told, one captures the existential drama of the patient's situation and its effects on his health carers, their sense of discomfort and anxiety. Whereas the other way of telling the story, which involves use of indirect, neutral constructions and a less elaborate story structure – a lower level of narrativity – edits out the drama. Readers are not required to accept either of these construals of events that have taken place, because what is recounted depends heavily on the situational context and purpose for which it is told. It is possible that if this account featured in an organisational narrative, it might dwell on the fact that the nurses prior to surgery did *in fact* notice that the patient would not speak about his family, but this observation became normalised and dismissed as 'non significant' and 'not noteworthy', until after the surgery. A lawyer might ask whether omitting to enquire further at the pre-surgery stage was reasonable, and if not, could this be considered an error actionable in law? Was the original observation by the nurses and the judgement which accompanied it – 'really odd' – documented in the nursing notes? Narrative considered as a set of 'discursive performances' offers enormous scope for strategy and ingenuity in just *how* what is being narrated is construed and conveyed orally, gesturally, and as text.

Clearly, how this fragment of a bioethics case is framed – not only which elements are emphasised or omitted but its narrative complexity – has implications for its reading and interpretation. It is not just a question of information content, but of the shaping, accenting, and structuring of informational content.

Let me attempt a different kind of illustration, by considering a clinical case that concerns a general practitioner's visit to a patient's home. Dr John Launer published the case in a prestigious medical journal to show hospital colleagues what he called a 'larger narrative' about the conditions of medical practice outside the relatively controlled environment of a hospital:

I saw the patient three days before Christmas. I had just completed my last surgery before going off for two weeks' break with my family […]. I set off in the car […] but the Christmas traffic was backed up for nearly a mile and I decided to turn round […]. No matter, I thought, I could do the visit on the way home – after the practice Xmas lunch – when the traffic might be lighter. It sounded as though the patient only needed a quick eyeballing anyway.

I had already talked on the phone that morning to the domiciliary care manager who had asked for the visit. The patient was a woman in her sixties, a known alcoholic who lives alone and frequently has falls. The manager was concerned about an escalation in the drinking and the falls […]. However, [her] main concern was that the patient's accommodation was clearly unsuitable. [N]eighbours were protesting about the loud drinking bouts, and […] were afraid that she would injure herself […]. In the new year, the manager said, we would have to get the social workers in and get her moved to somewhere safer and more suitable. I noted the phrase 'in the new year' with relief. The patient was not one of mine anyway, so the long-term arrangements would be someone else's problem. I could nip in and out of the house, check that the woman was mobile and no more incoherent than usual, and still get home by mid-afternoon.

The traffic was no better at the second attempt. I cut up a couple of cars in order to change lanes and gain a few seconds' advantage. When I rang the bell […] the woman pulled aside the curtain in her bedroom, and signaled to me that she would come to the door […]. She then managed to totter round to let me in, although she asked for my arm to lean on as we walked back to the bedroom. The place was bleak and disgusting, and I had to fight a feeling of being repelled by the woman herself. To save time, I asked her a few curt questions and checked her over while I did so. She had a swollen face that I assumed was the consequence of having two massive black eyes, but she managed to open both eyes when I asked her to. Her limbs were covered in bruises, and the skin had been sheared off her knees, with old slough in places. However, she told me she had made a cup of tea earlier and had drunk it. She also kept saying something about chicken and bacon, but I could not follow it. Her speech was honking and slurred, seemingly not just from the alcohol but perhaps from some other, lifelong impairment.

By now I was feeling impatient. I was angry about the traffic, angry about my vanishing afternoon, and angry with the colleague I was covering for (even though he had swapped the session at my request so I could get away). I had my own priorities, and making sense of the chicken and the bacon was not one of them […]. Her condition was shocking, but no doubt chronically so. She was sufficiently mobile to survive, and to get to her phone or her front door. [In any case] the care manager would visit again tomorrow. I was reaching the point where I had decided to quit […] and resume my life unimpeded by the needs of others, including people like this woman who live at the margins.

As an afterthought, I decided to check her chest. In the midst of the stuff about chicken and bacon she had mumbled something about being short of breath, but I had paid no attention, because I was only really concerned about her mobility. Now it occurred to me that she might have broken some ribs in a fall as well, so I reluctantly asked her to take off her blouse. As I pressed on her sides, I felt something I have only ever felt once before: a sensation similar to treading freshly fallen snow underfoot. Then I realised why her face was so swollen.

> At first she refused to go into hospital. The chicken and bacon, it turned out, were going to be part of a lunch that she was looking forward to. […] it took another hour to set up all the arrangements to get her admitted, including half a dozen phone calls and […] a further journey to the office and back to meet up with the care manager. The Christmas traffic was no better this time either.
>
> As I finally composed the letter for the ambulance crew to take up to hospital with the patient, I reflected on how GPs manage to reduce turbulent experiences like this into the clipped, logical and efficient narrative of clinical medicine. How many hospital doctors, I wondered, would be interested in the larger narrative: the squalor in which we see so many of our patients live, the pressures that lead us to cut corners, and the guardian angel who looks on when alienation and meanness of spirit threaten to take us over.[33]

This case vignette is framed with an account of pressures personal to the visiting doctor, to the working life of a London GP at a special moment in the year. It reveals not only a great deal of the GP's point of view, but a pronounced self-revelatory stance on the part of its narrator, who exposes his own thoughts, emotions, and fallibilities to the reader. This GP comes across as detached from the patient, though not detached from himself: a great deal of the case revolves around the GP's own concerns and drive, his frustrations, impatience, and annoyances which contrast strikingly with those of the patient who, in this account, appears somewhat devitalized and emotionless. Despite intentions to 'nip in and out' and to leave after a cursory eye-balling, the GP's curiosity about the patient gets the better of him!

Is it the chicken and bacon that saves the day? Or is it something about the patient's pathetic state, and her mention of shortness of breath and the 'honking voice' that moves him to examine her chest? On the one hand, her swollen face, black eyes, bruised body, scabby knees, and tottering gait all seem to signal the one thing the GP feels quite certain of: she is suffering from the effects of much too much alcohol. But the patient's strange voice and *what* she has to say – that she has had a cup of tea (implying perhaps that she has not vomited it up) and what is more, that she is now looking forward to the chicken and bacon – have the effect of *breaking down* the doctor's stereotype of an ageing alcoholic woman. In effect, *what* she says and *how* she says it unmasks someone who enjoys the ordinary things of life, who is desirous of chicken and bacon, someone who is not only pathetic and vulnerable, but possibly *especially* vulnerable in a way that had not previously occurred to her doctor. So Dr Launer examines her chest, seeking out the clinical signs of fractured ribs, for example, pain on compression of her ribcage, and thereby he experiences a rare sensation, the vibration, and sound, of snow crunching under foot. It can mean only one thing:

33 John Launer, 'Dr Scrooge's Casebook', *Quarterly Journal Medicine*, 97 (2004), 183 – 184 [abridged by B. Hurwitz].

surgical emphysema, air that has tracked upwards from her chest to cause facial swelling, perhaps from lung puncture or perhaps from gas gangrene.

Here we see medicine practised imperfectly but in a way that is both reflective and effective, a practice attuned to the complexities and ambiguities of language,[34] that attends to storied fragments, their incongruity and possible reconstruction, that takes due note of snippets of information important to the patient but lacking narrative coherence, and thus meaning, to the doctor: '[s]he […] kept saying something about chicken and bacon, but I could not follow it'. It is a practice that grasps – at the epiphanic diagnostic moment – its own fallibility, a medicine arguably fumbled towards by a doctor who is confident enough to write up, and to publish, what happens in a much less censored way than usually is found in case reports.

His report features a considerable amount of meandering detail (especially at the start of the case) which would generally be deemed entirely contingent and unsalient: the terrible traffic, the delay in visiting, it's Christmas lunch day in the practice, the doctor's bad driving and frantic rushing, his somewhat freighted and preoccupied mental state, concerns which seem initially to crowd-out any clear focus on the patient. Here is a depiction of a consultation whose fortunes turn on a combination of remarks and a manner of remarking which commits the doctor to a further examination, this time of the patient's chest. These are the sorts of factors that significantly influence the clinical assessment, but they would all be invisible in a conventional – non 'narrative based' – case report.

This is quite clear from the first line of the letter Dr Launer composes, which is to be sent to the hospital on admission of his patient: 'Dear Doctor, This woman appears to have surgical emphysema extending from her chest into her neck and face […]'.[35] So begins the cool, connected, professional account of the clinical findings in a fragmented and bruised woman, whom the GP is referring to hospital. It echoes the original purpose of the case report which, you will recall, was to show those who according to Dr Launer practise in narrow, specialized, and more protected settings than the GP, how the messy and muddled nature of medicine undertaken 'at the margins' is occluded from consciousness, a muddle not to be found in textbooks and generally omitted from letters.

Unpredictably, readers of his case report are presented with a different, perhaps a truer story: one collected and written up by an expert ethnographer and excellent communicator unafraid to expose good, poor, and mediocre practice in a narrative case report. The patient had been in grave danger, not only

34 I am indebted to John Launer's formulation in the unpublished paper 'Narrative-Based Practice' delivered at the University of Bergen, Department of General Practice, 20 April 2007. See also John Launer, *Narrative-based Primary Care* (Abingdon: Radcliffe Medical Press, 2002).

35 Launer, p. 184.

from a medical assessment that almost passed-by her attempts to communicate her particular concerns; from a clinical assessment that might have gone badly wrong if the doctor had failed to see the diagnostic wood from the personal, social, and existential trees.

This home visit did not end badly, because the GP was sensitized to *thinking with* – to borrow Arthur W. Frank's phrase – as well as to *thinking about* fragmentary narrative elements of the patient's account.[36] In the circumstances, elements that were only half under construction, half told, half blurted out, and which initially did not make much sense, may have made all the difference. As DasGupta points out:

> '[S]tories are like shifting, sometimes messy rooms we must plunge into, head first […]. Gaining the necessary skills to read the contradictions and pauses, nonlinear plots, false stories, untold stories, surreal tangents, and implausible characters […] lends physicians the skill to enter more fully into the empathic relationship […]'.[37]

Narrative Medicine is thus an amalgam of orientations, values, and techniques that recognises *acts of narration* and *performance*s, *listening* and *interpretation* to be as foundational to good clinical practice as is knowledge of applicable medical science. Narrative Medicine provides the most developed platform we have for practising with the sensitivities and skills needed to combine clinical and scientific knowledge with interpersonal understanding of the many and varied accounts encountered in the health care of individuals. It is an empathic and humane practice primarily because it is based on human and medical curiosity about another person at whatever level – medical, scientific, and existential – attention to such dimensions is required, in order to understand, represent, and respond to the patients' situation. Narrative Medicine looks to *ways of knowing* and *means of telling* that focus on language and representation. It is a practice that does not reject science but depends on it whilst drawing intellectual sustenance from beyond the scientific domain. It is reflective, it is interpretative, it is provisional, it is situationally embedded in the context in which it is performed. It should not misrepresent its own contribution to clinical practice, which is powerful but partial.

In all but name it is Narrative Medicine which a possé of professors of evidence-based medicine invokes in a canonical piece of advice acknowledging the importance of 'broad perspectives from the humanities' for the successful practice of medicine:

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36 Arthur W. Frank, 'Asking the Right Question about Pain: Narrative and Phronesis', *Literature and Medicine*, 23 (2004), 209 – 225. See also Arthur W. Frank, *The Wounded Storyteller* (Chicago: University of Chicago Press 1991).

37 Sayantani DasGupta, 'Being John Doe Malkovich: Truth, Imagination and Story in Medicine', *Literature and Medicine*, 25, 2 (2006), 439 – 462.

> […] knowing the tools of evidence-based practice is necessary but not sufficient for delivering the highest quality patient care. In addition to clinical expertise, the clinician requires compassion, sensitive listening skills, and broad perspectives from the humanities […].[38]

Narrative Medicine offers the best platform we have for theorising and developing the practical contributions of the humanities to the practice of medicine today.

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Pino Donghi

Science Popularization and Performativity

I. Scientific Discourse and Scientific Texts

In his attempt to define socio-semiotic enquiry, Gianfranco Marrone has argued that understanding whether society influences or is influenced by language is less relevant than investigating 'the ways in which society relates to itself, thinks about itself, and represents itself, through the texts, discourses and narratives it produces'.[1] Marrone cites Landowski to explain that:

> The empirical object of socio-semiotics is the ensemble of discourses and practices that intervene in the creation and/or transformation of the conditions in which individual and collective actors interact.[2]

In a text, we distinguish between expression (E) and content (C). In a discourse, expression is perhaps less relevant. In advertisement, a *text* has a precise expressive form: it can be shown on TV, printed in a newspaper, or read out on the radio, and in each of these different forms of expression (E) the content (C) is received in a specific way. By contrast, a *discourse* is more general; it is a statement with its own specific topics and configurations, its own ways of using space and time, its own actors. An advertising discourse is thus different from a political discourse, a news discourse, a religious discourse or any other kind of discourse.

Talking about a discourse entails talking about its production. A discourse is the set of rules that governs language (any language) as it is experienced in a specific intersubjective space – be it a broad or a narrow one. It is the set of socio-cultural constraints applying to the space. Marrone goes on to specify what happens with scientific discourse:

1 Gianfranco Marrone, *Corpi sociali. Processi comunicativi e semiotica del testo* (Torino: Einaudi, 2001), p. XVI.
2 Ibid., p. XVII.

> On the one hand, scientific discourse can be reconstructed as a set of written texts (reports, lectures, studies, and treatises) often accompanied by images (drawings, reproductions, photographs). On the other, it is a set of practices (group work, laboratory experiments, funding applications) in which technology is a social actor in the full sense of the word. If science is often seen as pure theory surrounded by a halo of mystery that enhances its authority, this is because it cancels the tracks of the practices that give it its meaning. What these practices mean is that science is above all a discourse encompassing physical objects and materials, actions, and passions.[3]

Is science a self-enclosed guild that prevents outsiders from seeing the work that precedes and underlies its results? Is this why science is inaccessible? It can be claimed that scientists deliberately distance themselves from the public, pride themselves on their separate identity, lock themselves in ivory towers, and then complain that no-one understands them or gives them the consideration they deserve. The argument fits what we think we know from common sense, but is it true?

II. The Pulse of Scientific Discovery

In July 1992 at Spoletoscienza[4] Stephen Toulmin was asked to name a subject missing in the usual curricula for historians, sociologists or philosophers of science. He replied that young people interested in anthropological research should be warned against looking for some primitive tribe which has lived in isolation since the dawn of time and knows nothing about our world. Even if it ever existed, such a tribe can no longer be found, and if present in some dark corner of the Amazonian forest, it would probably not be very different from those already contaminated by modern contacts and studies. As the sacred texts of anthropology explain, primitive populations have a similar kinship system and similar rituals: they eat, relate to supernatural beings, bury their dead, kill their enemies and look after their loved ones. Instead, an original contribution to cultural anthropology could be made by visiting cafeterias at MIT or Harvard and putting hidden microphones along the corridors of the labs at the universities of Northwestern in Chicago or UCLA. Scientists who talk among themselves and discuss their work and experiments while they drink campus coffee do not speak as they write in *The Journal of the American Medical Association*, *Physical Review Letters*, *Cell*, or *Nature*. Listening to the way they

3 Ivi, p. XXVI.

4 Spoletoscienza is a science popularization event organized by the Fondazione Sigma-Tau and, since 1958, presented annually in Spoleto at the Festival dei due Mondi (Festival of the Two Worlds). See <www.fondazionesigmatau.it/spoletoscienza/> and <http://www.festivaldispoleto.com/>.

argue would open up a future causeway in the anthropology of science. Was Toulmin serious? Certainly, the public laughed and many heads nodded in approval.[5]

Between the end of 1998 and the beginning of 2002, theatre director Luca Ronconi worked on a project for the Piccolo Teatro in Milan. His idea of turning a scientific text by the astrophysicist John D. Barrow into a play was fulfilled in *Infinities*, staged in a huge converted warehouse in Milan's Bovisa area. The play won the Premio Ubu for the best theatre show in the 2001 – 2002 season, went to Valencia and, in Spring 2003, came back to Milan. In two seasons at Bovisa, it was seen by a paying audience of more than 35,000. When it opened in March 2002, and again in its second season at Bovisa, it was booked out two months before the first night.[6]

When Ronconi started to talk about staging a scientific subject, he made clear that complexity should be neither smoothed over nor polished. It took us quite a time to understand what he was looking for. Amongst the proposals by friends and consultants, one deserves attention: Gerald Holton, the science historian, suggested contacting the American Institute of Physics in New York to ask for a file he believed to be unique, containing a unit from an educational kit called *Moments of Discovery*. The unit describes the discovery of the first astronomical, optical pulsar: at the end of the 1960s astronomers knew about radio frequency pulsars, but they had yet to find a pulsar that is visible in the ordinary light spectrum.[7]

Having met by chance by the side of a swimming pool at a motel in Tucson, John Cocke and Michael Disney soon discovered that they were both theoretical astronomers on their way to the Steward Observatory run by the University of Arizona, where they were each taking up positions as observational astronomers. As soon as they arrived, they asked to work with a telescope to get in a bit of practice. Donald J. Taylor, a young mathematician who joined them, pointed the telescope towards the Crab Nebula and in the next few days they saw an optical source which could only be a pulsar: beginner's luck (and they were beginners). The telephone had buttons they did not understand. They pressed a few of them, and one switched on a tape recorder which, unbeknown to them, recorded the discovery.

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5 For the debate which followed Toulmin's talk at Spoletoscienza in 1992 see Stephen Toulmin, 'La ragione è schiava delle passioni?' ('Is Reason a Slave to Passions?'), in *La passione del conoscere*, ed. by Lorena Preta (Roma – Bari: Laterza, 1993), pp. 3 – 28.

6 See <www.fondazionesigmatau.it/lascienzainscena> and the web site of Piccolo Teatro, <www.piccoloteatro.org>.

7 *Moments of Discovery. Unit 2: A Pulsar Discovery*, ed. by Arthur Einsenkraft, Joan N. Warnow, and Spencer R. Weart (Center for History of Physics, American Institute of Physics: College Park, 1984).

If you write to the Center for History of Physics, you can obtain a kit with a record of the astronomers' words, a transcript, interviews, and a copy of the paper reporting the discovery, published in *Nature* on the 8th February 1969. The tape, the transcript, the interviews and the paper tell the story of the same scientific discovery, but in very different ways. Of course it is possible to talk about a subject at different levels, but in science the usual assumption is that the peer reviewed paper is the starting point. *Moments of Discovery* shows that the publication in *Nature* is not the original text for the discovery. Rather than occurring at a defined moment in time in a defined place, the discovery of optical pulsars involved a series of moments in different places. Discoveries are based on the practices scientists use to make sense of their observations, on hypotheses, mistakes, changes of heart, replications of old experiments, debates in research groups and researchers' minds. The article is a translation of all these transactions. It must be written in a way that the scientific community can understand; it should provide instructions about how to repeat the observation or experiment, but it generally says little about conjectures, debates, mistakes, and revisions.

Journals provide authors with guidelines on how they should write scientific papers. Compliance with the guidelines is a precondition for publication. Are journals to be blamed, if the processes of discovery in science are so illegible, so inaccessible? To some extent, yes. According to Lewontin the language of scientists is so rarefied as to be incomprehensible even to colleagues in related disciplines. If scientific papers are poor translations of the processes underlying them, the causes are to be found in the language the scientific community has chosen to use for the job.[8] However, it is wrong to assume that popularization can start with the paper. Scientific journals are not offering a little bit of knowledge to everyone, rather their aim is to guarantee that a very few people with the necessary skills can understand every detail of what has been done so that in principle they can replicate and validate the experiment or observations. The meaning and importance of a scientific work cannot be explained to a broader audience by discussing the paper in *Nature*; public understanding of science can instead be fostered by a focus on the history of the discovery.

Instead of debating the ways in which the scientific community deliberately detaches from the public, or uses a language for novitiates only, it is worthwhile focusing on how science announces its goals before they are achieved.[9] A so-

8 Richard Lewontin, *Biology as Ideology: The Doctrine of DNA* (Concord: Anansi, 1991).

9 An emblematic case, likely to become a paradigm for the future, was Fraser, Hamilton Smith and Venter's 1995 paper on the minimum number of genes required for the viability of Mycoplasma genitalium. In January 1999 the three explained to a news conference of the AAAS how it might be theoretically possible to create a synthetic 'minimum genome'. In December of the same year, during a public discussion, they commissioned a study of the

ciological study would very likely show that science does cut itself off through language, but journals should not be the main object of investigation. In fact, the reason why they publish papers written in expert jargon which until recently could not be translated into the mass media language is that they take for granted the scientific knowledge of specialized readers. The authors write as they speak: for their peers. Thus, neither summaries of previous episodes nor attempts at popularization are to be found, because they are not needed.[10]

Today people who are not familiar with scientific language are interested in scientific articles. However, if details were added and paragraphs summarized for the benefit of the average reader, the length of papers would increase almost infinitely. As Borges noticed, inclusion of all particulars would require drawing a map on the same scale as the reality it represents. Popularization and dissemination of science involve understanding the differences between scientific and other types of discourse: science can be communicated by selecting materials which in an article would be superfluous.

III. Science on Stage

In 2002 John Barrow's five scenes on the paradoxes of infinity and Luca Ronconi's theatrical machine were hosted in Bovisa, in whose warehouses and galleries the costumes and scenery for La Scala Milan had been stored. In the summer of 2001 Barrow and Ronconi were at the Spoleto festival, sitting next to each other, swapping ideas, taking turns to jot them down on sheets of paper, almost tearing them from each other's hands. Ronconi mentioned Bovisa and, while speaking, sketched out the space and stage layout. He did not want Barrow to write 'for the theatre'; on the contrary, he asked him to create a scientific text which could not be translated into a play.

In the autumn of 1999 Barrow's ideas came in a fast train he arranged, carriage by carriage, in a carefully orchestrated crescendo of implications and analogies. The locomotive was a powerful idea encompassing the anthropic principle, the ubiquity of mathematics, theories of everything, impossibility, and nothingness.

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ethical implications and financed the committee, chaired by Arthur Caplan, with their own funds (a real novelty!). From then on they behaved consistently. In 2001 they published the report and in November 2002 made known they would conform to the guidelines suggested by the committee.

10 Journals have recently begun to popularize the most important results in special articles written for scientists from other disciplines. Often they or their publishers offer various levels of popularization on web sites. For instance *Science* has special sections for children and science students, *Nature* has sections for journalists and the general public. See, in this volume, Jorge S. Burns, 'Stem Cells: Heroes with a Thousand Faces', in PART II: Bioscientific Discourses and Narrations, pp. 259 – 278.

He proposed to write the piece in scenes, as he wanted each carriage to have its own locomotive power. There would be couplings, but the carriages would be built to move on their own. The texts were to be written so as to allow the scenes to travel in convoy or move independently, each on its own account. Ronconi liked the idea.

From the ideas Barrow put forward for a text, Ronconi chose 'Infinities in mathematics'. When they met in July 2000, the interpreter was concerned about over-interpreting what they were going to discuss. They were careful to speak one at a time: John made sketches, turning ideas into geometry, rendering the infinite into shapes which made sense to Luca. It was through the sketches that they managed to understand each other. The drawings built a bridge between two very different worlds.

They met up again in Varenna, invited by Elio Sindoni and Giulio Giorello, then in Bologna, hosted by Paolo Fabbri, and at the 2001 Spoleto festival. But the spark that set everything off came during the Jubilee year. While saying goodbye to each other in the hall of the Albornoz Palace Hotel, it was clear that the show was going to happen: the idea had become a project. Soon there would be a schedule, deadlines, texts (the first scene arrived by email from Sydney on the 4th of December 2000), translations, editorial reviews, and more meetings. It had been a long time starting but now the train had pulled out of the station and was on its way.

IV. The Challenge of Staging Science

The possibility of bringing Ronconi and Barrow together had first been discussed in the summer of 1999. Sergio Escobar, the director of the Piccolo Teatro in Milan, and Barrow were at Spoletoscienza. Carl Djerassi, the inventor of chemical synthetic mechanisms underlying development of the first contraceptive pill, was also there. He, the author of several plays on scientific themes, listened and encouraged us, but did not believe we could do it, to which Escobar replied: 'You don't know the Piccolo'.

At the beginning it was not at all clear what Ronconi's idea actually was. The very fact that he had contacted the Fondazione Sigma-Tau asking for collaboration put us in a state of euphoric buzz. Getting started took nearly the whole of 1999 and in those first months all the proposals were for science which could be translated into dialogue and thus easily adapted to what we saw as the requirements of the stage. The theatre had come looking for us, far away from its usual haunts, and we wanted to return the courtesy: some pre-digested text, a tame lecture, or a little known epistolary correspondence it was believed would serve the purpose. When we retrieved the above-mentioned original audio re-

cording of a scientific discovery, we thought our task was accomplished. Three experimental astronomers at the instant they catch sight of the first optical pulsar: here was the body of science, true, naked, original science. Ronconi was polite but firm: it was no good, not what he was looking for. One day I asked his opinion about *L'Homme qui …* (1993), Peter Brook's theatrical production inspired by *The Man Who Mistook his Wife for a Hat and Other Clinical Tales* (1985) by neurologist Oliver Sacks. Ronconi thought Brook's idea was interesting, but if one of his actors should play a discourse by Sacks, he would bend it to the language of Pirandello. He wanted a genuinely scientific text, and it was the theatre that should bend. A text which could not be reduced to a play would force him to create a new mode of dramatic expression, a form that had never been seen on stage. I realized it would be mathematics and decided to call Barrow in Cambridge.

He was in the middle of moving house. After having been the director of the Astronomy Center at Sussex University, living in Brighton, he was to become the head of the Department of Applied Mathematics and Theoretical Physics at Cambridge and a Fellow of Clare Hall. In his new job he would head the 'Millennium Mathematics Project', a university initiative to improve the perception of mathematics in British schools. That evening Barrow was not in. 'Do you want me to sing at La Scala?' he asked next morning. We discussed ideas over the phone, in Spoleto, by fax and email. In October 1999 we worked in Barrow's new house and carried on as we strolled through the corridors of the college. He was curious and amused, talked about infinity and its paradoxes. Which is longest? The list of the positive integers or the list of their squares? Galileo had put the same question in the mouths of Sagredo, Simplicio, and Salviati. He mentioned Hilbert's Hotel Infinity, and I remarked that Ronconi would appreciate the idea of a show which was 'infinite'. Borges' library of Babel, Ellis and Brundrit's paradox of duplication, mathematics as the science of the infinite, Herman Weyl's concept of continuum, Cantor's three levels of infinity were beginning to come together in his mind. He wanted to know the reasons for Ronconi's unusual project: staging the expression of science is certainly one answer.

Science has many ways of expressing itself. Ronconi and the Piccolo Teatro were thinking entirely in terms of performativity, trying to invent new forms of dramatic representation. For the Fondazione Sigma-Tau it was a perfect opportunity to achieve the project of science communication it had pursued ever since it was created, nearly twenty years earlier. If science consisted exclusively of papers in *Nature*, *Science*, *The Lancet*, or *Cell*, popularization would really be impossible. Knowing that scientific disciplines are so specialized, that the language is so formal and science papers are impenetrable to scientists working in other disciplines, we are supposed to accept the current conventional wisdom, as expressed by scientists and research centres we trust. But should we? Who would

claim that civil law, economics, or modern philosophical thought are understandable in terms of ordinary language? Do any of us think we are the ideal readers for the language of art criticism?

Any text produces multiple layers of interpretation, each of which implies different levels of accessibility. This is true for all discourses, because they are social processes, bound by constraints of language and social convention. If theatre can create new modes of expression able to disarticulate its discourse, why cannot science do the same? Why should it hide the practices that give it its meaning? Why should it cancel the actions and passions out of which it is conceived in order to appear immaculate and approachable? Public awareness of science can be formed by showing what happens at the back of the shop, just as Galileo did, when he visited the Arsenal in Venice.

Knowing that attempts at word for word translation would only betray the original, Ronconi and the Piccolo Teatro wanted to crash theatre and science together as if they were in a particle accelerator. The public stood in line to watch particles of discourse shooting off in unpredictable directions. *Infinities* was staged precisely because no-one knew what it would be like.

Room after room, paradox after paradox, the public saw five different scenarios: Hilbert's Hotel with an infinite number of rooms; eternal life; infinite replicability; Cantor room, where infinite is not a big number; space and time travel. People, divided into groups of 70, entered the show every 15 minutes and could re-enter from the first room or any other, along an infinite path to Infinities. Every time the scene was the same, but not entirely, as different actors, the large majority of them wearing masks, were acting the same lines.

The staging of *Infinities* offers an answer to what at first sight appear to be simple questions. How much is it possible to understand from a discourse that presupposes specific skills on the part of the listener? Does it matter whether we fully understand? Nobel prize-winner Roald Hoffmann and journalist Sylvie Coyaud addressed these issues in their review of *Infinities* in *Nature*:[11] 'Do we learn any mathematics? Yes. Does it matter? Not at all!' A large number of spectators came into contact with the paradoxes of infinity: did they learn new mathematical notions? Yes, according to Hoffmann and Coyaud, since you always learn something whatever you do. Is it relevant? Not really. What matters is that they went to the theatre and 'visited' science as they might have visited a museum. If their aim had not been enjoyment, they would probably have missed all the fun.

11 Sylvie Coyaud and Roald Hoffmann, 'Infinite ideas. A Theatrical Contemplation of Infinity Makes Full Use of Industrial Space', *Nature*, 416, 11 April 2002, 585, <http://www.nature.com/nature/journal/v416/n6881/full/416585a.html> [accessed 1 June 2011].

V. Genres of Science Popularization

The staging of scientific concepts shows the relevance of genres to science popularization. Novels, films, or TV plays can be classified as 'comedy', 'horror', 'mystery', 'period adventure', 'erotic'. More distinctions can be drawn in terms of different modes of expression: specific features distinguish film from television or literature. However, genres tend to overlap, even in a single work. Is *War and Peace* a historical novel? Is *De Bello Gallico* a war diary? No-one would deny that Galileo wrote science, yet the literary quality of his prose has always been recognized and appreciated. Milan Kundera's novels skilfully interweave philosophical essays, historical studies, and diary entries. From a technological point of view, the genre of a popular science TV programme is obviously television, certainly not literature, or film, or radio, but as far as content is concerned, the genre is science and also popularization.

According to Roman Jakobson verbal communication involves six factors: the sender and the receiver of a message, the message itself, a verbal or verbalizable context, the code and the physical channel used for transmission. Each of these factors is associated with a specific language function. When language refers to the state of the person who is communicating, it is emotional (and maybe expressive). When it refers to the receiver, it is poetic. When messages refer to the context of the communication, they are referential, metalingual when they refer to the code, phatic when they refer to the material substrate of the communication. Jakobson's schema is dated and, according to some authors, incomplete. Algirdas J. Greimas has pointed out that it refers to 'informational' practices, while 'persuasive' and 'interpretative' practices involve more manipulation than communication.

The genre 'science' activates the poetic function by focusing on the message, which consists of objects, elements, and events belonging to the world of science. However, popularization also entails a relationship between the expressive and the conative function, the communicative intentions of the sender and the skills he/she expects to find in the receiver. Popularization is thus 'informative', but also 'persuasive' and 'interpretative'. As far as the phatic function of language is concerned, that is the physical medium used to transmit the message, the genre usually adopted is television. As regards the code, or the sincretic mix of codes used by the programme, the metalingual level is involved, including words, pictures, gestures, and space.

What makes a piece of writing a work of science? *Cantatrix Sopranica L.* is the answer of Georges Perec, a key figure in a bizarre group of writers called Ouvroir de Littérature Potentielle (OuLiPo) and associated with Alfred Jarry's Collège de Pataphysique. Perec reproduces the rhythm, the structure, the proportions, and the form of a scientific paper, introducing elements chosen on completely arbitrary grounds. The result is a minor masterpiece of literary parody, a *divertissement*, another genre in its own right. As is usual in scientific papers, the Introduction is followed by three sections: 'Materials and Methods', divided into subsections on 'Preparation', 'Stimulation', 'Observation', and 'Histology'; 'Results'; 'Discussion'. The paper is illustrated with graphs and tables and exhilarating citations:

> Alka-Seltzer, L. Untersuchungen über die tomatostaltische Reflexe beim Walküre. *Bayreuth Monatschr. f. exp. Biol. 184*, 34 – 43, 1815.
> Marks, C.N.R.S. & Spencer, D.G.R.S.T. About the frightening reactions that accompanied first performances of *Il Trovatore* at the Metropolitan. *Amer. J. Music. Deficiency 7*, 3 – 6, 1899.
> Sinon, E., Evero, I & Ben Trovato, A. Psychopathological description of *La Furia* di Caruso. (in Italian). *Folia clin. Oto-rhinolaryngol., Foum Tataouine 6*, 362 – 363, 1948. (Quoted by Hun & Deu, 1960).

What is this strange scientific paper? Perec was a mathematician but also a man of letters. Like nearly all members of OuLiPo, he had a phenomenal knowledge of matters logical and mathematical. As a writer, he read scientific papers to understand them, but also to apprehend their underlying structures and use them in papers of his own. He amused himself by creating a parody, filling the form with novel content which had no right to be there. Maybe he was following Umberto Eco's suggestion that the noblest functions of things which do not take themselves seriously is to cast doubt on those which do; maybe he wanted to make us more familiar with the original model (even to parody a text is to grant it a form of recognition). Certainly, if writers can read scientific papers even without understanding, say, super-conductivity or insulin-dependency, and if they can commit to memory the formal structure and the way in which the argument is conveyed, they should be able to do the same with other kinds of text. They can study, mimic, and exploit form for their own ends, even without being interested in content, which may be completely incomprehensible.

Kepler apologized for having adopted the style of a traveller's tale, Galileo did the same when he mimicked and reworked the form of the Socratic dialogue. In Antonio Damasio's *Descartes' Error: Emotion, Reason, and the Human Brain* (1994) the story of Phineas Gage and his accident looks like a typical newspaper article. Luca Ronconi allowed theatre to be moulded by contact with a scientific

text. Barrow was invited to write as if for a scientific paper, but his experience as a theatre-goer led him to organize *Infinities* as a sequence of scenes.

The authors' choices matter, because they show there are many different ways to popularize science. A stage adaptation of a scientific essay pulls in thousands of spectators. A study in neuroscience engages readers with the kind of story they would normally find in a newspaper. In *Somnium* (posthumous, published in 1634) Kepler amuses himself and his readers by adopting the style of a travel diary. These cases show that there is no need for science to be incomprehensible. Any text is excruciating to read if written exclusively for a selected specialist public; but there is nothing that forces science itself to be incomprehensible. When authors decide to write for readers who are not peer reviewers, when they create a scientific text for the theatre, they are engaging themselves in a new and original form of translation. The relationships between the expressive and the conative function, the communicative intentions and the skills the sender expects to find in the receiver are crucial in science communication. Manipulation and interpretation need to be examined, issues such as 'passion' and 'point of view' cannot be overlooked.

Scientists constantly aim to convince the public opinion about the 'purity' of their assumptions, to prove that science is not a matter of passion or point of view, but they are growing aware that the emergence of Public Understanding of Science programmes and the ethical and political need for the dissemination of science knowledge demand new perspectives. Popularization involves translation. What scientists do should circulate together with their passions and points of view. A simplistic psychological approach is to be eschewed, as the focus is neither on personal attitudes nor on the 'psychology of the genius'. A more challenging aim instead is to explore and clarify the 'persuasive' strategies adopted in scientific projects.

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Part II:
Bioscientific Discourses and Narrations

Maurizio Ascari

'Disease is a crime; and crime a disease now unknown': Changing Views of Crime in Nineteenth- and Twentieth-century Culture

This paper highlights a dramatic change that took place in the conceptualisation of crime during the course of the modern age due to the shift from a worldview that pivoted on religion to one that has been increasingly informed by scientific thought.[1] The association between crime and sin, prevalent in the medieval and early-modern ages, gradually weakened throughout the nineteenth century, giving way to a corresponding nexus between crime and disease (notably insanity and epilepsy), which in turn came to be scrutinised as the cause of anti-social behaviour. This nexus became particularly relevant in those late nineteenth-century, pseudo-scientific texts that pivoted on the concepts of atavism, heredity, and degeneration, such as the works of Cesare Lombroso and the other Italian 'criminal anthropologists', Enrico Ferri and Raffaele Garofalo, but also of Havelock Ellis, who popularised these continental theories in Great Britain.

To study the development of the discourses of crime – also in relation to detection and punishment – I will analyse both literary and pseudo-scientific sources. First, I will touch on the so-called *providential fiction*, which embodied the religious plot of sin and punishment and exerted a form of psychological policing on the population. Secondly, I will deal with nineteenth-century *sensation fiction*, whose hybrid nature mirrors a time of deep cultural change.

1 One can hardly study the changing definitions of crime and the criminal in the modern age without taking into account Foucault's seminal theories. I am aware, of course, of the transition that Foucault traced between sovereign power, which aimed to punish crime, and disciplinary power, which aimed to punish the criminal. I am also aware of the concomitant transition between spectacular rituals of punishment (whose object was the body of the criminal, and whose aim was to insure the prevention of crime by means of exemplum), and the disciplinary conception of punishment as being focused on the soul of the criminal, which was accompanied by a new strategy of prevention resting on the certainty of punishment due to new and pervasive technologies of detection. See Michel Foucault, *Power/Knowledge: Selected Interviews and Other Writings 1972 – 1977*, ed. by Colin Gordon (New York: Pantheon Books, 1980) and Id., *Surveiller et punir. Naissance de la prison* (Paris: Gallimard, 1975). See also Simon During, *Foucault and Literature: Towards a Genealogy of Writing* (London and New York: Routledge, 1992).

Thirdly, I will venture into the domain of *criminal anthropology* to study the growing importance of the paradigm of heredity and briefly hint at its literary rendering. Finally, I will offer a brief analysis of *Cain; or, The Future of Crime*, a book by the lawyer George Godwin which featured in the popular series 'To-day and To-morrow' in 1928. A coda will briefly relate these reflections to some recent developments in criminography and criminology.

I. Providential Fiction

In Chaucer's 'The Nun's Priest's Tale' two friends are on a pilgrimage, a sort of sacred mission. When they arrive in a city where all the inns are full they have to separate for the night and one of them is subsequently killed. The other is informed of what has happened by means of a dream which leads to the discovery of the corpse. As we can see, here detection is directed from above. It is God himself who unveils this dark deed, according to the providential logic that is voiced in the medieval proverb 'Murder will out'.

Revelatory dreams, the apparitions of ghosts, exceptional coincidences are the stage props of a cultural mise-en-scène which aimed at convincing public opinion that, despite the inefficiency or collusion of mundane power, criminals were fated to be discovered and punished by God. This paradigm of sinful crime and divine detection was still prominent in the early-modern age, and as late as 1752 Henry Fielding wrote a pamphlet entitled 'Examples of the Interposition of Providence in the Detection and Punishment of Murder'. The late eighteenth-century *Newgate Calendars* also conformed to this supernatural view of detection, which survived well into the nineteenth century.

Of course I am not implying that the general climate of Enlightenment had no influence on the cultural discourses of crime: it suffices only to think of Cesare Beccaria's *Dei delitti e delle pene* (1764, *Of Crimes and Punishments*), which soon achieved European renown. This thinker argued against the barbarous practice of torture, advocated a humane treatment of criminals, and called the attention of the public to the importance of clues, on which the fully modern and scientific view of detection is grounded.

II. Sensation Fiction

As a result of these changes, in the first half of the nineteenth century conflicting views of crime, detection, and punishment vied for supremacy, also in relation to the development of pseudo-sciences such as physiognomy and phrenology. In this epoch, moreover, fictional representations of crime and detection increas-

ingly incorporated the discourses of medicine, as Heather Worthington convincingly argued.[2] Samuel Warren's fictional 'Passages from the Diary of a Late Physician' (which were serialised in *Blackwood's* between 1830 and 1837) are a case in point, since in these professional anecdotes the medical gaze investigates cases whose crime interest is often uppermost.

Sensation fiction mirrored this complex cultural phase, which was marked also by a new interest in the study, management, and treatment of insanity.[3] The theme of hereditary madness marked the literary career of William Wilkie Collins right from the beginning, as is shown by *Mad Monkton* (1855), which can be read either as a ghost story or as a case of monomania, and *The Woman in White* (1860), where all the members of the Fairlie family somehow prove to have 'weak nerves'. In order to study how the concepts of crime, sin, and madness intertwined with the deterministic paradigm of heredity in the heyday of sensation fiction, I will focus on two novels that were published in the 1860s – Elizabeth Braddon's *Lady Audley's Secret* (1862) and Collins's *Armadale* (1866).

As we know, Braddon's fair and gentle heroine turns out to be a reckless villainess. Lady Audley is both a bigamist and a murderess, although in the ambiguous ending of the novel she is confined to a lunatic asylum rather than to a prison, which also avoids a public scandal involving her husband's aristocratic family. Is Lady Audley a criminal or is she mad? Many a critical essay has been devoted to this question, which has much to do with the conventional representation of femininity in the Victorian age. At the time, the idea of female crime was difficult to accept, particularly when it concerned young middle-class women, as is proved by the notorious cases of Constance Kent[4] and Madeleine Smith.[5] Thus by conflating female crime with madness Braddon somehow reassured her public. In order to appreciate the novelty of Braddon's heroine, we should remember that both Lady Macbeth – an illustrious antecedent of sensation villainesses – and the protagonist of Edward Bulwer-Lytton's *Lucretia; or The Children of the Night* (1846)[6] become mad as a consequence of their crimes, which somehow 'violate' their feminine identity.[7] On the other hand, Lady

2 Heather Worthington, *The Rise of the Detective in Early Nineteenth-Century Popular Fiction* (Basingstoke: Palgrave Macmillan, 2005), pp. 46 – 68.

3 Jenny Bourne Taylor, *In the Secret Theatre of Home: Wilkie Collins, Sensation Narrative, and Nineteenth-century Psychology* (London and New York: Routledge, 1988), pp. 27 – 70.

4 In 1860 a small boy was murdered in the village of Road. Although a clue pointed to the boy's stepsister Constance as the culprit, the local police eventually arrested the nursemaid, only to release her. Five years later Constance confessed to the murder.

5 In 1857 Madeleine Smith was tried for the murder of her lover Emile L'Angelier, but although circumstantial evidence was against her the court issued a 'not proven' verdict.

6 Laura Ciolkowski, 'The Woman (In) Question: Gender, Politics, and Edward Bulwer-Lytton's *Lucretia*', *NOVEL: A Forum on Fiction*, 26, 1 (1992), 80 – 95.

7 'Come, you spirits / That tend on mortal thoughts, unsex me here,' (Act I, scene v, lines 38 – 39)

Audley's madness is described as conducive to the crime and accounts for the villainess's transgression, being presented as a disease she inherited from her mother.[8]

Heredity plays a major role also in the criminal plot of *Armadale*, where it is associated not with madness, but with sin. In this novel of baroque complexity – where as many as five characters share the same name, Allan Armadale – Collins relied on parallelism and coincidence to such a degree that the result is a wildly allegorical text, a sensational *roman à thèse* which aims at disproving nothing less than the following Biblical maxim: 'for I, the Lord your God, am a jealous God, visiting the iniquity of the fathers on the children, on the third and the fourth generations of those who hate Me'.[9]

Without attempting a summary of Collins's highly improbable but no less enticing plot, I will remind you of its central predicament. After committing a murder, Allan Armadale sr. dies and the weight of his guilt falls on his infant son, who is subsequently hated by his mother and stepfather, and therefore runs away from home to lead a desperate life with gypsies and ruffians. When this boy becomes an adult, destiny brings him into close contact with the son of his father's victim. At the core of the story we find a premonitory dream whose correct interpretation is vital. At first a series of preternatural clues seem to warn the young protagonist of the danger that he may re-enact his father's crime, according to a superstitious view of fate, but in the end it turns out that his role is that of saviour and that his behaviour will, on the contrary, redress his father's conduct. Collins's novel can be read as a pamphlet against the widespread prejudice that a sinful tendency is hereditary – a prejudice that is voiced by the murderer himself in his deathbed letter to his son:

> I look into the Book which all Christendom venerates; and the Book tells me that the sin of the father shall be visited on the child. I look out into the world; and I see the living witnesses round me to that terrible truth. […] I look in on myself – and I see My Crime, ripening again for the future in the self-same circumstances which first sowed the seeds

is the dark invocation Lady Macbeth pronounces to overcome her feminine nature and help her husband perform the fatal deed of murder. William Shakespeare, *Macbeth* (1606), in *The Norton Shakespeare*, ed. by Stephen Greenblatt (New York and London: W. W. Norton & Company, 1997), p. 2572.

8 This is how Lady Audley describes her visit to her mother in the asylum where she was confined: 'Her madness was an hereditary disease transmitted to her from her mother, who had died mad. She, my mother, had been, or had appeared sane up to the hour of my birth, but from that hour her intellect had decayed, and she had become what I saw her. I went away with the knowledge that the only inheritance I had to expect from my mother was – insanity!'. Elizabeth Braddon, *Lady Audley's Secret*, Introduction by Norman Donaldson (New York: Dover, 1974), p. 230.

9 *Exodus*, 20.5; *Deuteronomy*, 5.9.

of it in the past; and descending, in inherited contamination of Evil, from me to my son.[10]

Like most of Collins's works, *Armadale* is suspended between past and present, between romance and novel, between traditional beliefs and disciplinary knowledge. This is why it is such a good example of the syncretic nature of nineteenth-century culture. Interestingly, it was precisely in 1866 – the year when *Armadale* appeared – that the Austrian monk Gregor Mendel published the results of his cross-breeding experiments with pea plants, which would provide the foundations for the new science of genetics. Few years later – in 1869 – Francis Galton published his well-known *Hereditary Genius*, although he would coin the term 'eugenics' only in 1883.[11] Combining statistical methods with the evolutionary theories of his cousin Charles Darwin, Galton pursued the pseudo-scientific dream of improving the human species by forms of selective breeding, which meant that 'inferior' human beings should be prevented from generating an offspring.[12]

III. Criminal Anthropology and Fin-de-siècle Crime Fiction

At the end of the century the concept of heredity played a major role in Victorian culture, notably in criminal anthropology, as is proved by Havelock Ellis's *The Criminal* (1890), a chapter of which is devoted precisely to heredity. Following Lombroso's eclecticism, Ellis chose to support the criminal anthropologists' theories by reverting to the childhood of Western civilisation, and ransacked classical texts to provide cultural evidence in favour of what he regarded as a scientific tenet, i. e. 'The hereditary character of crime', which was 'involved in the old Hebrew conception […] of a God who visited the sins of the parents upon the children unto the third and fourth generation'.[13] Ellis regarded this hereditary character as resulting from two factors – 'innate disposition' and 'contagion from social environment'.[14] As we can see, the English scholar adopted in turn a

10 William Wilkie Collins, *Armadale*, ed. by Catherine Peters (Oxford and New York: Oxford University Press, 1989), p. 40.

11 Francis Galton, *Inquiries into Human Faculty and Its Development* (London: Macmillan, 1883).

12 As we know, eugenics exerted a widespread influence throughout the 1920s, for instance in the USA, and it was also in the 1930s that the criminal use of eugenics on the part of the Nazis triggered sharp criticism, contributing to the downfall of this attempt to control the evolution of humankind.

13 Havelock Ellis, *The Criminal* (London: Walter Scott, 1890), p. 91.

14 Ibid., ivi.

historical, a biological, and a sociological perspective to present criminal 'instincts' as an inherited trait of the individual.[15]

Since Ellis did not consider the majority of criminals to be 'normal' people who had deliberately chosen the path of evil, but rather as the victims of a deterministic plot, in his eyes the notion of punishment lost 'much of its foundation', for 'We cannot punish a monstrosity for acting according to its monstrous nature'.[16] This passage is followed by an extended discussion of the prison system, which is strongly criticised by Ellis as being a school for crime rather than a place of reform. The medical model that underlies the last chapter of the book right from its title – 'The Treatment of the Criminal' – is apparent from Ellis's assertion that the prison must be 'a moral hospital',[17] a definition that well agrees with his view of the 'instinctive criminal' as affected by 'moral insanity'.[18]

Late nineteenth-century crime fiction also dealt with the problem of inherited 'disease' (usually of a mental or venereal nature), as is shown by a range of texts including Arthur Conan Doyle's 'The Third Generation' (from *Round the Red Lamp*, 1894). The hero of Doyle's story is a young aristocrat who suddenly discovers he has developed the symptoms of the venereal disease that had been contracted by his debauched grandfather. The young man feels he is an innocent victim of fate, as is proved by the desperate exclamation he addresses to the physician who is examining him: 'Talk about the sins of the father – how about the sins of the Creator?'[19] To make the matter even more tragic, the unfortunate youth is about to get married, but when the doctor discovers this he cannot stifle a stern reproach and stigmatises such behaviour as 'criminal'.[20] A way out of this ill-fated union has to be found and the only advice the doctor can offer is that of deliberately committing a penal offence, so as to compel the bride's family to cancel the marriage. As we can see, paradoxically the innocent victim of heredity must turn criminal in order to preserve his innocence, but the young man will find another issue from his ethical dilemma and the following morning a newspaper article announces his 'accidental' death.

15 As a proof of the strong emphasis Ellis placed on ancestry, one may quote his cameo portraits of Thomas Griffiths Wainewright, a notorious poisoner who came from a wealthy and cultivated family, which Ellis described however as 'a failing and degenerating stock', thus explaining the deviant behaviour of Wainewright. Ibid., p. 12.

16 Ibid., p. 233.

17 Ibid., p. 271.

18 Ibid., p. 17.

19 A. C. Doyle, 'The Third Generation', in Id., *Round the Red Lamp, Being Facts and Fancies of Medical Life* (Freeport, New York: Books for Libraries Press, 1969), p. 53, <http://etext.lib.virginia.edu/toc/modeng/public/DoyLamp.html> [accessed 1 June 2011].

20 Ibid., p. 55.

IV. *Cain; or, The Future of Crime*

Starting from this ebullient cultural phase, when the nexus between crime and disease was explored from different perspectives, I will now focus on a text from the 'To-Day and To-Morrow' series that provides a fascinating insight into the early twentieth-century debate concerning the nature of crime and punishment – George Godwin's *Cain; or, The Future of Crime* (1928). The volume rests on the contention that the notion of crime is relative, since its definition depends on the cultural framework of each society. In order to support his view of crime as an 'illness to be cured',[21] Godwin referred to the utopian society Samuel Butler had depicted in *Erewhon* (1872). In this imaginary land if a man falls ill before he is seventy he is tried before a jury and runs the risk of being imprisoned. Conversely, as Butler wrote, 'if a man forges a cheque […] or does any other such things as are criminal in our own country, he is […] taken to a hospital and most carefully tended at the public expense'.[22] In Butler's satirical text, the Erewhonians' paradoxical attitude to crime and disease is functional to a strategy of estrangement,[23] but Godwin took it very seriously, since it harmonised with his pseudo-scientific worldview.

After showing that the cultural practice of punishment was rooted in the primitive custom of revenge, Godwin argued that in the future society's response to crime would evolve towards a form of 'cure', thanks also to the development of psychoanalysis:

> When the delinquent of to-morrow has been found guilty […] He will not be harried as a 'sinner', or degraded as a monster. He will be treated as a sick person, and the psychopathologist who will set about his cure will do so with the detachment of the operating surgeon.[24]

The most interesting – and also disquieting – aspect of the volume is the emphasis Godwin placed on the nexus between crime and a cluster of pseudo-scientific concepts including heredity, race, and degeneracy. Godwin, who was an advocate of eugenics, believed that much anti-social behaviour was not actually punished by society simply because society had been oblivious of its far-reaching consequences:

21 George Godwin, *Cain: or, The Future of Crime* (London: Kegan Paul, Trench, Trubner & Co., 1928), p. 1.
22 Samuel Butler, *Erewhon*, ed. by Peter Mudford (Harmondsworth: Penguin, 1970), p. 102.
23 Don R. Osborn, 'Samuel Butler's *Erewhon* as Social Psychology', *Teaching of Psychology*, 17, 2 (1990), 115 – 117.
24 Godwin, p. 39.

> In the future we may find that by making the test of crime its effect, not only upon the community of to-day but also upon the race, certain things now criminal will cease to be so, while others not now crimes will become offences.[25]

Far from leaving the matter at a theoretical level, Godwin exemplified this issue so as to alert the public to the inadequacy of the law to protect society: 'Again, in England to-day, it is a crime to marry two women; but it is not a crime for a syphilitic father to beget children of an epileptic mother', although 'the man who marries two wives injures the community in no way', while in the latter case the couple's offspring is 'foredoomed to degeneracy and predisposed to crime'.[26] This passage not only reminds us of the delicate subject Doyle tackled in 'The Third Generation', but also reveals Godwin's consistent effort to detach the notion of crime from its religious cultural matrix and to relate it to a scientific view of society's present and future welfare.

The result is an ambivalent stance, for on the one hand – also due to his faith in psychoanalysis – the author advocated the abrogation of the death penalty and the creation of a benevolent prison system that would ensure the reintegration of the delinquent into society, while on the other – due to his faith in eugenics – he anticipated the Nazi-Fascist notion of 'crime against the race':

> Down the centuries, down the ages, the chant of these communities has been: the race, the race, the race. Therefore the weak, the deformed, the lazy, and the vicious are exterminated. Disease is a crime; and crime a disease now unknown.[27]

Due to the emphasis on crime as a disease to be treated and the begetting of diseased offspring as a crime to be prevented, *Cain* testifies to the complex nature of the interwar period, when the scientific and pseudo-scientific concepts that had evolved in the second half of the nineteenth century engendered a web of contradictory cultural responses, which ultimately contributed to the ideological background of Nazi-Fascism.

This is amply proved by the chapter Godwin devoted to those he defined as 'The irreclaimables', i. e. those degenerates whose progeny is destined to bring havoc to future ages:

> Segregation looms to-day as a necessity of the immediate future because in the past we have shrunk from sterilization or painless elimination. […] If human life be indeed sacred, then the life-stream of the race is sacred above the lives of individuals. It must be safeguarded from the transmitter of the damaged germ-plasm. It is the sacrifice of the living few for the unborn multitude. […] It is the offence of certain members of the

25 Ibid., p. 15.
26 Ibid., p. 12.
27 Ibid., p. 100.

> community that they have been born at all. The sins of the fathers are visited by the gods upon the children. Ruthless elimination is the remedy.[28]

An unquestioning belief in heredity underlies these statements, which testify to the emphasis Godwin placed on the biological prevention of crime rather than on its psychological cure. As we have seen, Godwin aimed at substituting the conventional Christian morality of Western society with a new biological morality. The ultimate consequence of this attitude, however, is the perverted dream of manufacturing a race of superhuman beings where there is no place for either physical, mental or moral imperfection: 'In the future – wrote Godwin – we shall probably regard it as a meritorious act on the part of a mother that she destroys at birth, say, a Mongol idiot'.[29]

As we can see, the shift from a religious view of crime as a sin to a scientific, or pseudo-scientific, view of crime as a disease was a multifaceted process which produced a wide range of ideological and material changes, both desirable and not. On the one hand, traditional prejudices and the barbarous practices they supported were progressively overcome – torture was substituted by increasingly accurate forms of scientific detection, and prison was no longer conceived solely as a place of punishment, but also as an instrument of reform that should lead, whenever possible, to the reintegration of the criminal in society. On the other hand, the uncanny alliance between the old Biblical paradigm of hereditary sin and the new biological paradigm of heredity helped create a dangerous pseudo-scientific scenario where the fear of degeneration combined with an uncritical belief in eugenics. This deterministic view of crime resulted in the apocalyptic vision of a scientific doomsday that would enable criminal anthropologists and biologists to free humanity from its debased components.

V. Minority Reports

The idea of crime as illness is still central to our imagination today, although we tend to relate it to the psyche rather than to the body. The importance given to serial killers[30] in contemporary criminography testifies to our fascination for 'inborn' criminals whose motives result from aberrant psychological profiles. Moreover – both in reality and in its mass-mediated representations – psychiatrists, psychoanalysts, and psychologists are involved in the various phases of the process of detection and punishment, including the definition of criminal responsibility and the reinsertion of the criminal into society.

28 Ibid., pp. 32 – 33.
29 Ibid., p. 50.
30 The term 'serial killer' became of current use only in the 1970s.

Although deterministic patterns which pinpoint the causal chain leading to crime still play a major role in our culture, what I wish to underline is the existence of counter-narratives that variously subvert the predicament of an individual who is 'predestined' to commit a crime. This idea is not new. Suffice it to think of Oscar Wilde's jocular 'Lord Arthur Savile's Crime' (1891), where a man is told by a chiromantist that he will commit a crime and eventually kills the man to relieve himself of the burden of future guilt and dishonour. As in Doyle's 'The Third Generation', the main character is engaged to be married and his first preoccupation is the reputation of his wife. In this humorous text 'predestination' is linked to pseudo-science, since chiromancy is related to physiognomy and phrenology,[31] but this subject is also related to a major concern of every society, i. e. the prevention of crime, a policy that when mishandled can have potentially dystopian effects.

These two dimensions coalesce in the 'pre-crime' investigation that is at the core of Stephen Spielberg's *Minority Report* (2002). Based on a short story by Philip K. Dick, the film is set in Washington in 2054. A pre-crime police has been established thanks to the psychic powers of the 'pre-cogs' – three genetically modified human beings who are able to predict future crimes. A political issue is at the heart of the film, since the country is about to vote on the possible adoption of the pre-crime programme on a national basis. The system, however, is flawed, as is proved by the plight of the main character, a policeman who is accused of a murder he will commit within the next 36 hours. The three pre-cogs constitute a hive mind, but what is revealed in the course of the film is that their visions of the future do not always agree. The hero's hopes are therefore based on the 'minority report' of pre-cog Agatha, who offers a different version of events. Within the pseudo-scientific framework of *Minority Report*, genetic engineering and pre-cognition jointly contribute to the enforcement of a deterministic view of human behaviour that is ultimately proved to be unreliable. In this 'parable' of our times, the panopticon myth of absolute knowledge clashes against a powerful topos of crime fiction, that is to say the sensational appeal of the innocent who is unjustly accused.

Minority Report exemplifies our mistrust of both state apparatuses and the pattern of predestination, which infringes upon our sense of human freedom and dignity. It is my contention that this attitude is also at the root of the postmodern reassessment of Judas – a phenomenon whose origins date back to the early 1970s, when the film version of *Jesus Christ Superstar* (1973) was released, triggering a scandal of global dimensions. So let us read once again the

31 Wilde's ironic fictionalisation of chiromancy uncannily reminds also of the scientific study of fingerprints, which was becoming popular in those years. Francis Galton's *Finger Prints* was published in 1892.

Gospel's account of the words Jesus used to address his disciples during his last Passover meal,

> 'Truly, I say to you, one of you will betray me'. And they were very sorrowful and began to say to him one after another, 'Is it I, Lord?' He answered, 'He who has dipped his hand in the dish with me will betray me. The Son of Man goes as it is written of him, but woe to that man by whom the Son of Man is betrayed! It would have been better for that man if he had not been born'. Judas, who would betray him, answered, 'Is it I, Rabbi?' He said to him, 'You have said so'.[32]

The ambivalence of this passage is apparent. Is Jesus 'denouncing' Judas so as to make it apparent to his disciples that he knows what his fate will be? Or is he paradoxically inviting Judas to betray him so that he can fulfil the Scriptures? As we know, in recent decades Judas – whose 'mythic biography', pivoting on greed and disloyalty, nourished the dark flame of anti-semitism – has somehow been rehabilitated. I regard the recent publication of the Gospel of Judas as a sign of the times rather than a coincidence, since Western societies were ready for a reappraisal of this archetypal figure. In this apocryphal text the necessity of Judas's supposed 'betrayal' is presented as a sublime act, for Judas is a tool in the hands of Jesus. He is the only disciple who has rightly understood Christ's message and who is ready to free him of his mortal coil and allow his passage to a higher sphere.[33]

The reassessment of Judas – whose condemnation was regarded in the past as without appeal, and whose status is now controversial, for he might even be regarded as a martyr – is a symptom of our epistemological and ethical attitudes. Ours is the age of minorities and 'minority reports'. We look for nuances in human behaviour and we are ready to swap our point of view for that of others. Complexity is the keyword of our times. We are suspicious of absolutes, of any univocal discourse, of black and white views of crime and justice. A recent and popular TV series is significantly entitled *In Justice* and focuses on the creation of a 'National Justice Project' the aim of which is to reassess cases that have been closed too hurriedly, and to free those innocent people who have been wrongfully imprisoned or even sentenced to death.[34]

As we can see, contemporary representations of justice often dramatise the danger of fallibility.[35] Correspondingly, crime is no longer confidently explained

32 Matthew 26.21–25. *The Bible*, English Standard Version, <http://www.biblegateway.com/passage/?book_id=47&chapter=26&version=47> [accessed 1 June 2011].

33 *The Gospel of Judas*, trans. and ed. by Rodolphe Kasser, Marvin Meyer, and Gregor Wurst (Washington, D.C.: National Geographic Society, 2006).

34 *In Justice*, which started on 1 January 2006 on ABC, was jointly produced by ABC, King Size Productions, and Spud TV.

35 Paradoxically, this can be regarded as a symptom of the wide social consensus the justice system enjoys in Western countries.

as a disease and we are increasingly aware that an 'integrated approach' to this social and cultural phenomenon is necessary, involving disciplines ranging from anthropology and economics to medicine, psychology, and sociology.[36] Moreover, although certain crimes – such as murder – are universally condemned, we are also increasingly aware of the 'cultural' forces that can displace the border between legitimate and illegitimate behaviour within each society.[37]

This 'cultural' approach to crime is extremely fertile. In their attempt to lead the discipline beyond its 'positivist' stage, some criminologists are now trying to build up trans-disciplinary connections with ontology, epistemology, ethics, and aesthetics.[38] The recent development of 'cultural criminology' is another sign of this attempt to analyse the multifaceted cultural implications of crime. This new and lively discipline, which was born from the marriage between criminology and cultural studies, explores areas of contemporary societies ranging from subcultures of crime to the media construction of crime and crime control.[39]

Briefly, although the contemporary landscape of criminology and criminography is far too complex to be mapped out in a few paragraphs, what I wish to underline in conclusion is that this plurality of approaches to crime has a political value and is in itself a proof of our critical attitude towards this phenomenon as well as a safeguard against the cultural regression that is concomitant with all-explaining pseudo-scientific theories of human behaviour.

36 Clive R. Hollin, *Psychology and Crime: An Introduction to Criminological Psychology* (London: Routledge, 1989), p. 1.

37 Ibid., p. 4: 'A society's legal system is a reflection of the consensus of what, within that particular society, will and will not be tolerated as acceptable conduct'.

38 Jack Katz, *The Seductions of Crime: Moral and Sensual Attractions in Doing Evil* (New York: Basic Book, 1988); *Philosophy, Crime, and Criminology*, ed. by Bruce A. Arrigo and Christopher R. Williams (Urbana, IL: University of Illinois Press, 2006); Christopher R. Williams, 'Potential Spaces of Crime: The Playful, the Destructive, and the Distinctively Human', *Crime Media Culture*, 3, 1 (2007), 49 – 66.

39 Jeff Ferrell, 'Culture, Crime, and Cultural Criminology', *Journal of Criminal Justice and Popular Culture*, 3, 2 (1995), 25 – 42; *Cultural Criminology*, ed. by Jeff Farrell and Clinton R. Sanders (Lebanon, NH: Northeastern University Press, 1995); Jeff Ferrell, 'Cultural Criminology', *Annual Review of Sociology*, 25 (1999), 395 – 418; *Cultural Criminology Unleashed*, ed. by Jeff Farrell and others (London: Glasshouse Press, 2004); Keith J. Hayward and Jock Young, 'Cultural Criminology: Some Notes on the Script', *Theoretical Criminology*, 8, 3 (2004), 259 – 273; Martin O' Brien, 'What is *Cultural* about Cultural Criminology?', *The British Journal of Criminology*, 45, 5 (2005), 599 – 612.

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Mary Kemperink

Physiognomies of Genius: Norm and Deviation in Nineteenth-century Literary and Scientific Writings

> Wo Wirkung, Kraft, Tat, Gedanke, Empfindung ist,
> die von Menschen nicht gelernt und nicht gelehrt werden kann,
> da ist Genie! […]
> Das Ungelernte, Unentlehnte, Unlernbare, Unentlehnbare,
> Innig-Eigentümliche, Unnachahmliche, Göttliche ist Genie […].
> Johann Kaspar Lavater, *Physiognomische Fragmente*, 1778[1]

I. Introduction

In 1888 a promising young Dutch author, Lodewijk van Deyssel, published an essay entitled 'Literatuur-fyziologie' ('Literature-physiology') in which he developed a thesis about the fundamental nature of the artist and presented a picture of himself. Without hesitation he stated:

> alle kunstenaars en groote denkers zijn neurasthenici, en het 'genie', de 'artisticiteit' is, zoolang de wereld bestaat, geweest en zal altijd blijven: een toestand van het zenuwgestel in het menschen-organisme, die de pathologische terminologie 'abnormaal' noemt, dat wil zeggen: afwijkend van den norm, en gelijkend op toestanden die men bij 'krankzinnigen' en 'misdadigers' aantreft.[2]

Artists are exceptional because they personify the abnormal, an abnormality van Deyssel defines in terms of disordered physiology. The mind of the artist comes close to the twisted brain of the madman and the criminal; genius and neurasthenia are conceived to be medical conditions.

The medical, pathological view of the artist expressed by van Deyssel and his

1 'Where there is impact, force, action, thought and perception that cannot be learned or taught, there is genius […]. That which is not learned or deduced, which is impossible to teach or be deduced, profoundly authentic and divine, that is genius', my translation.

2 Lodewijk van Deyssel, 'Literatuur-fyziologie', in Id., *Verzamelde opstellen* (Amsterdam: Scheltema & Holkema's Boekhandel, 1894), pp. 243 – 246 (p. 244): 'all artists and great thinkers are neurasthenics, and what is called "genius" or "artistic talent" has been and will always be for as long as the world exists simply a condition of the nervous system of the human organism, which in pathological terms is called "abnormal", i. e. a deviation of the norm, comparable to conditions found in the case of the "madman" or the "criminal"'.

fellow writers was an amalgam of literary and medical, notably psychiatric, conceptions. The nineteenth century marked the institutional separation of literature and science, which however remained intertwined in the production and circulation of knowledge.[3] Both were part of one and the same culture, with literature representing scientific knowledge and science making use of literary elements, such as myths and epic structure. An insight into how literature not only represents knowledge but also helps produce it can be gained by examining the self-image of nineteenth-century Dutch writers and their conception of genius.

II. The Artist as a Romantic Genius

Since the eighteenth century the ancient concept of genius has occupied a key position in philosophical and poetical theories of the artist. By declaring in his *Kritik der Urteilskraft* that genius is 'eine angeborne Gemüthsanlage, durch welche die Natur die Kunst die Regel gibt',[4] Kant emphasised the exceptional nature of a person ruled by intuition and not by reason, and drew a clear boundary between the genius of the artist and the man of science.[5] Late eighteenth-century German idealist philosophers reinforced the idea that genius was associated with intuition and artistic creativity. Although Schelling recognized scientific genius and believed scientific discoveries to arise in part from intuition, he emphasised the gap between art and science developed by Kant. For Schelling only art resulted exclusively from genius. A work of art gives access to the Absolute, as the Absolute Self reveals itself in what he called 'das Genieprodukt'.[6] In contrast to Kant, Schelling believed that art possesses metaphysical qualities and thus replaces religion. The metaphysical concept of art and the view of the artist as a genius guided by intuitive forces of feeling and imagination flourished within the circle of German idealist philosophers, including Friedrich Hölderlin and Friedrich von Schlegel. Absolute Truth could be heard from the voice of the poet, who was considered to be 'abnormal', not in a negative sense, but because he had been chosen by God and gifted at birth with a prodigious 'Empfindsamkeit' (sensitivity) and imagination.

3 Mary Kemperink and Leonieke Vermeer, 'Literatuur en wetenschap: een dynamische en complexe relatie. Enkele theoretische en methodologische overwegingen', *Nederlandse Letterkunde*, 13, 1 (2008), 33 – 66.

4 Jochen Schmidt, *Die Geschichte des Genie-Gedankens in der deutschen Literatur, Philosophie und Politik 1750 – 1945*, Band I: *Von der Aufklärung bis zum Idealismus*, 3rd edn (Heidelberg: Winter, 2004), p. 361: 'an innate frame of mind by which nature regulates art'.

5 Schmidt, p. 363.

6 Ibid., p. 311: 'the product of genius'.

The genius poet/artist was highly praised by artists who for the most part were portraying their own images. For the Christian Dutch Romantic poet (and the most Romantic among the Dutch poets were Christian) the poetic gift derived straight from God. The poet was regarded as a direct mediator between God and mankind. In 1832 the young poet Nicolaas Beets made his debut with *Jose*, a historical poem in the spirit of Byron. For the Netherlands this was a Romantic novelty and the first in a series. Beets described his own poetic talent in terms of a 'spark', a 'flame', a 'glow', a 'divine gift':

Gy hebt de vonk der hooge Poezy,
In 't kinderhart, van d'aanvang af zien gloren;
Gy zaagt den gloed, gy ziet de vlam in my,
En 't is u zoet mijn zangen aan te hooren
O gy waardeert, gy kent de Godsgaaf wel.[7]

The poem shows affinities with 'De Kunst der Poezy' ('The Art of Poetry', 1809), the poetic manifesto of Beets' predecessor Willem Bilderdijk. The intuitive faculties of the poet, 'tot hooger vlucht geboren' (born to a higher flight),[8] show that artistic creation thrives on sensitivity:

Uw hart, uw zelfgevoel, ô Dichters, is uw regel!
Dat prent in elken trek het echt, het Godenzegel.[9]

The poet reaches a higher truth than the philosopher and the scientist:

En uw zang zal waarheid zijn,
Waarheid uit de hemelkringen;
En des Wijsgeers wijsheid, schijn.[10]

For Bilderdijk the poet stands at the top of creation, higher than the philosopher, his head in the clouds. He has the ability to feel and guess the divine truth.

However, in this Romantic, high spirited conception there are dangerous elements that link genius to a divine form of insanity. Driven by feeling and imprisoned in his own imagination, the poet is isolated from the familiar world and in danger of losing a sense of reality.

7 Nicolaas Beets, *Jose. Een Spaansch verhaal* (Te Amsterdam: J. Immerzeel Jr., 1834), p. 3: 'You have seen the spark of high Poetry / In the child's heart, at its very start. / You saw the glow, you saw the flame in me. / It gives you pleasure to hear my song / Oh you value, you recognize God's gift indeed'.

8 Willem Bilderdijk, 'De Kunst der Poezy', ingeleid en van aantekeningen voorzien door W. van den Berg en J. J. Kloek (Amsterdam: Prometheus, 1995), Nederlandse Klassieken, vol. V, p. 78.

9 Ibid., p. 84: 'Oh Poets, your heart, your self-awareness is your rule! / It is these that imprint in each of you the real God's gift!'.

10 Ibid., p. 98: 'And in your song Truth speaks, / Divine Truth; / And the Philosopher's Truth only pretence'.

III. Genius, Madness, and Degeneration

In the course of the nineteenth century, the positivism of August Comte and the growing authority of the sciences stimulated a revaluation of rationality to the detriment of irrational faculties, such as feeling and intuition. To access the real, the physical, Nature has to be studied, not 'guessed at' or 'felt'. Knowledge is acquired only by observation and attention to what can be seen and measured. This positivist turn left the poet empty-handed and without any connection to a divine task.

At the same time the poet became a serious object of scientific research. While the differences between the 'normal' and the 'abnormal' were being defined and categorized, scientists enthusiastically began to pathologise behaviours embodied in the alcoholic, the criminal, and the prostitute. They employed a materialist approach, searching for physical features and psychological characteristics grounded in physiology; within this process genius was assigned a particular status.

From the start, physicians who dealt with the phenomenon of genius tended to define it as a kind of human variety connected with insanity and degeneration.[11] One of the first to do so was the French physician Louis François Lélut. In his studies on Socrates and on Pascal (1836 and 1846 respectively) Lélut interpreted genius as a form of insanity.[12] This view was developed by Jacques-Joseph Moreau de Tours in a provocative and authoritative work entitled *La Psychologie Morbide dans les Rapports avec la Philosophie de l'Histoire, ou l'Influence des Névropathies sur le Dynamisme Intellectuel* (1859). Moreau maintained that madness and genius were coevil: 'Folie, idiotie en génie sont congénères, *in radice convenient*'.[13] Two years before him, the physician Bénédict Auguste Morel had published a widely discussed book on degeneration, *Traité des Dégénérescences physiques, intellectuelles et morales de l'Espèce humaine, et des causes qui produisent ces Variétés maladives.* Man was subject to an increasing process of degeneration, which Morel defined as a deficiency of the transmission system responsible for heredity: instead of transmitting features of previous generations in a way that preserves health, sick varieties emerge and bad features are progressively transmitted.

Medical interest in degeneration developed further in the nineteenth century.

11 Eckhard Neumann, *Künstlermythen: Eine psycho-historische Studie über Kreativität* (Frankfurt – New York: Campus, 1986), pp. 130–163.

12 Louis François Lélut, *Du Démon de Socrate. Spécimen d'une Application de la Science psychologique à celle de l'Histoire* (Paris: Trinquart, 1836); Id., *L'amulette de Pascal, Pour servir à l'Histoire des Hallucinations* (Paris: Baillière, 1846).

13 Pierre Larousse, *Grand Dictionnaire Universel du XIX^{ème} siècle* (Paris, 1872), Tome VIII, p. 1134: 'Madness, idiocy, and genius are related; in their roots they are one and the same'.

Thinkers such as Charles Féré, Alfred Fouillée, Théodule Ribot, and Ernest Monin included in the list of degenerative features almost everything that did not correspond to commonly held ideas of physical beauty, health, and morality. Alongside protruding ears, homosexuality, alcoholism, and murderousness, genius was also categorised as degenerate.

In England Francis Galton presented genius as a manifestation of mental health that had nothing to do with degeneration[14] and in France there were objections to what was viewed as a regrettable devaluation of genius on the part of Moreau. In the *Grand Dictionnaire Universel du XIX*^{ème} *Siècle* (1872) the anonymous author of the long entry on 'génie' strongly objects to Moreau's method of presenting genius as a sick man and then selecting a series of features to 'prove' this theory. The anonymous author, who considers genius and madness to be two opposing poles of intelligence, criticizes Moreau's use of biographic and autobiographic materials, and rejects his 'méthode tout à fait incertaine' (absolutely uncertain method).[15] These sharply critical remarks could easily be applied to the work of a notorious Italian scientist responsible for the popularization of the genius as a madman and a degenerate, Cesare Lombroso.

IV. Cesare Lombroso

In *Genio e follia*, published in 1864, followed by numerous editions and translated into French, German, and English,[16] Lombroso theorized that genius is a specific but definite form of degeneration. In the fifth edition, which appeared in 1888 under the title of *L'uomo di genio in rapporto alla psichiatria, alla storia ed all'estetica*,[17] the concepts of genius and talent overlap because, even if they are distinct, the line that separates them cannot be easily defined. In his view, both artistic and scientific genius share an element of creativity.[18]

Lombroso starts with a series of presumptions underpinned with a handful of examples and anecdotes, statements by artists themselves together with stories and legends about their lives. He quotes letters by Cola da Rienzi, Michelangelo, Tasso, Newton, Rousseau, Foscolo, Leopardi, Manzoni, Schopenhauer, Heine,

14 Francis Galton, *Hereditary Genius: An Inquiry into the Laws and Consequences* (London and New York: Macmillan, 1892, 1st edn 1869). See especially the preface to the second edition, published in 1892.

15 Larousse, pp. 1154 – 1155.

16 One can presume that German and French translations, easily available in Dutch libraries, were read by Dutch scientists and other interested intellectuals.

17 Cesare Lombroso, *L'uomo di genio in rapporto alla psichiatria, alla storia ed all'estetica*, 5° ed. del *Genio e follia* completamente mutata (Torino: Bocca, 1888).

18 Lombroso, *L'uomo di genio in rapporto alla psichiatria, alla storia ed all'estetica*, 6° ed. completamente mutata (Torino: Bocca, 1894), p. XIII.

Darwin, Flaubert, and Benjamin-Constant to demonstrate their pathological condition.

To the extent that he builds his psychology on a physiological basis, Lombroso's approach is a materialist one. He explains the exceptionally active mind of the man of genius as stemming from excessive brain volume. Furthemore, genius is a form of atavism[19] and cannot be tolerated by Nature which, in striving toward a harmonious mean, tends always to even things out. Just as animals that manifest a specially developed talent are 'punished' with infertility, genius is the last flickering of a degenerating race – the final flowering after which a family is finally extinguished. Nevertheless, being the necessary consequence of evolutionary progress, degeneration cannot be defined as entirely negative.

A good deal of what Lombroso considers to be characteristics of the genius are traits of the degenerate as well. On the physiological level he mentions protruding ears, an irregular set of teeth, an outspoken asymmetric scull and face, baldness, and rachitis (though these particular features are less prominent in the genius who generally has pleasant looks). Psychologically, the genius lacks moral sense, patriotism, love for his family, and shows impulsivity, egocentrism, and vanity accompanied by a craving for the mystical. In contrast to the excessive development of specific abilities, such as an excellent memory and aesthetic awareness, stands a complete lack of other, more practical faculties, such as the ability to deal with money. The genius ends up as a lunatic. Lombroso also presents a diagram of geniuses who died insane, including Schumann and Chateaubriand, Newton and Ampère.

One by one, the old features of the Romantic concept of genius are translated into medical terms, stripping it of its blessed position. First of all, genius is an *exception* to the normal specimen of mankind; abnormal in Lombroso's terms. High age (from seventy up to one hundred and five years) and an extremely powerful brain become significant features of genius.

Second, genius is viewed as *innate*. Hereditary predisposition plays the main part in its appearance, evidenced by the existence of whole artistic families, such as those of Palestrina, Bach, and Titian. Moreover, geniuses are found especially in families showing signs of degeneration: Richelieu's sister, for instance, believed her back was made of crystal.[20] Another predisposition to the birth of genius is the intersection of races, and this is why outstanding thinkers like Cuvier, Proudhon, and Fourier are found in the Franche-Comté, for in that border area the French race is submitted to German influences.

19 Daniel Pick, *Faces of Degeneration. A European Disorder, c. 1848 – c. 1918* (Cambridge: Cambridge University Press, 1989), p. 114.

20 Lombroso, *L'uomo di genio in rapporto alla psichiatria, alla storia ed all'estetica*, 6° ed. completamente mutata, p. 219.

Third, genius is *original.* Lombroso's striking insights are based on the idea that schools and academies have a pernicious influence on genius. He is extremely negative about educational systems that aim exclusively at the average pupil, something which is detrimental to people with outstanding capacities.

Fourth, the genius possesses an unusual *sensitivity* driven by waves of constantly changing feelings and impressions. In genius, one sees a nervous temperament living on tense nerves; and it is due to this sensibility that the work of art arises *spontaneously*, without any effort. Very often, it is created in a dream or while doing something else.

Fifth, Lombroso ridicules the elevated position and the high opinion artists have of themselves, accounting these to be sheer vanity and megalomania. In contrast to the strong impact of heredity on genius, Lombroso holds the surroundings responsible for its appearance, but also mentions anti-degenerative influences, such as a mild climate and fertile soil. He believes these explain why in Italy and in the German region of Mainz there are so many excellent thinkers and poets. Geniuses are also produced in metropolises like Paris. In the theories of degeneration propounded by Morel, Monin, Féré, and others, the city is mentioned as a pool of degeneration, the negative pole of the Arcadian landscape. Lombroso points to two contrasting (degenerating and regenerating) influences for the production of geniuses who, on his account, remain degenerates. A contradiction lurks in this way of thinking: as scientists and writers are often found to operate in big cities, such as Paris and London, Lombroso needs to explain why metropolises stimulate geniuses. On the other hand, admired painters and poets are found to come from Tuscany, so the Italian hills must also be favourable to engendering of geniuses. Reasoning of this kind, which makes use of *post quod, ergo propter quod*, resounds in his work.

Lombroso speaks exclusively of great men. Women do not fit within his genius concept. As with all the vertebrates, he maintains that the female stands beneath the male in matters of intelligence and creativity. This fundamental inequality arises from the belief that women have less differentiated brains, less developed senses and a more conservative nature. Moreover, her primary biological task, procreation, demands most of her energy.

Female geniuses such as Sappho, Aspasia, and George Sand are in fact a kind of man in disguise. Discussing George Eliot's physiognomy, Lombroso points to her big, masculine face and scull and her visible moustache.[21] On the other hand, male geniuses show a degenerative, insane constitution and female features, such as a high voice and a sexual preference for men.

Lombroso's theory was severely criticized by physicists who accused him of ridiculing genius by stressing the pathological element too much. One of his

21 Ibid., p. 262.

sharpest critics, the German physicist William Hirsch, rejected the strict division of 'healthy' and 'unhealthy'. In *Genie und Entartung* (1894) he declared that a definition of genius was impossible, since it could only be a matter of 'less' or 'more'. In other words, the traits of the genius were to be found in attenuated form in the average, non-genius man.[22] Lombroso's identification of 'atavism' with 'degeneration' also met with opposition. In the eyes of specialists like Morel, Féré, and Möbius, degeneration was not the return to the characteristics of distant ancestors. According to Darwin atavism was a correction brought about by Nature, which preserved the basic type of the species by returning to earlier features. On the contrary, degeneration was seen by Morel as 'une déviation maladive d'un type normal de l'humanité',[23] a progressive disturbance of hereditary transmission.[24] After Morel many other scientists, such as Féré, Ribot, Fouillée, and Monin adopted this view, even though the distinction between atavism and degeneration made the concept of the genius-degenerate harder to digest.

Nevertheless, Lombroso's fundamental issue, the identification of genius with diagnosed madness, gained popularity. The German/Hungarian physicist and author Max Nordau further developed Lombroso's ideas in a notorious and widely translated book, *Entartung* (*Degeneration*, 1893).[25] Here Nordau declared that degeneration had spread widely all over the modern world. Like Lombroso (to whom he dedicated his volume), Nordau had his own stark biases.

The popularization of the basic idea of genius being a form of mental illness can be found under the entry 'genius' in encyclopaedias dating from the forties to the end of the nineteenth century. Even in France, where there was a strong opposition to Lombroso, the idea that madness and genius had something in common was accepted, although a principle distinction between the two concepts was introduced. They were not to be thought one and the same thing, for genius means being gifted with bright intelligence and critical judgement, whereas the mad may not be. The entry 'Génie' in *La Grande Encyclopédie: Inventaire Raisonné des Sciences, des Lettres et des Arts par une Société de Savants et de Gens de Lettres* (1885 – 1902) explains that the extraordinary mental activity of genius generates a lack of balance:

22 William Hirsch, *Genie und Ertartung. Eine psychologische Studie* (Berlin and Leipzig: Coblentz, 1894), pp. 76 – 82.

23 B. A. Morel, *Traité des Dégénérescences physiques, intellectuelles et morales de l'Espèce humaine, et des Causes qui produisent ces Variétés maladives*, accompagné d'un atlas de XII planches (Paris: Baillière, 1857), p. 47.

24 Charles Féré, *La Famille névropathique. Théorie tératologique de l'Hérédité et de la Prédisposition morbides et de la Dégénérescence* (Paris: F. Alcan, 1894), p. 243.

25 Nordau's book and the Dutch translation were published in the same year. See Max Nordau, *Ontaarding*, bewerkt door F. M. Jaeger [Maurits Smit] (Zutphen: Thieme, 1893).

> Ne le nions pas, il y a presque nécessairement un peu de déséquilibre dans le génie, puisqu'il sort, par définition, de l'ordinaire et consiste en une sorte d'hypertrophie mentale.[26]

It is worth noting that the old Romantic and Pre-Romantic idea of genius in all these medical theories remains untouched. Notions of exceptionality, antisocial behaviour, creativity, sensibility, imagination, and originality are retained and given qualifications of a medical kind; as a consequence, genius becomes closely associated with the pathological.

In the Netherlands artistic genius became closely associated with degeneration and insanity towards the end of the nineteenth century. Even Dutch psychiatrists like Jacob van Deventer, who explicitly wanted to stress the difference between genius and madness, acknowledged that they also carried striking similarities.[27] In the final handbook for medical students by Gerbrandus Jelgersma, *Leerboek der Psychiatrie* (*Handbook of Psychiatry*, 1911), the author stresses the pathological complexion of genius (a conclusion he derives from several biographies and autobiographies), but asserts that this does not in any way diminish its value.[28] In the widely read cultural magazine *De Gids* (*The Guide*, 1896) the liberal politician J. G. Patijn mentions Lombroso as a meteor in the scientific sky.[29]

An exception to the predominant focus on heredity is *Het genie. Een scheppingsgave* (*The Genius. A Gift of Creation*, 1911), in which the protestant journalist and clergyman Anthony Brummelkamp emphatically defends a conception of genius as God's gift. Like his antagonists, he examines poetical statements by artist-authors themselves, notably the Romantic protestant poets Willem Bilderdijk and his disciple Isaac da Costa. His concept of genius includes the same ingredients utilised by his positivist opponents, namely intuition, sensibility, inspiration, and spontaneity.[30]

The Pre-Romantic and Romantic model of the genius as an exceptional, unsociable, creative, imaginative, spontaneous, and original individual remains unaltered in the Netherlands throughout the nineteenth century, but starts to be examined from a medical point of view from the 1850s onwards. Genius then

26 *La Grande Encyclopédie inventaire raisonné des Sciences, des Lettres et des Arts par une Société de Savants et de Gens de Lettres*, sous la direction de André Berthelot (Paris: H. Lamirault et cie, 1885 – 1902), Tome 18, p. 739: 'We should not deny that inevitably there is something disturbing in genius, who by definition rises above the average and is marked by a certain mental hypertrophy'.

27 Jacob van Deventer, *Genie en waanzin*, in Id., *Zenuw- en zielenleven*, Serie 1, 1911.

28 Gerbrandus Jelgersma, *Leerboek der psychiatrie*, vol. I. *Algemeen gedeelte* (Amsterdam: Scheltema & Holkema, 1911), p. 246.

29 J. G. Patijn, 'Het "type-criminel"', *De Gids*, Februari 1896, 320 – 351 (p. 320).

30 Anthony Brummelkamp, *Het genie. Een scheppingsgave* (Leiden: Donner, 1901), especially pp. 12, 16, 20, 32.

becomes a hereditary pathology characterised by degeneration, insanity, and even immorality.

IV. The Artist's Self-Image

At the end of the nineteenth century medicalization of the genius-artist not only became part of public opinion, it also nestled in the poetical concept of artists themselves. This is true especially for the naturalist novelists who in their work explicitly tend towards the scientific. Literature itself became a source of scientific, psychological, and sociological information. Widely read, for instance, was Émile Zola's 1886 novel *L'Œuvre*, in which the painter Claude Lantier perishes from his feverish creative urge. The same year that this new volume of Zola's cycle *Les Rougon Macquarts* appeared, it was reviewed by the Dutch novelist Lodewijk van Deyssel. While characterizing Lantier as a powerless artist in whose veins runs the spoiled blood of his father,[31] van Deyssel as a writer undoubtedly recognized his own pains and struggles.

Fin-de-siècle medical theories on the genius-artist had a wide resonance. Authoritative scientists gave their verdict on artists' creative personality, forcing them to look at themselves as people affected by mental illness. Oversensitivity and unpredictable changes of mood became proof of artistic authenticity. The self-image of the artist incorporated a pathological condition entailing nervous temperaments, neurasthenia, extraordinary sensations, and various forms of degeneration.

Letters by Dutch writers exhibit the cherished stigmata of the artist. On the 15th of June 1891 Lodewijk van Deyssel heartily saluted the state of psychical exaltation in which he found himself as the sign of an approaching creative period. He wrote in his diary:

> In uw oren suist het, zoo als in geen jaren, ten teeken van abnormaal, verhoogd zenuwleven. Interpreteer dat als het stoomend juichen uwer ziel over de behaalde overwinning.[32]

Significant, here, are the words 'abnormaal' [abnormal] and 'zenuwleven' [life of the nerves], which bring his state of mind into pathological view. Van Deyssel, Marcellus Emants, Arnold Aletrino, Frederik van Eeden, and Frans Coenen, to

31 Van Deyssel, 'L'Œuvre', in Id., *Verzamelde opstellen*, pp. 101 – 107 (pp. 101 – 102).

32 *De briefwisseling tussen Lodewijk van Deyssel en Arnold Ising Jr., 1883 – 1904*, editie Harry G. M. Prick ('s-Gravenhage: Nederlands letterkundig Museum en Documentatiecentrum, 1968), vol. I, p. 147: 'Your ears are buzzing, as never before, which is a sign of an abnormal, heightened nervous awareness. See this as the gushing jubilation of your soul over the victory achieved'.

mention only some famous fin-de-siècle Dutch novelists, all thought of themselves as ill, depressive, and feeble. Their letters rain complaints such as insomnia, a dysfunctional metabolism, an overall sensation of weakness, cold shivers, et cetera. Illness is nothing to be ashamed of and all kinds of physical and psychical defects are openly discussed. Being the children of a dying epoch, they are more degenerate than their healthier predecessors. Paradoxically, in their eyes, increasing degeneration is a proof of artistic progress.

V. The Artist as a Literary Character

Not only do authors present themselves as exceptional pathological cases, but through their characters they also give shape to their own medicalized view of the artist. Sometimes these come close to self-portraits, as in the case of Louis Couperus' novel *Metamorfoze* (*Metamorphosis*, 1897). The main character, a writer who in many ways resembles his creator, is depicted as feminine and unstable, suffering from neuroses and hysteria. Time and again he is referred to as a 'child', or a 'boy',[33] stuck in his psychical development which reveals atavistic traits (in Lombroso's terms). While admiring him as an artist, a mature woman like Hélène cannot have erotic feelings for the man.[34] Unfortunately, it is precisely his immaturity and oversensitive soul that make him an artist.[35]

Almost a prototype of the modern degenerate-artist is depicted by Marcellus Emants in his theatre play *Artiest* (*Artist*, 1894). The protagonist, a sensitive, excitable, depressive painter and a novelist, is unfit for marriage and unfaithful to his young wife. Her family criticizes his immorality, but also considers it to be intrinsic to modern, late-nineteenth-century artists.

> FRANS
> Zij dan alle moderne artiesten zedelooze menschen?
> RUDOLF
> Nagenoeg, en zooals niet in daden dan toch in gedachten.[36]

For Emants artists cannot become 'normal' members of society, they live by the swell of their emotions. Their sentiments and moods change quickly and are more intense than those of average human beings. In the novel *Zegepraal* (*Tri-*

33 Louis Couperus, *Metamorfoze*, in Id., *Volledige Werken Louis Couperus* (Utrecht – Antwerpen: Veen, 1987 – 1996), XIII, pp. 80, 117, 140, 141.
34 Ibid., p. 145.
35 Ibid., p. 123.
36 Marcellus Emants, *Artiest. Tooneelspel in drie bedrijven* (Amsterdam: Van Holkema & Warendorf, 1894), p. 136: 'Frans: Are all modern artists immoral? / Rudolf: Almost all, if not in deed, but in thought'.

umph, 1904)[37] by Israël Querido the artist proudly writes to his beloved that no one has a nature more sensitive than his. However, the price he has to pay for this gift is high, as he twice almost perishes from a serious nervous breakdown. In her family novel *Armoede* (*Poverty*, 1909) Ina Boudier-Bakker stresses the contrast between the artist and the non-artist in terms of ill-health and health. She depicts the opposition between the oversensitive, fragile musician Paul and the healthy, down-to-earth Kitty. It is not surprising that the latter fails in her career as a singer, being simply too healthy and thus lacking the delicate constitution of an artist.

In these novels physical infirmity corresponds to mental illness, demonstrated in excessive nervousness and sensitivity. The word madness is often used in respect of these qualities and the genius artist and madman overlap; not only does artistry imply mental fragility, but mental illness counts as a symptom of genius. In Frans Coenen's *Bleke Levens* (*Pale Lives*, 1899) Caroline is an extremely nervous pianist. Her friends and acquaintances perceive her to be mentally ill, but at the same time this very disability improves her reputation as an outstanding musician.[38]

Often innate oversensitivity and nervousness are connected to a descent: the artist is a member of a weakening, dying family and usually remains childless. In the novel significantly entitled *Pathologieën. De Ondergangen van Johan Vere de With* (*Pathologies. The Fall of Johan Vere de With*, 1909) the poet Johan is depicted as the degenerate offspring of a distinguished noble family. In Couperus's novel *Van Oude Menschen, de Dingen die Voorbij Gaan* (*Old People and the Things that Pass*, 1906) the artist, Lot, believes that his family has lasted long enough. He has no intention of begetting any offspring, although he is just married and his healthy spouse takes quite a different view.[39] The degenerated state of the artist in literature is often connected with instances of gender dysmorphism. So Lot is called female and girlish in part because of his softness and interest in elegant clothing. 'Jij hadt een jongen moeten zijn en ik maar een meisje' (You should have been born as a boy and me as a girl), he confides to his energetic sister.[40]

In contrast, the sparse number of female artists we meet in novels often possess a masculine outlook, like Lombroso's George Eliot. Thus the literary and talented Gabriëlle in the novel of the same name by Marie Metz-Koning has a boyish attitude and a nearly masculine face[41] and the female musician in the

37 Israël Querido, *Zegepraal* (Haarlem: Bohn, 1904).
38 Frans Coenen, *Bleke Levens* (Utrecht – Antwerpen: Veen, 1984), p. 109.
39 Couperus, *Van Oude Menschen, de Dingen die Voorbij Gaan*, in Id., *Volledige Werken Couperus*, XXV, p. 9.
40 Ibid., p. 121.
41 Marie Metz-Koning, *Gabriëlle* (Bussum: Van Dishoeck, 1894), pp. 47, 87.

novel *Kalverstraat* (*Kalverstreet*, 1904) by Bernard Canter has a masculine handwriting.[42] Where the female artist does appear, there is usually something wrong with her femininity. Women are not meant to be geniuses; they are only expected to bring them forth.

In literary representations the artist is often considered to be gifted with sharp psychological insight. Intuitively he understands the deeper feelings and underlying motives of the people he meets. This is not only so for the modern novelist, who acts as a psychologist, depicting and explaining his characters; it also goes for poets and painters. In the novel *Een Huwelijk* (*A Marriage*, 1890) by Johan de Meester psychology is presented as a discipline in which all artists are interested.[43] The artist *ex officio* is a sharp-witted psychologist. In his novel *Langs Lijnen van Geleidelijkheid* (*The Inevitable Law*, 1900) Couperus portrays Duco, a talented painter, a dreamer and an outsider. Nevertheless, because he is a sensitive artist, he exhibits sharp psychological insight:

> […] hij, artist en droomer, zag dikwijls als helderziend de emotie schemeren door het voordoen der menschen, zag de ziel, als een licht door albast heen.[44]

The word 'helderziend' (clairvoyant) used by Couperus points to occultism. He and some other fin-de-siècle novelists bestowed occult faculties on the artistic genius. The artist sees more sharply and deeply, but in an occult way, and is sensitive to matters that exist between heaven and earth. Thus he approaches the earlier Romantic conception of the artist or poet as a prophet, an intermediary between God and mankind, and exemplifies the newly awakened interest in occultism.[45]

VI. Translations of the Concept

Around 1850 discussions about genius shift from philosophical and poetic to scientific discourse. Literature and science share the presupposition that geniuses exist and that a true artist is an exceptional human specimen of sorts, an

42 Bernard Canter, *Kalverstraat* (Amsterdam: Vennootschap "Letteren en Kunst", 1908, 1st edn 1904), p. 102.

43 Johan de Meester, *Een huwelijk* (Bussum: Van Dishoeck, 1907, 1st edn 1890), p. 58.

44 Couperus, *Langs lijnen van geleidelijkheid*, in Id., *Volledige Werken Couperus*, XVI, p. 55: 'He, an artist and a dreamer, saw often as if clairvoyant the shimmer of emotion through people's actions, saw the soul as light shining through alabaster'.

45 H. F. Ellenberger, *The Discovery of the Unconscious: The History and Evolution of Dynamic Psychiatry* (New York: Basic Books, 1970); Alan Gauld, *The Founders of Psychical Research* (London: Routledge & Kegan Paul, 1968); Id., *A History of Hypnotism* (Cambridge: Cambridge University Press, 1992).

innate genius characterised by originality, sensibility, imagination, unsociability and intuition. So far the Romantic poets and the physicians are in agreement.

However, they disagree on the status they attribute to the artist-genius. For poets and idealist philosophers genius is a gift from God (or Nature) which gives the poet access to the metaphysical. Scientists regard genius as a more or less pathological state: it is not blessed, but cursed, a medical case that can be diagnosed and, if necessary, treated. Lombroso, following Moreau de Tours, represents this approach in its most extreme manifestation, identifying genius with degeneration and atavism. But less radical scientists intend to subject the artist-genius to medical observation, looking for causal, positivist explanations of the condition and giving diagnoses in terms of psychological categories and diseases, such as nervous temperament and neuroses.

Towards the end of the nineteenth century in the Netherlands, somewhat later then in France, there is a reverse tendency, moving from science towards literature (especially the realist/naturalist novel). Medical scientists and novelists agree that there is a connection between artistic genius and disease. They adopt the idea of an artistic nervous temperament, ridden with pathological oversensibility, un 'dégénéré superieur' (a superior degenerate).

However, there are also differences in medical and literary perception which underline the high position of the artist among his fellow men. In literature the artist is presented as a gifted psychologist with wonderful insight into the human mind. As a result, he becomes the peer of the medical scientist and, in possessing a greater creativity, he can go further than the scientist and formulate hypotheses for further scientific research.[46] Thus the artist is depicted in a positivistic, scientific manner. At the same time, many writers preserve an old metaphysical position, although in less Christian terms: poets and artists are presumed to show mankind something of the unknown and unnameable, something of the metaphysical. In this respect, the late nineteenth-century Dutch authors follow their Romantic predecessors in disagreeing with the scientists.

In short, there is a mutual shift from literature towards science and then backwards from science towards literature. Scientists adopt and translate the concept of genius; authors adopt the scientific medical approach of the scientists, presenting themselves, as well as their characters, as pathological cases. In these transfers the concept of genius as such remains intact, although it is put under tension by two contradictions: firstly, there is a contrast between the idea of an elite corps of geniuses and the socialist ideology of equality (one should mention utopian and socialist authors like Frederik van Eeden and Henriette Roland Holst). Secondly, an incompatibility is discernible in the conception of

46 See Émile Zola, 'Le roman expérimental', in Id., *Le roman expérimental* (1880), chronologie et préface par Aimé Guedj (Paris: Garnier-Flammarion, 1971), pp. 62 – 97, especially p. 83.

the genius-artist as creator and the realistic-naturalistic poetics of the novelist as a social and psychological observer.

Throughout the nineteenth century, despite these oppositions, the concept of genius persisted, reflecting its deep cultural roots. The existence of genius as such was considered to be a simple, obvious truth, a shared belief not worthy of questioning. Soon after Lombroso's presentation of the 'innate criminal', aspects of this concept were questioned, for instance by French criminologists like Gabriel Tarde and Paul Brouardel. Yet, Lombroso's view of an innate type of genius (or artist) was too firmly rooted in the poetic concept of the period to be rejected, and the idea of the artist as exceptional still prevails today.

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Alessandra Calanchi

'I lost my Body in an experiment': Reshaping the Human in Edward Page Mitchell's Short Stories

I. Edward Page Mitchell's Short Stories

Anglo-American science fiction offers interesting examples of interface between science and literature.[1] Between 1874 and the end of the century the American columnist Edward Page Mitchell (1852 – 1927) anonymously published a series of amazing short stories in the most popular newspapers and magazines of his time – *The Sun*, the *San Francisco Evening Post, Scribner's Monthly.* A century later, after falling into oblivion, such stories were collected by the science fiction historian Sam Moskowitz,[2] who divided them up into five groups (Science Fiction, Unknown-Fantasy, Supernatural, Neo-John Collier, and Future War Farce). Moskowitz's work is extremely important, since it is largely thanks to him that we can read Mitchell's stories today; and yet his grouping is arbitrary and too Edgar Allan Poe-oriented to be accepted at face value by twenty-first century readers. The borders dividing the territories of Science Fiction, Fantasy, and the Supernatural are much more blurred and overlapping, and it is from their juxtaposition, not from their separation, that interfaces may be revealed.

This imperfect taxonomy, however, offers a good starting point for exploring E. P. Mitchell's conceptualization, speculation on, and (mis)representation of such terms as human, soul, brain, body, and science. In his stories the interface between science and literature originates from another interface, or maybe interference, between science and the supernatural. In dealing with invisibility, time-travel, dematerialization, and brain surgery he has a double aim: to be

1 *La realtà e i linguaggi. Ai confini tra scienza e letteratura*, ed. by Mimma Califano Bresciani (Firenze: Le Lettere, 1998); H. Bruce Franklin, *Future Perfect. American Science Fiction of the Nineteenth Century* (New York: Oxford University Press, 1978); *Literature and Science. Theory and Practice*, ed. by Stuart Peterfreund (Boston: Northeastern University Press, 1990); Antonio Sparzani, *Relatività, quante storie. Un percorso scientifico-letterario tra relativo e assoluto* (Torino: Bollati Boringhieri, 2003).

2 *The Crystal Man. Stories by Edward Page Mitchell*, ed. by Sam Moskowitz (New York: Doubleday & Co., 1973).

scientific and to create sensation. For Mitchell the double condition of *human* as matter *and* spirit (that is, energy) is central both to scientific experimentation and literary representation. His stories tackle histology, chemistry, mathematics, physics, physiology, psychology, and surgery, and in all the ones analysed here the main character is a Doctor or a Professor who comes from (or has studied in) Germany or Europe: Professor Surd (mathematician) in *The Tachipomp* (1874), Professor Dummkopf in *The Soul Spectroscope* (1875) and *The Man Without a Body* (1877), Doctor Harwood in *Exchanging Their Souls* (1877), Professor Daniel Dean Moody (psychologist and spiritualist) in *An Extraordinary Wedding* (1878), Professor Surdity in *The Pain Epicures* (1878), Doctor Rapperschwyll and Professor Fischer in *The Ablest Man in the World* (1879), Professor Schwank (psycho-neurologist) in *The Professor's Experiment* (1880), Professor Van Stopp in *The Clock that Went Backward* (1881), and Professor Frolicker (histologist) in *The Crystal Man* (1881). The laboratories, hospitals, museums, and conference halls in which they perform their experiments are what Bachtin would call *chronotopoi.*

By describing cases of body manipulation, physical dematerialization, and artificial intelligence Mitchell interprets the enthusiastic mood of his time and foresees scientific progress. Moreover, by spreading revolutionary theories and notions he actually gives a great boost to the popularization of science and to the 'scientification' of fiction.

Science popularization can be dangerous, if it brings simplification and confusion, but it is also bound to raise crucial questions about social identity and the future of the individual and humankind (post-humanity included).[3] The protagonist of *The Crystal Man* (1881), for example, has found the formula for invisibility but is doomed to loneliness and suicide, while in *The Senator's Daughter* (1879) a young lady in love with a Chinese gentleman voluntarily submits to freezing for ten years, in order to be able to marry him without her father's permission.

The fact that science is still dangling between phenomenological reality and the supernatural in the latter part of the nineteenth century is not an obstacle, but rather activates literary imagination without any loss of scientific accuracy.[4] A typical example of the interplay between supernatural beliefs and scientific evidence is offered by the soul, which escapes the religious domain and becomes a truly scientific matter. Although it lacks material consistency, it is perceived as

3 For a thorough analysis of the creation/perception of the sense of the future, see J. F. Clarke, *The Pattern of Expectation 1644 – 2001* (London: Jonathan Cape, 1979).

4 George Levine, *Realism and Representation. Essays on the Problem of Realism in Relation to Science, Literature, and Culture* (Madison: The University of Wisconsin Press, 1993) and *Metaphor and Thought*, ed. by Andrew Ortony (Cambridge: Cambridge University Press, 1993).

real and unquestionable at a time when matter is starting to be considered a form of energy and vice-versa.

Mitchell's tales can be grouped according to the different fields of scientific experimentation they are inspired by: Medicine and Psychology (Treatment of Pain, Hypnosis, Brain Surgery, Cryonics); Physics and Chemistry (Matter / Energy Transmission, Invisibility / Time Reversal); Participant Evolution (Proto-Informatics, Artificial Intelligence, Physiology, Anatomy, Sociological Sciences).

II. Medicine and Psychology

Treatment of pain is explored in *The Pain Epicures* (1878), where Nicholas Vance, a student at Harvard University, suffers from acute neuralgia and takes the advice of a speculative logician who persuades him first to take drugs, a 'fine white powder' then called 'morphia', and to train his own mind to convert pain into 'exquisite pleasure'.[5] It is a sort of hypnosis by which he 'can transform agony into joy, torment into delight',[6] finally culminating in an orgy in which people pursue not health, but pain.

The Professor's Experiment (1880) tells of brain surgery as a means to alter personal viewpoint. A young man is denied permission to marry his fiancé by her father, the famous doctor Bellglory at Harvard, because they have divergent scientific ideas. Consequently, Professor Schwank proposes the young man should undergo brain surgery. His technique consists of 'trephining' the skull (using a surgical instrument with a cylindrical blade).

> 'You must change your convictions'.
> 'Impossible'.
> […]
> 'Impossible, did you say? […] on the contrary, my dear boy, nothing is easier than to change one's convictions. In the present advanced conditions of surgery, it is a matter of little difficulty […] I should remodel your intellect to suit the emergency'.[7]

In *The Senator's Daughter* (1879) freezing temperature is used as a means to revive people in the future. Considering that cryogenics dates to the 1950s, this tale anticipates the technique by some 70 years. The word cryogenics literally refers to the production of icy cold; today the term is used as a synonym for low-

5 Edward Page Mitchell, *The Pain Epicures*, in *The Crystal Man. Stories by Edward Page Mitchell*, pp. 319 – 320.
6 Ibid., p. 321.
7 Mitchell, *The Professor's Experiment*, in *The Crystal Man. Stories by Edward Page Mitchell*, pp. 146 – 147.

temperature states. Cryobiology studies the effect of low temperature on organisms, and an emerging new branch, cryonics, is a medical technology for preserving humans and animals with the intention of future revival. The three works mentioned share a strong connection to medical science and psychology, in which the body is objectified, fragmented, and even frozen; yet the concern for the mind experiencing pain, pleasure, and emotions is crucial. Medicine and psychology are challenging arenas for discussing the 'human' and for experimenting on the possibilities of a post-condition for human beings.

III. Physics and Chemistry

Physics and chemistry offer even more extraordinary tools for scientific/fictional speculation. *The Man Without a Body* (1877) is considered a landmark since it is the first fictional exposition of how matter can be transformed into energy and transmitted to a receiver to be reformed. The 'Telepomp', a more sophisticated version of the 'Tachipomp', the machine described in Mitchell's first story (*The Tachipomp*, 1874), is based on the model of a train on which somebody is walking faster and faster, thus increasing the total speed. The head of the famous Professor Dummkopf (a name that in German means 'dumm' or 'silly' head) is kept inside the Arsenal Museum at Central Park, NY. When the head, which can speak, says to the narrator: 'I lost my Body in an experiment', it is not the Professor who is speaking, but his Head only:

> I knew the Head was trying to speak to me.
> […] 'How does it seem without a body?'
> […] 'I would give both ears for a single leg'.
> […] 'you are the celebrated Professor Dummkopf?'
> 'That is, or was, my name […]. I lost my Body in an experiment'.[8]

Who/what has lost whom/what? Is it the Professor who has lost his Body except its most precious part (his amazing brain)? Or is it the Head that has been separated from the rest of the Body? If so, how does it manage to speak? If in literature synecdoche enables the part to stand for the whole, in science a single atom, or molecule, or biological cell, contains information about a whole body. But what, at this point, has the Soul to do with all this? If Soul is energy, then all is energy, because the whole body can be reduced by a chemical process to atoms and then totally dematerialized.[9] Soul is also matter, as shown in the prequel, entitled *The Soul Spectroscope* (1875), where Professor Dummkopf photographs

8 Mitchell, *The Man Without a Body*, in *The Crystal Man. Stories by Edward Page Mitchell*, pp. 63 – 64.
9 Ibid., p. 65.

smells and bottles sounds to prove their physical consistency, their 'materiality'.[10] The tale is written in the form of a long article where Professor Dummkopf's experiments are listed and commented upon. In the subtitle of the article we read that his research is based on the work of a Professor Tyndall, probably modelled on the Irish scientist John Tyndall (1820 – 1893), expert in thermodynamics and microbiology and the author of seminal studies on heat, light, and sound: 'The professor is firm in the conviction that modern science has narrowed down to almost nothing the border territory between the material and the immaterial'.[11]

Professor Dummkopf is actually interpreting the end-of-century debate on the wave-particle duality of matter culminating in Albert Einstein's formulation of the Special Theory of Relativity (1905). The notion that mass and energy are different manifestations of the same thing is also described by Professor Dummkopf:

> It may be found that the boundary between mind and matter is as purely imaginary as the equator that divides the northern from the southern hemisphere. It may be found that mind is essentially objective as is matter, or that matter is as entirely Subjective as is mind. It may be that there is no matter except as conditioned in mind.[12]

While Einstein will theorize that it should be possible to convert matter into energy, Dummkopf makes exactly the opposite point. He believes:

> […] that every force, physical, intellectual, and moral, may be resolved into matter, formulated in terms of matter, and analyzed into its constituent forms of matter; that motion is matter, mind is matter, law is matter, and even that abstract relations of mathematical abstractions are purely material.[13]

Since Dummkopf seems to be more intrigued by matter than by energy, he wants to bottle sound. The idea may seem silly, but apart from the picturesque container chosen by Mitchell – a bottle – and the fact that he obviously could not rely on any electronic technology at the time, his *sound machine* is a remarkable anticipation not only of the 'sea-shell radio' attached to people's ears in the novel *Fahrenheit 451* by Ray Bradbury (1951), but also of the contemporary MP3 or iPod player:

> You may keep the sound wave forever if you will only keep it corked up tight. […] I could put the operas into the market at from eighty cents to a dollar a bottle. For oratorios and symphonies I should use demijohns, and the cost would of course be

10 Mitchell, *The Soul Spectroscope. The Singular Materialism of a Progressive Thinker*, in *The Crystal Man. Stories by Edward Page Mitchell*, pp. 156 – 157.
11 Ibid., p. 156.
12 Ibid., ivi.
13 Ibid., p. 157.

> greater. I don't think that ordinary bottles would hold Wagner's music. It might be necessary to employ carboys.[14]

Professor Dummkopf is intrigued also by energy, since he wants to create a 'spectroscope of the soul', a sort of proto lie detector or polygraph. A device able to register alterations in blood pressure and heart pulsation was invented in 1913 by William Moulton Marston and has recently developed into a common gadget. The Handy Truster, launched in 2008 at a cost of less than 50 dollars,[15] is the size of an MP3, can also be connected to a cellular phone and uses voice recognition technology. Dummkopf's 'soul spectroscope' is something very similar, since it records 'the minute exhalations or emanations proceeding from the soul – and these exhalations or emanations are, of course, made of matter'.[16] 'Soul' and 'matter', two important keywords in this tale, also refer to energy. 'Soul' can be related both to the brain, which is something visible, and to the mind, or similar items such as 'ether', 'spirit', and 'psyche', which are invisible.

In an analogous way, if matter can be dematerialized by means of chemistry, time direction might be inverted by means of physics. *The Crystal Man* (1881) tells of an experiment in invisibility based on chemical principles and *The Clock that Went Backward* (1881) postulates that time can be rewound, changing the entire course of history. These tales are not only a remarkable anticipation of H. G. Wells's *The Invisible Man* (1897) and *The Time Machine* (1888), but also prefigure modern experimentation on the transmission of matter through space and time.[17]

Mitchell's need to distance himself from the supernatural is well articulated in *The Crystal Man*, where a young scientist who has become invisible after experimenting on his own body says: 'By this time I had cleared my mind of the last lingering suspicion of the supernatural. These phenomena were perhaps not inexplicable; all that I lacked was the key'.[18] And then: 'I am not nervous. I am a man of science, accustomed to regard all phenomena as explainable by natural laws, provided we can discover the laws'.[19]

When the invisible man gives his hand to the narrator, he does not see it but reaches forth until he meets the 'pressure of warm, living fingers'.[20] The supernatural meets science: the narrator first performs an act of faith – he strongly

14 Ibid., pp. 158–159.
15 See *Snapshotspy. Advance Computer Monitoring Solutions*, <www.snapshotspy.com> [accessed 8 June 2011].
16 Mitchell, *The Soul Spectroscope*, p. 159.
17 See Alessandra Calanchi, *Dismissing the Body. Strange Cases of Fictional Invisibility* (Bologna: Clueb, 1999).
18 Mitchell, *The Crystal Man*, in *The Crystal Man. Stories by Edward Page Mitchell*, p. 6.
19 Ibid., p. 7.
20 Ibid., ivi.

believes and the hand appears – and then a scientific explanation is offered. The detailed account is 'a rough translation' from German, because the man has studied at Heidelberg or Freiburg: written in a typical scientific style,[21] it is a long paragraph which aims to establish the verisimilitude of the story. The narration then continues in a less formal way, with many similes from everyday speech ('colorless as an albino', 'My hair and beard looked like spun glass and my skin like marble', 'like a bleached man', 'like a porcelain figure', 'like a jellyfish in the water').[22]

On the one hand, Mitchell's literary experiments on the body are the link between Edgar Allan Poe (*The Man That Was Used Up*, 1850) and the postmodern writer William Gibson (*Neuromancer*, 1984), who invented cyberfiction and often presents images of minds without bodies and bodies without minds. On the other hand, it is obvious that Mitchell is interpreting the debates of the age when he faces and rewrites the nature of matter (Le Bel, 1874; van 't Hoff, 1874), the relationship between movement, heat, and electricity (Joule, 1843; Helmoltz, 1847), the wave theory and electromagnetic fields (Faraday, 1852; Maxwell, 1873), and the hypothesis of time reversal (Thomson, 1874).[23]

IV. Participant Evolution

In *The Ablest Man in the World* (1879) the Russian baron Savitch had a reasoning machine put inside his own head. This 'machine' can be reached simply by unscrewing the top of the head, and consists of 'a dome of polished silver'.[24] It is in fact an extremely sophisticated computer which was directly inspired by Charles Babbage's calculating machine. The British mathematician and philosopher Babbage (1791 – 1871), explicitly referred to in the story, is also remembered as the proto-informatics scientist who in 1834 discovered the principle of the analytical engine; he is the forerunner of the modern electronic computer, long before David Hilbert in 1900 paved the way for what is now called computer science, and Professor Norbert Wiener (of MIT) in 1948 declared the similarities between the human nervous system and mechanical communication (e. g. telephone communication). The term *artificial intelligence* was probably

21 Ibid., pp. 7 – 8.
22 Ibid., p. 10.
23 See Enrico Bellone, *Caos e armonia. Storia della fisica* (Torino: Utet, 2004); John J. O'Connor and Edmund F. Roberston, *The MacTutor History of Mathematics Archive*, <www-history.mcs.st-and.ac.uk> [accessed 8 June 2011].
24 Mitchell, *The Crystal Man*, p. 29.

invented even later by the computer scientist John McCarthy in the course of a congress held in Dartmouth in 1956.[25]

In *The Ablest Man in the World*, the baron makes use of informatics (or better, proto-informatics), physiology, anatomy, and even sociological sciences in his amazing experiment on artificial intelligence. We find informatics first:

> Given the data, there was no limit to [its] possibilities […]. My new machine was fed with facts, and produced conclusions. In short, it *reasoned*; and the results of its reasoning were always true, while the results of human reasoning are often, if not always, false. The source of error in human logic is what the philosophers call the 'personal equation'. My machine eliminated the personal equation; it proceeded from cause to effect, from premise to conclusion, with steady precision.[26]

Secondly, the baron's experiment in Mitchell's tale involves physiology and anatomy:

> I had seen men living with pistol balls imbedded in the medulla oblongata. I had seen the hemispheres and the cerebellum removed from the crania of birds and small animals, and yet they did not die. I believed that, though the brain were to be removed from a human skull, the subject would not die.[27]

Finally, the baron seems to take into due consideration sociological sciences:

> […] a profound study of history from the sociological point of view, and a not inconsiderable practical experience of human nature, had convinced me that the greatest geniuses that ever existed were on a plane not so very far removed above the level of average intellect.[28]

When finally the baron has his own brain removed and substituted with a reasoning machine, he becomes something that had no name at the time, but which today we would call a *cyborg* or a bionic being, that is, a human being on whom mechanical or electronic devices have been implanted without his or her DNA being altered.[29] It is worth mentioning that it was two doctors working at the Rockland Hospital in New York, Manfred E. Clynes and Nathan S. Kline who, as late as 1960, created the term *cyborg* to define a cybernetic organism (80 years after Mitchell's own literary creation). In the famous article 'Cyborgs and Space' they argued that the human species was already on the path to what they called

25 Sam Williams, *Arguing A.I.: The Battle for Twenty-First Century Science* (New York: Random House, 2002), passim. See also Vincenzo Tagliasco, *Dizionario degli esseri umani fantastici e artificiali* (Milano: Mondadori, 1999).

26 Mitchell, *The Crystal Man*, p. 37.

27 Ibid., ivi.

28 Ibid., ivi.

29 See Andrew Pilsch, 'Cyborgs', in 'Cyborgs', in *The Science Fiction Lab at Georgia Tech*, <http://sciencefictionlab.lcc.gatech.edu/SFL/doku.php/cyborgs> [accessed 8 June 2011].

'participant evolution'.[30] Since then this field of research has focused on how the human body and brain can be deliberately redesigned by technological means in order to overcome biological limitations. According to later theories, human beings will progressively become transhuman and ultimately posthuman.

Mitchell's literary production in the last decades of the nineteenth century is crucial for a number of reasons. Firstly, he plays an important role as a contributor to popular fiction, mass culture, and the popularization of science. Secondly, he actively participates in the reshaping and reformulation of the self both as a private and political subject. By raising questions about the future of humankind, Mitchell reshapes the notion of *human* and *humanity*, reformulating them in terms of their relations with society and scientific power. Cryonics, brain surgery, and artificial intelligence do not only create sensation; they arouse a sense of expectation and foster acceptance of many possible futures, envisioned in metaphysical as well as political terms. Thirdly, the human body becomes a political arena, a scientific laboratory, and a social frontier. Mitchell suggests that, although individuals now hope for a better life thanks to body manipulation, the sciences may be more inclined to promote the power of dominant groups rather than make men happy.[31] Fourthly, these tales show both the origins of the debate concerning the human and the post-human and the contribution of science fiction to the creation of the post-modern vision of the body as 'raw material' and 'the human itself as *fantasy*'.[32] The collapse of biogenetic boundaries and the presence in such tales of the transorganic body as in *The Professor's Experiment*, *The Senator's Daughter*, or *The Man Without a Body*, point to science becoming a new kind of Super-natural, in the name of which the human body can be dematerialized, frozen, made invisible, or mutilated without losing its *humanity*. On the contrary, through such processes it became the living metaphor of the *human* at the end of the nineteenth century. By considering the soul as *energy* and the body as *raw material*, the road is open to the problematization of the notion of matter, human, and post-human, and to the creation of contemporary, or post-modern, body culture.

30 Manfred E. Clynes and Nathan S. Kline, 'Cyborgs and Space', *Astronautics* (September 1960), 27–31. Originally published in *Drugs, Space and Cybernetics. Proceedings of the Psychophysiological Aspects of Space Flight Symposium*, San Antonio, TX, Air Force School of Aviation Medicine, May 1960, ed. by Manfred E. Clynes and Nathan S. Kline (New York: Columbia University Press, 1960), republished in *The Cyborg Handbook*, ed. by Chris Hables Gray (Routledge: New York, 1995), pp. 29–33.

31 See Bertrand Russell, *Icarus; or, The Future of Science* (London: Kegan Paul, Trench, Trubner, 1924).

32 J. P. Telotte, *Replications: A Robotic History of the Science Fiction Film* (Chicago: University of Illinois Press, 1995), pp. 17, 33.

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Mechanized Humanity: J. B. S. Haldane, J. D. Bernal, and Their Circle

> No one really has the guts to say it, but if we could make better human beings by knowing how to add genes, why shouldn't we?
>
> James D. Watson[1]

Humanity has always dreamt of tinkering with the evolutionary process. Visions of physical metamorphoses, improved bodily vigour and immortality, genetically hybridised animals and plants are only some of the manifestations of that longstanding fantasy which has found expression in myth, legend, fiction, film, and the visual arts. After Darwin, however, as Bruce Clarke remarks, the 'metamorphic imaginary […] has a distinctly evolutionary valence'.[2]

The control of human evolution is the unifying theme of the 'To-day and To-morrow Series' published between the 1920s and 1930s. The future of humanity is explored in J. B. S. Haldane's *Daedalus; or, Science and the Future* (1924), the first volume in the series, F. C. S. Schiller's *Tantalus; or, The Future of Man* (1924), H. S. Jennings' *Prometheus; or, Biology and the Advancement of Man* (1925), Garet Garrett's *Ouroboros; or, The Mechanical Extension of Mankind* (1926), Ronald Campbell MacFie's *Metanthropos; or, The Body of the Future* (1928), and J. D. Bernal's *The World, the Flesh and the Devil: An Enquiry into the Future of the Three Enemies of the Rational Soul* (1929). Although, as H. F. Carlill observes in *Socrates; or, The Emancipation of Mankind* (1927), it is 'difficult to imagine the race of the future',[3] the object of the 'To-day and To-morrow' series is precisely that of guessing what the future will bring in a great variety of areas.

1 See Gregory Stock, 'Humans: Objects of Conscious Design', *BBC. Science & Nature: TV & Radio Follow-up*, <http://www.bbc.co.uk/science/horizon/1999/stock.shtml> [accessed 10 June 2011]. See also *Engineering the Human Germline: An Exploration of the Science and Ethics of Altering the Genes We Pass to Our Children*, ed. by Gregory Stock and John Campbell (New York: Oxford University Press, 2000), p. 79, and 'Gregory Stock, 'The Last Human', in Id., *Redesigning Humans: Choosing Our Children's Genes* (London: Profile Books, 2002), p. 12.

2 Bruce Clarke, *Posthuman Metamorphosis: Narrative and Systems* (New York: Fordham University Press, 2008), p. 2.

3 H. F. Carlill, *Socrates; or, The Emancipation of Mankind* (London: Kegan Paul, 1927), p. 87.

Central to these authors' speculations about the future was a concern with the future of the body, a topic that inevitably touches on the themes of eugenics, heatedly discussed at the time. Indeed, all of these writers were for a while associated with, and defenders of, a form of eugenics, although Haldane[4] and Russell[5] later distanced themselves from eugenic ideologies.[6] As Diane B. Paul explains, there was a general consensus that

> *individuals* varied significantly in their genetic endowments, not just in respect to physical characteristics or even intelligence but also in respect to specific traits of character and personality; that the fitter should be encouraged, and the less fit discouraged, from reproducing; and that such a policy could only be successfully pursued in a society that provided approximately equal opportunities to all its members.[7]

In their contributions to the 'To-day and To-morrow' series these authors articulate radical visions about the future of the human body in the context of such eugenicist presuppositions, although in many cases the scope of their forecasts is so far-reaching that the body is lost from sight, replaced by a type of hive mind or compound brain permanently interconnected in a post-Darwinian virtual network.

I. J. B. S. Haldane

Haldane, one of the founders of population genetics, puts across his vision of future scientific developments with special reference to the fields of physics and biology. *Daedalus; or, Science and the Future* was the first publication in which he set out his eugenicist views in an essay about the 'influence of biology on history during the 20th century',[8] which an undergraduate reads to his supervisor in 2073. According to the student:

> as early as the first decade of the twentieth century we find a conscious attempt at the application of biology to politics in the so-called eugenic movement. A number of earnest persons, having discovered the existence of biology, attempted to apply it in its then very crude condition to the production of a race of super-men, and in certain countries managed to carry a good deal of legislation.[9]

4 See Ronald William Clark, *J. B. S.: The Life and Work of J. B. S. Haldane* (London: Hodder & Stoughton, 1968).
5 See Bertrand Russell, *Icarus; or, The Future of Science* (Nottingham: Spokesman Books, 2005, 1st edn 1924), and Id., *The Scientific Outlook* (London: Routledge, 2001, 1st edn 1931).
6 Diane B. Paul, 'Eugenics and the Left', *Journal of the History of Ideas*, 45 (1984), 567–590.
7 Ibid., p. 570, emphasis in original.
8 J. B. S. Haldane, *Daedalus; or, Science and the Future* (New York: E. P. Dutton and Company, 1924), pp. 56–57.
9 Ibid., p. 57.

Despite strong opposition, selection was adopted a generation after Germany had done so, the advantages proving to be huge. Animal species can already be considerably altered, humans are undergoing mutations. In *Animal Biology* (1927), co-authored with Julian Huxley, Haldane remarks:

> The one great difference between man and all other animals is that for them evolution must always be a blind force, of which they are quite unconscious; whereas man has, in some measure at least, the possibility of consciously controlling his evolution according to his wishes. But that is where history, social science, and eugenics begin, and where zoology must leave off.[10]

It was, however, in 'The Last Judgment' (1927) that Haldane offered a much more detailed view of the future of humankind. The essay, which reprises many thematic concerns of *Deadalus*, projects the forecast forty million years into the future. In a similar manner to the time traveller in H. G. Wells's *The Time Machine*, we are shown the death of our planet brought about by catastrophic climate changes, due to the depletion of all fossil fuels and the radical diminution of the world population and extinction of most animal and plant species.[11] Efforts to harness tidal energy and the subsequent squandering of such an enormous energy source eventually result in the steady slowing down of the earth's rotation, the lengthening of the days, and the gradual distancing of the moon, whose final orbital approach would most likely lead to the destruction of the earth and all life left on it.

It is at this stage that the imperialist need to colonize space as a matter of survival becomes compelling. Simultaneously, it becomes necessary to introduce modifications to the human form to ensure adaptation and survival in radically new atmospheric conditions, and thereby tinkering with evolution. Although the human form remains basically unchanged, the most salient alteration is the disappearance of teeth, mostly due to the introduction of synthetic food, while the greatest evolutionary accomplishment is the disappearance of pain.

According to Haldane, humans eventually manage to land on Venus, having undergone a form of controlled evolution that would enable them to survive on the planet. Enforced evolution was so quick that unions between the first and the last space colonizers to reach Venus are infertile. As a result of the plans to colonize Jupiter a new 'dwarf form of the human race about a tenth of our height,

10 J. B. S. Haldane and Julian Huxley, *Animal Biology* (Oxford: The Clarendon Press, 1927), p. 335.

11 For an analysis of H. G. Wells's influence on Haldane's work, with special reference to 'The Last Judgment', see Mark B. Adams, 'Last Judgment: The Visionary Biology of J. B. S. Haldane', *Journal of the History of Biology*, 33 (2000), 457 – 491.

and with short stumpy legs but very thick bones, is therefore being bred',[12] a novel breed unconcerned by pride and personal preference in the choice of the partner. The breadth and wealth of Haldane's vision is impressive: he blames human greed and individualism, emphasizing the disastrous effects of human action on the environment.[13]

In 'Man's Destiny' (1932) he speculates that in the far future, when humans can live for extended periods of time as well as move to other planets, material, intellectual, and spiritual progress will grow indefinitely.[14] In 'Biological Possibilities for the Human Species of the Next Ten-Thousand Years' (1963) his predictions range far and wide, from clonal reproduction to positive eugenics. Haldane believes that our species will divide into two or more branches, a prospect he no longer envisions with the trust exhibited in 'The Last Judgment.'[15]

II. J. D. Bernal

J. D. Bernal makes similar forecasts in his contribution to the 'To-day and Tomorrow Series' entitled *The World, the Flesh and the Devil: An Enquiry into the Future of the Three Enemies of the Rational Soul* (1929). Arthur C. Clarke described it as 'the most brilliant attempt at scientific prediction ever made'[16] and went on to acknowledge that many of his own ideas were inspired by Bernal, whose prognostications are in many ways as radical as those of Haldane. Bernal addresses several topics: space travel and colonization, the future of the universe and the radical alteration of humanity in order to adapt to space exploration and to settle on other planets, an aspect that Haldane also dealt with at length. Like Haldane, Bernal believed that 'man himself must actively interfere in his own making and interfere in a highly unnatural manner'[17] so as to be successful in space colonization. Evolution can balance the relationship between nature and

12 Ibid., p. 308.

13 For an account of the influence of Haldane's 'The Last Judgment', in particular on Olaf Stapledon's *Last and First Men: A Story of the Near and Far Future* (1930), see Adams, pp. 467 – 468.

14 See Brian Stableford, 'Haldane, J[ohn] B[urton] S[Sanderson], 1892 – 1964, *The Inequality of Man and Other Essays* (1932), in Id., *Science Fact and Science Fiction: An Encyclopaedia* (London: Routledge, 2006), p. 226.

15 A similar scenario was already mooted in H. G. Wells's *The Time Machine*, where in the far future humanity divides into two species, the Eloi and the Morlocks.

16 Arthur C. Clarke, 'A Choice of Futures', in Id., *Greetings, Carbon-Based Bipeds! Collected Essays, 1934 – 1998*, ed. by Ian T. Macauley (New York: St. Martin's Griffin, 2001), pp. 410 – 415 (p. 410).

17 J. D. Bernal, *The World, the Flesh and the Devil: An Enquiry into the Future of the Three Enemies of the Rational Soul* (Bloomington and London: Indiana University Press, 1969), p. 30.

the environment to enable human beings to realize fully their potentialities either by altering the 'germ plasm or the living structure of the body, or both together';[18] the first method had also been Haldane's favourite. Following Haldane, Bernal believes that future human beings will be created in an ectogenetic factory and will have 'anything from sixty to a hundred and twenty years of larval, unspecialized existence'.[19] Following a period that could be equated with that of a chrysalis, human beings will emerge, endowed with the ability to extend sensations and actions indefinitely:

> the new man must appear to those who have not contemplated him before as a strange, monstrous and inhuman creature, but he is the logical outcome of the type of humanity that exists at present.[20]

The new human being will be like a cylinder containing the brain and will have organs more complex than ours. Thought transference will eventually lead to a kind of compound brain able to perform co-operative thinking,[21] a type of 'hive mind' that was also envisioned by Haldane in 'The Last Judgment'. Both Haldane and Bernal's fantasies of the 'hive mind' would find their way into countless science-fictional novels. A notable example is Olaf Stapledon's *Last and First Men* (1930), directly influenced by Bernal's *The World, the Flesh and the Devil.*

Reflecting on the consequences for the individual of such a compound mind, Bernal muses that 'some kind of equilibrium will have to be found between each partial and corporate personality'.[22] As Clarke states, in words that resonate with some of the scenarios discussed here, including Bernal's:

> the posthuman does not transcend the human as the discourse of the human has imagined transcendence. Rather, the neocybernetic posthuman transcends the vision of disconnection that has isolated the human for so long in its own conceit of uniqueness. The reconnections called for will not be fusions that dissolve autonomies but couplings preserving operational differences. The neocybernetic posthuman is the human metamorphosed by reconnection to the worldly and systemic conditions of its evolutionary possibility.[23]

Bernal ponders the psychological effects of Freud's theories on the tripartite make-up of the ego. Will the three corporate personalities 'form greater and greater complexes until there is only one intelligence, or will there be a multiplication of separate and differently-evolving complexes with resulting con-

18 Ibid., ivi.
19 Ibid., p. 36.
20 Ibid., p. 41.
21 Ibid., p. 42.
22 Ibid., p. 66.
23 Clarke, *Posthuman Metamorphosis*, p. 196.

flicts?'.[24] Bernal further muses that death will be perceived as less terrible; it will still exist, but the multiple individual will be immortal, since memories and feelings will be transferred to the common stock before death. Memories will be shared, but individual identity will still persist.[25] Acknowledging that this state of affairs is hard to imagine, he warns his readers that his speculations should be taken as a fable. This is a vision of human bodily transcendence that would clearly not appeal to everybody, but Bernal is not content to stop here. The next step would be not just to manufacture life but to devise materials out of which to create new life, which would continue to develop, until eventually 'consciousness itself may end or vanish in a humanity that has become completely etherialized'.[26] He also envisages an alternative scenario according to which humanity would be split in two distinct sections, one developing a 'fully-balanced humanity, the other groping unsteadily beyond it',[27] a vision mooted by Haldane in 'Biological Possibilities for the Human Species of the Next Ten-Thousand Years'. Pursuing engagement with Freudian psychology, Bernal considers also the evolution of human desire, whose fulfilment often takes the form of various activities aimed at the compensation and sublimation of suppressed drives. The goal of applied psychology consists of bringing the 'ideals of the superego in line with external reality, using and rendering innocuous the power of the id and leading to a life where a full adult sexuality would be balanced with objective activity'.[28] The desire for progress will have to supersede the aversion felt by many towards mechanization and the transformation of the human body, because advancement in both areas is both inevitable and desirable. Indeed, repressed impulses will be placed at the service of these goals, driving humanity forward while enabling a more fulfilled existence. This is a dream that bears many similarities with the theories expressed by Herbert Marcuse in *Eros and Civilization* (1955): in a non-repressive civilization 'human needs are fulfilled in such a manner and to such an extent that surplus-repression can be eliminated'[29] and 'a new basic experience of being would change the human existence in its entirety'.[30]

24 Bernal, *The World, the Flesh and the Devil*, p. 67.
25 Some of the prognostications in Bernal's *The World, the Flesh and the Devil* could have inspired J. B. S. Haldane's novel *The Man with Two Memories* (1976).
26 Bernal, *The World, the Flesh and the Devil*, p. 47.
27 Ibid., p. 60.
28 Ibid., p. 57.
29 Herbert Marcuse, *Eros and Civilization: A Philosophical Inquiry into Freud* (Boston: Beacon Press, 1966), p. 151.
30 Ibid., p. 158.

III. J. D. Bernal's 'Human Zoo' and Sloterdijk's 'Human Park'

Bernal's vision of the splitting of humanity into those who stay behind on Earth as members of a kind of human zoological park rigidly ruled by higher entities and those who leave to take part in space colonization can be linked with Peter Sloterdijk's contemporary view of the future of humankind inhabiting a zoo.

In *The World, the Flesh and the Devil* Bernal predicts that in the world of the future, eugenically controlled by the authorities, scientists and other superior beings would develop into virtually a new species, travel to other planets and leave the old humanity back on Earth.[31] Like Haldane, Bernal sees space colonization as a possible solution:

> Mankind – the old mankind – would be left in undisputed possession of the earth, to be regarded by the inhabitants of the celestial spheres with a curious reverence. The world might, in fact, be transformed into a *human zoo*, a zoo so intelligently managed that its inhabitants are not aware that they are there merely for the purposes of observation and experiment.[32]

This vision is strikingly similar to Sloterdijk's human zoo. In *Rules for the Human Park* (*Regeln für den Menschenpark*) (2000)[33] he argues that the notion of humanism has been gradually eroded, a dilution brought about above all by mass culture and the gradual disappearance of a classical education, with a consequent bestialization and taming of humans. 'Anthropotechnology', the term Sloterdijk uses for biotechnology, can offset the increasing domestication of human beings. Since Plato the human community has been described as a zoological park, or a theme park: in Sloterdijk's perspective, the central question pertaining to the Platonic zoo revolves around the difference between the population at large and those who rule over it: is it a difference of degree or a more specific, intrinsic one? Plato develops what Sloterdijk terms a political anthropotechnique, which in all probability will be updated and concretized in the genetic terms available to modern science. As a consequence, humanity needs to formulate a code founded on the positive application of genetic technologies.

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31 For a detailed account of Bernal's views on science and scientists see Andrew Brown, *J. D. Bernal: The Sage of Science* (Oxford: Oxford University Press, 2005).

32 Bernal, *The World, the Flesh and the Devil*, pp. 79 – 80, emphasis mine.

33 Peter Sloterdijk, *Regeln fur den Menschenpark. Ein Antwortschreiben zu Heideggers Brief uber den Humanismus* (Frankfurt am Main: Suhrkamp, 1999); *Règles pour le parc humain. Une lettre en réponse à la Lettre sur l'humanisme de Heidegger*, trad. de l'allemand par Olivier Mannoni (Paris: Mille et Une Nuits, 2000). For online versions see <http://www.zeit.de/1999/38/199938.sloterdijk3_.xml> [accessed 10 June 2011] and <http://multitudes.samizdat.net/Regles-pour-le-Parc-humain> [accessed 10 June 2011].

In Bernal's vision of a far future world 'lesser humans' are left behind on planet Earth to become inhabitants of a 'Sloterdijkian' human park controlled by a totalitarian regime. His speculations about organs grown in the laboratory to replace failing ones and brain downloading into computers and other artefacts can be regarded as the foundation of transhumanist philosophy. In 1972 physicist Freeman Dyson delivered the Third J. D. Bernal Lecture at Birkbeck College, London, highlighting 'that biological engineering is the essential tool which will make Bernal's dream of the expansion of mankind in space a practical possibility.[34] In the meantime, the implementation of self-reproducing machinery will contribute to building the freely floating spatial cities that Bernal imagined for human habitation.

IV. F. C. S. Schiller, H. S. Jennings, Garet Garrett, and Ronald Campbell MacFie

In *Tantalus; or, The Future of Man* (1924), philosopher and eugenicist F. C. S. Schiller asserts that 'biologically speaking, Man has ceased to be a progressive species long ago'.[35] Schiller sees humanity as still 'Yahoo-manity', 'irrational, impulsive, emotional, foolish, destructive, cruel, credulous',[36] and advocates 'the eugenical reform and reconstruction of our social organization'.[37] More optimistic than J. B. S. Haldane, who despises eugenics, and Bertrand Russell, who does not trust it, Schiller believes that superman will gradually replace the primitive Yahoo. In *Social Decay and Eugenical Reform* (1932) he further argues that negative eugenics is not sufficient to check the 'deterioration to which the human stock is exposed, owing to the rapid proliferation of what may be called human weeds'.[38] Positive eugenics must be introduced in order to achieve healthier, more vigorous and capable human beings.[39]

34 Freeman Dyson, 'IV. Big Trees', in Id., *The World, the Flesh, and the Devil*, 16 May 1972, <http://impearls.blogspot.com/2002_11_10_impearls_archive.html#84429829> [accessed 10 July 2011]. Dyson's lecture was first published by Birkbeck College for private circulation in 1972 and subsequently reprinted as Appendix D to *Communication with Extraterrestrial Intelligence (CETI)*, ed. by Carl Sagan (Cambridge, Massachusetts: The MIT Press, 1973).

35 F. C. S. Schiller, *Tantalus; or, The Future of Man* (London: Kegan Paul, 1931), p. 14.

36 Ibid., p. 37.

37 Ibid., p. 57.

38 F. C. S. Schiller, *Social Decay and Eugenical Reform* (New York: Garland, 1984), p. 28.

39 See also, in the 'To-day and To-morrow' series, H. Stafford Hatfield's *Automaton; or, The Future of the Mechanical Man* (London: Kegan Paul, 1928); in fiction, Karel Čapek's *R.U.R. (Rossum's Universal Robots)*, trans. by Claudia Novack-Jones (1921; Harmondsworth: Penguin Classics, 2004), and E. V. Odle's *The Clockwork Man* (London: Heinemann, 1923).

Prometheus; or, Biology and the Advancement of Man (1925) by geneticist and zoologist H. S. Jennings also engages with eugenics and the improvement of humankind, suggesting that those he describes as 'superior parents' should be encouraged to have more children. Jennings advocates radical measures for the enhancement of people and argues that even selective eugenics will not solve the problems connected with biparental reproduction. He thus examines the potentialities of cloning, inspired by Haldane's view that humankind will experience a new kind of freedom, when procreation and sex become independent of each other.[40] If cloning could be achieved

> man would have his fate in his own hands. He could multiply the desirable combination until the entire population consisted of that type.[41]

Such an idea was vigorously opposed by Haldane, who believed that uniformity of genes would be highly deleterious. He defended genetic variety as leading to an ideal society where different human types could thrive and in 'Darwin and Slavery' (1949) asserted that it is the difference in the innate powers of individuals that makes the world interesting.[42]

Another writer who speculates about the future of the human body is Garet Garrett. In his *Ouroboros; or, The Mechanical Extension of Mankind* (1926) he envisages the enhancement of human powers through prosthetic devices and artificial parts. Garrett sees bodily extension as in keeping with the drift to consumerism and a society characterized by excess.

In *Metanthropos; or, The Body of the Future* (1928) the poet and physician Ronald Campbell MacFie discusses the origins of humankind and muses on whether humans can alter themselves by controlling evolution and variation. For him 'man's control over his own evolution is perhaps the most interesting and most important in all biology',[43] an idea shared by a large number of the contributors to the 'To-day and To-morrow' series. The future technologies used by human beings to alter their genes will be the subject of strict legislation. In time 'it will be possible […] to breed almost numberless varieties of the highly moral,

40 A similar vision will be later elaborated by feminist writers. See for example Shulamith Firestone in *The Dialectic of Sex: The Case for Feminist Revolution* (New York: Bantam, 1970).

41 H. S. Jennings, *Prometheus; or, Biology and the Advancement of Man* (London: Kegan Paul, 1927), p. 87. In *The Biological Basis of Human Nature* (New York: W. W. Norton, 1930) Jennings further reflects on the importance of genetics and the fundamental role it will have in humankind's change and selective improvement.

42 J. B. S. Haldane, 'Darwin on Slavery', *The Daily Worker*, 14 November 1949. See also Daniel J. Kevles, *In the Name of Eugenics: Genetics and the Uses of Human Heredity* (Cambridge, Massachusetts: Harvard University Press, 1997), p. 147.

43 Ronald Campbell MacFie, *Metanthropos; or, The Body of the Future* (London: Kegan Paul, Trench, Trubner & Co., 1928), p. 51.

the highly intellectual, and there seems some likelihood that the Metanthropoi of the future will be divided into nations akin in mental and moral outlook'.[44]

V. Artificial Nature and the 'Operable Man'

The works examined here defend a course of progress deemed inevitable in a great variety of fields, starting from the manipulation of the human body. The artificial and technological are contrasted with what was described as 'natural', a category itself unstable and elusive.

Throughout his career Haldane was consistently interested in effecting changes in living organisms. In 'Reshaping Plants and Animals' (1944) he draws attention to the inbred artificiality of flora and fauna:

> We live in an artificial world, even in peace time. We are apt to think that this has only been so in the last few hundred years, since machines took over a lot of work which used to be done by men or animals. However, our domesticated animals and plants are not products of nature, but human products. A Jersey cow is as artificial as a cream separator, a bulldog is no more natural than a machine gun, a wheat plant is as much a human product as a loaf of bread. There are no wild animals or plants with their special qualities; and there never were.[45]

This notion can also be extended to humanity which is always already artificial, cyborgian in Donna Haraway's sense.[46] The drive to create life and new human beings extends to novel 'natural' forms, something that botanists, farmers, and scientists have done for centuries. As Slavoj Žižek remarks:

> biogenetics means the end of nature. That is to say, nature itself is experienced as something which follows certain mechanisms which can be changed. Nature becomes a technical product that loses its spontaneous natural character.[47]

By highlighting the artificial nature of both humans and the natural world, Žižek draws attention to the implicit potential for controlled evolution. In *Organs without Bodies* he explains why we must consider ourselves as inherently artificial:

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44 Ibid., p. 95.

45 J. B. S. Haldane, *'Reshaping Plants and Animals'*, in J. S. Huxley, H. G. Wells, J. B. S. Haldane, et al., *Reshaping Man's Heritage: Biology in the Service of Man* (London: George Allen & Unwin, 1944), pp. 31 – 37 (p. 31).

46 Donna Haraway, 'A Cyborg Manifesto: Science, Technology, and Socialist-Feminism in the Late Twentieth Century', in Id., *Simians, Cyborgs, and Women: The Reinvention of Nature* (London: Free Association Books, 1991), pp. 149 – 182.

47 Slavoj Žižek and Glyn Daly, *Conversations with Žižek* (London: Polity 2004), p. 92.

> [D]oes the very fact of the possibility of biogenetic manipulations not retroactively change the self-understanding of ourselves as 'natural' beings, in the sense that we now experience our 'natural' dispositions themselves as something 'mediated,' not simply as so immediately given but as something that can be in principle manipulated (and is thus simply contingent)?[48]

This intrinsic evolutionary capacity activated by biotechnological interventions is indeed repeatedly emphasized by Haldane, Bernal, and other contributors to the 'To-day and To-morrow' series. In analogous vein, Sloterdijk maintains that it is technology that makes humans evolve and authentically brings about humans:

> humans encounter nothing strange when they expose themselves to further creation and manipulation, and they do nothing perverse, when they change themselves autotechnologically, given that such interventions and assistance happen on such a high level of insight into the biological and social nature of man, that they become effective as authentic, intelligent and successful *coproductions with evolutionary potential.*[49]

Sloterdijk's 'operable man', Bernal's 'transformable man' and Žižek's emphasis on human metamorphoses suggest that redirecting the evolutionary process is a necessary, grand endeavour.

Many of the prognostications put forward in the 1920s by Haldane, Bernal, and others have been taken up by numerous contemporary scientists, transhumanists, and futorologists. For futurist Ray Kurzweil being human 'means being part of a civilization that seeks to extend its boundaries',[50] eventually transcending biology. According to him, the paradigm shift brought about by technological revolutions in computer science, biotechnology, and nanotechnology will virtually eliminate biological death and foster the impetus towards a nonbiological existence in which the contents of human brains are routinely uploaded.

Kurzweil's forecasts are similar to Haldane's: by 2030 we will become more nonbiological than biological and by the 2040s nonbiological intelligence will have prevailed. Like Haldane and Bernal, Kurzweil believes that humans will have to take control of evolution, since biological processes are activated by a very limited class of materials, proteins, which are folded from one-dimensional strings of amino acids, and thinking processes depend on very slow chemical

48 Slavoj Žižek, *Organs without Bodies: On Deleuze and Consequences* (New York and London: Routledge, 2004), p. 124.

49 Peter Sloterdijk, 'The Operable Man: On the Ethical State of Gene Technology', trans. by Joel Westerdale and Günter Sautter, lecture at UCLA conference *Enhancing the Human: Genomics, Science Fiction, and Ethics Collide*, Goethe Institute, Los Angeles, 21 May 2000, unpublished.

50 Ray Kurzweil, *The Singularity Is Near: When Humans Transcend Biology* (New York: Viking, 2005), p. 374.

switching. In the 2030s and 2040s, Kurzweil predicts, human bodies will undergo a profound redesign: version 3.0. will enable bodily transformation in virtual-reality environments. Clearly, for Haldane, Bernal, and Kurzweil the essence of being human resides in the capacity to overcome human limitations, including the ones dictated by biology. According to biophysicist Gregory Stock, the arrival of 'metaman', part biological, part mechanical, part electronic is imminent. Metaman will apply biological techniques to embryos and then to the reproductive process itself, finally taking control of human evolution.[51]

The predictions put forward by Bernal and Haldane have been dramatized in the work of many contemporary writers, such as Naomi Mitchison, Octavia Butler, Michel Houellebecq, Margaret Atwood, and Nancy Kress.[52] Their dystopian, futuristic scenarios share much with the ones envisioned in the 'To-day and To-morrow' series, in which fictional scientists decide to intervene in the evolutionary process often with unpredictable and disastrous consequences.

Haldane's 'Biological Possibilities for the Human Species in the Next Ten Thousand Years' ends with an assessment of the utopian frame of mind. Extrapolations into the near and far future have always lured thinkers. Indeed, the need to foresee is what makes humans human:

> I have sketched my own utopia, or as some readers may think, my own private hell. My excuse must be that the description of utopias has influenced the course of history.[53]

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51 Gregory Stock, *Metaman: The Merging of Humans and Machines into a Global Superorganism* (New York: Simon and Schuster, 1993), p. 164.

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Clare Thake Vassallo / Victor Grech

'Extravagant Fiction Today, Cold Fact Tomorrow': The Theme of Infertility in Science Fiction

I. Science and Fiction

In 1851 William Wilson defined 'Science-Fiction' as a new kind of literature which could interweave the truths of science with those of fiction.[1] Today the deliberate intermingling of the scientific and the literary remains a characteristic feature of the genre. The novel which best defines the advent of modern science fiction is Mary Shelley's *Frankenstein, or the Modern Prometheus* (1818), which pre-dates by some three decades the coinage of science fiction.

What differentiates early and contemporary sci-fi is the treatment of themes. In attracting not only readers of realistic fiction and science, but also of pulp magazines, sci-fi created its own readership which came to the genre with a blend of scientific as well as literary encyclopaedic competence. Though ignored and derided for much of the twentieth century, sci-fi made a come-back with the advent of mass produced magazines and cheap, accessible paperbacks. It became a thriving genre which continues to attract an ever-increasing share of mainstream and cult attention. In exploring 'all that we know about the universe, and what we imagine we might eventually know',[2] sci-fi attracts a readership with interests that go beyond the traditional domains of literature.

The influential role played by magazines, especially in the United States from the 1920s onwards, is fundamental to the history and development of sci-fi. In 1926 Hugo Gernsback, known as the founding father of the genre in the US, created and edited *Amazing Stories*,[3] the world's first sci-fi magazine. In 1937 John W. Campbell founded *Astounding Science Fiction*, which he edited for thirty four years.[4] If *Amazing Stories* made a significant contribution to the

1 William Wilson, *A Little Earnest Book upon a Great Old Subject* (London: Darton, 1851), pp. 138 – 140.

2 Greg Bear, 'Introduction: On Losing the Taint of Being a Cannibal', in Id., *Bear's Fantasies. Six Stories in Old Paradigms* (Newark, New Jersey: The Wildside Press, 1992), p. 1.

3 Hugo Gernsback, 'A New Sort of Magazine', *Amazing Stories*, ed. by Id., 1, 1 (April 1926), p. 3.

4 John W. Campbell, *Wonder's Child: My Life in Science Fiction* (New York: Bluejay Books,

popularization of the genre, *Astounding Science Fiction* launched many sci-fi writers who were to shape the mid-twentieth century genre. Some of these were to take the popular version of the genre to more scientific, narratologically sophisticated levels, eventually making it agreeable and acceptable to academic publishers. The slogan on the masthead of the first issue of *Amazing Stories*, 'Extravagant Fiction Today, Cold Fact Tomorrow', still carries great resonance. Sci-fi is constituted by a 'novum'[5] of highly variable form and content which may seem 'extravagant', but which often is represented as the 'cold fact of tomorrow'.

Scientists and doctors frequently appear in sci-fi as protagonists, such as the most famous Dr Frankenstein. There are also a number of scientist-authors; H. G. Wells, who read science as an undergraduate, and Isaac Asimov, a biochemist, successfully blended scientific knowledge to their talent for suspense and storytelling. Not only does the genre feature scientists as protagonists and authors, but it assumes readers will adopt complex roles.[6]

Once one accepts the definition of modern sci-fi as 'a new kind of fiction [that combines] adventure and exploration' with 'the popularization of science',[7] it is evident that the typology of characters found in such works will include people with a scientific or medical background. The works which fall into this genre are so numerous that it would be arduous to create a comprehensive poetics of medicine in sci-fi. However, a focus on a subspecialty of medicine – infertility –

1984). See R. Scott Latham, 'Foreword', in *Treasury of Science Fiction*, ed. by Groff Conklin (New York: Bonanza Books, 1980), p. vii: 'he changed the direction of science fiction writing. He adamantly refused to accept the tired old BEM space operas. He wanted hard, logical science, presented in the context of real, believable characters. He encouraged social and political themes; he urged [writers] to dream clearly to examine the world that was and to extrapolate what it might be'. The summer of 1939 was particularly important as the July issue featured *Black Destroyer* by A. E. van Vogt and *Trends* by Isaac Asimov, the August issue included *Life-Line*, Robert Heinlein's first story, and the September issue included *The Ether Breathers* by Theodore Sturgeon. Campbell preached his type of science fiction through his editorials and other science fiction magazines copied the style. He himself was an author and, under his influence, stories were toned down, science became more sensible, and style improved. He also paid his contributors as his publishers, Francis Scott Street and Francis Shubael Smith, were very successful. In this way, he influenced the career and thinking of virtually every major science fiction writer of the time. Moreover, readers and writers interacted by developing ideas, conventions, and images. Science fiction matured and entered its 'Golden Age' from the late 1930s to the mid 1940s. See Isaac Asimov, 'Introduction', to *Before the Golden Age 1*, ed. by Id. (London: Futura Publications, 1974), pp. xiii-xix.

5 Darko Suvin, 'On What Is and Is Not a SF Narration; With a List of 101 Victorian Books That Should Be Excluded From SF Bibliographies', *Science Fiction Studies*, 5, 1 (March 1978), 45 – 57. Suvin defines science fiction as a genre dominated by a 'novum', a fictional novelty that is congruous with contemporary reality and stems logically as an extrapolation.

6 Umberto Eco, 'Introduction: The Role of the Reader', in Id., *The Role of the Reader: Explorations in the Semiotics of Texts* (Bloomington: Indiana University Press, 1979), pp. 3 – 43.

7 John Anthony Cuddon, *Dictionary of Literary Terms and Literary Theory*, 3rd edn (Harmondsworth: Penguin Books, 1991), p. 842.

may help to define a poetics of this specific intersection.[8] The theme of global infertility has eschatological implications which are highly amenable to treatment by sci-fi. In the sciences, worst-case scenarios are important and attractive because they represent the extreme end of a spectrum of possible outcomes which translate into narrative structures imbued with possibilities for suspense, complications of plot, and interesting resolutions.[9]

Infertility is not a particularly popular sci-fi theme, whereas the opposite eschatological scenario, the Malthusian dystopia engendered by super human fecundity, is portrayed far more frequently. The overpopulation dystopia was memorably developed in Isaac Asimov's *The Caves of Steel* (1954),[10] J. G. Ballard's 'Billenium' (1961),[11] John Brunner's *Stand on Zanzibar* (1968),[12] and Robert Silverberg's *The World Inside* (1971).[13] Population dynamics became a popular theme in sci-fi around the middle of the twentieth century, while in the last decade the emphasis is laid upon environmental causes, as in David Brin's *Earth* (1990)[14] and Orson Scott Card's *Pastwatch* (1996).[15]

The theme of infertility is extensively explored in Brian Aldiss's *Greybeard* (1964),[16] Richard Cowper's *The Twilight of Briareus* (1974),[17] and P. D. James's *The Children of Men* (1992).[18] *Greybeard* was one of the first novels to envisage the possibility of mass human infertility. Aldiss, responding to the cold-war tensions of the time, included atomic bomb testing amongst its major causes. Cowper's *Twilight of Briareus* similarly took account of contemporary research which implied the possibility of global infertility through the radiation effects of a nearby supernova explosion. The novel was influenced by the drug culture of the time and the experience of LSD 'trips' was used as a fictional means through

8 A poetics of infertility in science fiction aims to be encyclopaedic in its scope; to overview doctors and medicine in mainstream literature and in science fiction in general; and to be understandable to those in medicine and science.

9 This approach has been adopted in an epidemiological paper on disease spread through mathematical calculation of the increasing presence of Zombies. See Philip Munz, Ioan Hudea, Joe Imad, and Robert J. Smith, 'When Zombies Attack!: Mathematical Modelling of an Outbreak of Zombie Infection', in *Infectious Disease Modelling Research Progress*, ed. by Jean Michel Tchuenche and Christinah Chiyaka (New York: Nova Science Publishers, 2009), pp. 133 – 150.

10 Asimov, *The Caves of Steel* (New York: Signet, 1955). See also the follow-up story *The Naked Sun* (New York: Bantam Books, 1957).

11 J. G. Ballard, 'Billenium', *New Worlds*, 112 (November 1961).

12 John Brunner, *Stand on Zanzibar* (New York: Doubleday, 1968).

13 Robert Silverberg, *The World Inside* (New York: Doubleday, 1971).

14 David Brin, *Earth* (London: Futura Publications, 1990).

15 Orson Scott Card, *Pastwatch: The Redemption of Christopher Columbus* (New York: Tor Books, 1996).

16 Brian Aldiss, *Greybeard* (London: Cox and Wyman, 1964).

17 Richard Cowper, *The Twilight of Briareus* (New York: The John Day Company, 1974).

18 Phyllis Dorothy James, *The Children of Men* (Harmondsworth: Penguin Books, 1992).

which aliens could 'piggy-back' additional effects of the nova's radiation upon humans. The third novel, P. D. James's *Children of Men*, is a deviation from her usual mystery genre; James refuses to define this futuristic novel as science fiction for fear it might be identified with a genre still regarded by some as shallow and puerile. She extrapolates current trends in declining fertility, but offers no explanation as to why this trend should increase to an absolute degree in the future.

Aldiss and Cowper, both regular sci-fi authors, were clearly influenced by John W. Campbell, who insisted on plots with scientific credibility. These two novels attempt to offer plausible causes of mankind's infertility. Conversely, James did not trammel herself with sci-fi rules and did not put forward any detailed explanation. Her attitude typifies the mainstream authors' disregard for the conventions of the genre. Such approaches are rare and can be found in very few sci-fi novels dealing with infertility, such as Wright F. Moxley's *Red Snow* (1930)[19] wherein a red, snow-like precipitation sterilises all women with no clear reason offered that accounts for its source.

II. Richard Cowper's *The Twilight of Briareus*

Richard Cowper is a pseudonym used by John Middleton Murry, Jr. (1926–2002), the critically acclaimed English master of catastrophic science fiction. *The Twilight of Briareus*, generally considered his best work, focuses on mass human sterility and the potential end of the human race.

Briareus[20] Delta[21] is one hundred and thirty two light years away, very close as

19 Wright F. Moxley, *Red Snow* (New York: Simon and Schuster, 1930).

20 Briareus is a creature from Greek mythology, one of the three hundred-armed, fifty-headed Hecatoncheires, son of Poseidon and Gaea and brother of Cottus and Gyges. He was called Aegaeon by men and Briareus by the gods. The most widely spread myth recounts that Briareus and his brothers were called by Zeus to his assistance when the Titans were making war upon Olympus. The gigantic enemies were defeated and consigned to Tartrus, at the gates of which the three brothers were placed. See 'Briareus', in *Encyclopædia Britannica*, <http://www.britannica.com/EBchecked/topic/79185/Briareus> [accessed 15 June 2011].

21 Ancient astronomers divided the sky into constellations according to perceived patterns of gods, men, and beasts. The brightest stars were given individual names by Arabic astronomers around the tenth century AD. In 1603 J. Bayer, a German lawyer, devised a more logical stellar naming system by using the genitive name of a particular constellation and labelling the stars with letters from the Greek alphabet. For example, the brightest star in the constellation Centaurus is Alpha Centauri, the second brightest is Beta Centauri and so on. Therefore Briareus Delta is the fourth brightest star in the constellation Briareus. See Dennis L. Mammana, *The Night Sky: An Observer's Guide* (New York: BDD Promotional Book Company, 1993).

interstellar distances go. It becomes a supernova[22] and its light and other radiation, which includes gamma and cosmic rays, reach Earth in 1999. This particular supernova emits radiation at a rate some two hundred million times that of our sun and remains visible for nine days. It knocks out communications satellites, produces magnificent auroras and causes the temporary suspension of supersonic flights on earth. It precipitates very unseasonable weather including hailstorms, tornadoes, cyclones, and hurricanes, followed by epidemics of disease in afflicted areas. The scientifically plausible impetus that sets off a dramatic chain of events in the novel is based on a contemporary eschatological hypothesis, and not created *de novo*. In addition, extrasensory perception, a popular theme of the 1970s, is brought into the development of the story. While such a form of perception appears to be ethereal, mystical, and improbable, some aspects are plausible and even government agencies have considered the hypothesis that at least a few of them may exist.[23]

The 'twilight generation', conceived close to the influence of the supernova, is subtly different from the rest of humanity, because it has been manipulated by a collective psychic alien intelligence using the supernova radiation. A distinctive physical characteristic is their golden eyes. Apparently similar to the seemingly human but actually alien offspring in John Wyndham's earlier work *The Midwich Cuckoos* (1957),[24] the children in Cowper's novel are obvious products of the 1970s, praising peace, love, and understanding. The 'twilight' appellation may have been garnered from Rod Serling's earlier television series *The Twilight*

22 Earlier calculations from the 1970s had estimated that supernovae as far as fifty-five light years away from Earth could remove up to ninety percent of Earth's ozone layer, as proposed by M. A. Ruderman, 'Possible Consequences of Nearby Supernova Explosions for Atmospheric Ozone and Terrestrial Life', *Science*, 184, 4141 (7 June 1974), 1079 – 1081. However, new calculations have shown that a supernova would need to be much closer, within twenty-six light years of Earth, to significantly damage the ozone layer and double cancer-causing levels of ultraviolet radiation. This will happen only once per 670 million years. Moreover, none of the stars within a twenty-five light year radius from the sun is a likely supernova candidate. See Neil Gehrels, Claude M. Laird, Charles H. Jackman, John K. Cannizzo, and Barbara J. Mattson, 'Ozone Depletion from Nearby Supernovae', *The Astrophysical Journal*, 585 (10 March 2003), 1169 – 1176.

23 During the Cold War, both the Pentagon and the Central Intelligence Agency launched spying missions around the world. These missions included mind-reading and attempts to forecast the future. For a fascinating exposition on this black budget subject, see Jim Schnabel, *Remote Viewers: The Secret History of America's Psychic Spies* (New York: Dell Publishing, 1997).

24 John Wyndham's *The Midwich Cuckoos* (New York: Ballantine Books, 1957) is a science fiction classic wherein an unseen alien race with unimaginable powers somehow impregnates all women of childbearing age in several rural areas, including Midwich in England. Identical alien children are born at the same time, have golden eyes, overwhelming mental powers and a collective mind that includes the ability to control the actions of ordinary humans.

Zone (1959 – 1964).[25] The protagonist, Calvin Johnson, is a professor of English Literature and his wife is on the contraceptive pill. They decide to have children but cessation of the pill does not lead to conception. The supernova manifests itself at around the time when the couple visit their doctor seeking advice.

Along with doctors and scientists, the professor of English Literature also makes a frequent appearance in sci-fi. Both *The Twilight of Briareus* and *The Children of Men* feature an academic. The protagonist of the latter is:

> Theodore Faron, Doctor of Philosophy, Fellow of Merton College in the University of Oxford, historian of the Victorian Age, divorced, childless, solitary, whose only claim to notice is that he is a cousin to Xan Lyppiatt, the dictator and Warden of England.[26]

Such professions frequently entail university settings, young students and the idyllic comfort of professors' rooms in university towns; these appear not only in *The Twilight of Briareus* but also in *Greybeard*, since a part of the action is set in the ageing halls and towers of Oxford University. Oxford resonates symbolically through the three novels as the last bastion of free thought, a place which protects and supports the questioning intellect of both scientists and humanities scholars.

The writer or professional man of letters, frequently found in literature with a self-reflexive bent, became a point of reference in twentieth-century fiction, where the narrator's voices shift from a first person account or journal, which offers a limited point of view, to a third person description, which creates distance.[27] This diegetic feature can be found in two of the three novels under consideration here. *The Children of Men* makes use of a diary in the first part, whereas *The Twilight of Briareus* drives the narrative very deliberately through the shifting of voices, use of memory, and accounts of events, thereby introducing issues of narratological significance.

The Twilight of Briareus is written almost entirely in the first person and reports events which begin with the explosion of the supernova and extend to some months before the self-sacrificial death of the protagonist, Calvin Johnson. His questioning and hallucinogenic insights, imbued with overriding sexual stimuli, lead him to doctors and later to a 'scientific oddball'[28] professor based at

25 *The Twilight Zone* was a half-hour adult anthology series, one of the first which explored the bizarre and the unexpected via science fiction and fantasy.

26 James, p. 4.

27 In innumerable novels the first person and the journal create an impression of memory guiding the narrative through a very limited point of view. A seminal novel which deliberately plays with first and third person narrators, while an editorial voice explains the condition of the text, is Thomas Mann's *Doctor Faustus: The Life of the German Composer Adrian Leverkuhn as Told by a Friend* (1947), trans. by H. T. Lowe-Porter (Harmondsworth: Penguin, 1968).

28 Cowper, p. 97.

Oxford. The seven chapters lead to a gradual realization of Calvin's central role and the understanding of his predicament as a 'Peripatetic diplodeviant',[29] a latter day Socratic sacrificial victim. The novel is preceded by an epigraph taken from Matthew Arnold's *Stanzas from the Grande Chartreuse* (1855), 'Wandering between two worlds, one dead, / The other powerless to be born'. The oscillation between two orders of reality, two states of perception, two kinds of humanity born before and after 'the twilight' conveys the same fear permeating the final lines of W. B. Yeats' *Easter* (1916), '[…] changed, changed utterly: / A terrible beauty is born', cited by the narrator.[30]

The second narrator, Spencer Unwin, is a fictional editor commenting on Calvin's manuscript, which is the text offered to the reader. He maintains that he wrote the *Editorial Note* in Geneva on the 4th May 2016. Inserted between Chapter seven and the final Chapter eight titled 'Dawn', it explains that 'Calvin Johnson's surviving narrative ends at this point'.[31] Therefore the last chapter consists of 'the remaining journal notebooks and the occasional loose jottings which Mr Johnson made during the period when he was engaged on his narrative'.[32] The last chapter, unlike the previous seven, is a compilation of dated entries from the protagonist's journal, edited as accurately as possible some sixteen years after his death in 2000. His name, Calvin, the year 2000, and the sacrificial role bring to mind the Christian sacrifice of a reluctant messiah. The *Postscript* written in the third person, with which the novel ends, describes the events which ultimately brought about Calvin Johnson's death.

During his travels Calvin encountered Elizabeth Toombes, a girl conceived by her mother, a zeta sleeper, at the moment of the supernova's appearance. Calvin and Elizabeth, who turns out to be the only extant female diplodeviant, conceive a child and the sexual act is mentally witnessed by all zetans. Elizabeth refuses to receive proper antenatal and perinatal care. During her pregnancy, Calvin makes a form of direct contact with the Briarean agency. The Briareans, a group mind with no sense of individuality, wish to absorb Calvin who naturally fears losing his personality. After having accepted to be absorbed, he decides to commit suicide and dies exactly when Elizabeth delivers a girl, Rachel with golden eyes, signalling the start of a new era of peace on Earth. A summary of these events is given in the *Postscript* in an informative 'footnote' written in an impersonal tone.

29 It is the title of the seventh chapter, the last by Calvin. Cowper, p. 171.
30 Ibid., p. 96.
31 Ibid., p. 202.
32 Ibid., ivi.

III. P. D. James's *The Children of Men*

The twelfth novel written by Phyllis Dorothy James White, more frequently referred to as P. D. James, marks an unusual departure from the detective or mystery genres with which she is most associated. *The Children of Men* revolves around mass human sterility, this time within the dystopian political context of a totalitarian England run by the Warden Xan Lyppiat and a Council of four members.

Lyppiat, first cousin of the protagonist and *de facto* tyrant, rose to power in a period of faltering governance, rising crime rates and a worldwide sense of futility. A strong man of action at a time when all hope and ambition had been lost, he promised security, comfort, and pleasure. The story begins after the Warden has been in power for fifteen years, at the head of a Council that helps him to rule. He has total control over the civil service and runs England on fascist lines, with the State Security Police (SSP) enforcing his bidding, the Grenadiers being his private army. The Isle of Man is the 'Man Penal Colony' where criminals are exiled permanently in deportation fashion for minor crimes including 'crimes of violence against the person' and for 'second convictions of burglary'.[33]

The story commences on the 1st of January 2021 with the death of the last person known to be born, a man now aged twenty-five years, two months and twelve days. The death occurs during a 'pub brawl'. The man had been born on the 19th October 1995; this is called 'Year Omega':

> All children born in the year 1995 are called Omegas. No generation has been more studied, more examined, more agonized over, more valued or more indulged. They were our hope, our promise of salvation, and they were – they still are – exceptionally beautiful.[34]

The tragic event coincides with the decision by the protagonist, Theodore Faron, Professor of Philosophy, to begin a journal:

> As I begin writing, the three events, the New Year, my fiftieth birthday, Ricardo's death, hardly justify sullying the first pages of this new loose-leaf Notebook. […] If there is nothing to record, I shall record the nothingness and then if, and when, I reach old age – as most of us can expect to, we have become experts at prolonging life – I shall open one of my tins of hoarded matches and light my small personal bonfire of vanities. I have no

33 The 'Man Penal Colony' is very similar in concept to *Coventry*, a short story in Heinlein's 'Future History Series' first printed in *Astounding Science Fiction*, July 1940. The story timeline takes place between Heinlein's *If This Goes On …* and *Methuselah's Children*, both published in *Astounding Science Fiction*, the former on Feb-Mar., 1940, the second in Jul-Aug-Sep., 1941.

34 James, pp. 13 – 14.

> intention of leaving the diary as a record of one of man's last years. Even in my most egotistical moods I am not as self-deceiving as that.[35]

The novel is not written entirely in the first person. It is divided into Book One, Omega, and Book Two, Alpha, in an obvious reversal of the usual order, which signals that the end is followed by a new beginning. Both sections take place in 2021, the first from January, when Theo begins his diary, to March, at which point he leaves Oxford for a prolonged visit to Europe, his status as the Warden's cousin still affording him benefits. The second part, Book Two, unfolds over a single month, October, when the baby boy is born.

In *The Children of Men* the trend towards a declining European birth rate is first noted in 1991 and attributed to increasing levels of birth control, abortion, and postponement of pregnancy by professional and career women coupled with a desire for smaller families and a superior life standard. The scenario is not unrealistic: it has been amply documented that male fertility has decreased drastically and has been paralleled by significant increasing incidence of male genitourinary abnormalities and testicular malignancy. These changes are almost certainly environmental; pollution, smoking, alcohol, and sexually transmitted diseases play roles.[36] Miscarriage is more common in women who conceive with partners with lower sperm counts or abnormal sperm.[37] The major cause is probably disruption of male embryonal programming and gonadal development during fetal life, due to chemicals with highly oestrogenic properties – endocrine disrupters – that adversely affect genetically susceptible individuals.[38] This has been matched not only by wildlife data showing reproductive and developmental problems in fish, birds, and mammals, but also by laboratory studies showing that minute amounts of oestrogenic chemicals induce these changes. In addition, many chemicals not previously suspected of being oestrogenic have been found widely in the environment.[39] Moreover, the Y chromosome that determines maleness in most mammals – including humans – has been shown to be shrinking progressively over the generations. Unlike all (non-sex) chromosomes, the Y does not exchange DNA with any other chro-

35 Ibid., p. 4.

36 Aleksander Giwercman, Elisabeth Carlsen, Niels Keiding, and Niels E. Skakkebæk, 'Evidence for Increasing Incidence of Abnormalities of the Human Testis: a Review', *Environmental Health Perspectives*, 101, Suppl. 2 (July 1993), 65 – 71.

37 Mirjam Furuhjelm, Birgit Jonson, and C. G. Lagergren, 'The Quality of Human Semen in Spontaneous Abortion', *International Journal of Fertility*, 7 (1962), 17 – 21.

38 Kirsten A. Boisen, Katharina M. Main, Ewa Rajpert-De Meyts, and Niels E. Skakkebæk, 'Are Male Reproductive Disorders a Common Entity? The Testicular Dysgenesis Syndrome', *Annals of the New York Academy of Sciences*, 948 (December 2001), 90 – 99.

39 C. M. Lathers, 'Endocrine Disruptors: a New Scientific Role for Clinical Pharmacologists? Impact on Human Health, Wildlife, and the Environment', *Journal of Clinical Pharmacology*, 42, 1 (January 2002), 7 – 23.

mosome and therefore cannot repair spontaneous mutations through genetic recombination.[40] Indeed, it has been estimated that in about 5,000 generations – 125,000 years – male fertility will be roughly 1 percent of what it is now.[41] The chromosome may eventually dwindle away completely, its gender determining role being assumed by genes located on other chromosomes elsewhere in the genome,[42] something that has already happened in two species of Armenian vole.[43]

The Children of Men presents conflicting views about the decline in birth rate: overpopulation problems are avoided, but nations with negative growth rates are concerned, since they wish to retain their own peoples and cultures. Infertility then becomes universal and a professor of statistical palaeontology declares that humanity will have been one of the shortest lived species ever. Miriam, a midwife working at the John Radcliffe antenatal clinic in Oxford and later a member of the group of dissidents, observes that something is amiss with conceptions when she notices that there are no antenatal bookings at her hospital seven months ahead. 'It was then I knew, I must have been one of the first to know. I was there at the end. Now I shall be there at the beginning'.[44]

The cause of this infertility could not be tracked down by medical science and although it was initially seen to be a disease, it was not found to be an infectious or contagious one. As Theo explains:

> I clearly remember the confident words of one biologist spoken when it had finally become apparent that nowhere in the world was there a pregnant woman. 'It may take us some time to discover the cause of this apparent universal infertility.' We have had twenty-five years and we no longer expect to succeed.[45]

Initially, countries coordinate research efforts and create a 'European Centre for Human Fertility'. However, international mistrust prevails and armies of spies are deployed to ensure that any possible cures will be shared. Infertility is attributed to the male half of the species (due to poor quality sperm), but banked frozen sperm also proves to be useless. All hope of racial continuity is lost when even the Omegas, on reaching puberty, are found to be infertile because they

40 H. J. Muller, 'Some Genetic Aspects of Sex', *American Naturalist*, 66 (1932), 118 – 138.

41 Brian Charlesworth, 'Model for Evolution of Y Chromosomes and Dosage Compensation', *Proceedings of the National Academy of Sciences of the United States of America*, 75, 11 (1 November 1978), 5618 – 5622. See also Bryan Sykes, *Adam's Curse: A Future Without Men* (New York: Norton, 2004).

42 Douglas Fox, 'The Descent of Man', *New Scientist*, 2357, 24 August 2002, p. 29.

43 Walther Vogel, Silke Jainta, Wolfgang Rau, Claudia Geerkens, Annette Baumstark, Lina S. Correa-Cerro, Carolin Ebenhoch, and Walter Just, 'Sex Determination in Ellobius Lutescens: The Story of an Enigma', *Cytogenetics and Cell Genetics*, 80, 1 – 4 (1998), 214 – 221.

44 James, p. 214.

45 Ibid., p. 7.

have no viable sperm production. Individual and mass suicides result, especially among the younger age groups.

Book One outlines Theo Faron's involvement in the dissident plot which sought to stop the Man Penal Colony, the Quietus, and the mistreatment of workers, called the Sojourners, brought in from other countries. Being the Warden's only living relative and 'the only one in England he's ever listened to',[46] Theo meets the Five Fishes, formed by his ex-midwife Miriam, Julian, her husband, Rolf (the ambitious natural leader of the group), the Roman Catholic priest Luke and the young Gascoigne. Rolf explains that only Luke and Julian are Christians and they meet in Churches because these are the only available buildings. When Theo returns to England and decides to join the Five Fishes, religious symbolism increases. After the priest Luke is killed by the Omegas ('the painted faces') as a sacrifice, Julian, who is expecting a baby by him, escapes with the rest of the group. Theo, in love with her, is cast in the role of Joseph, who seeks to protect her – even with his own life – and stands by at the birth of a baby boy in a forest, on a bed of wood shavings. He then kills Xan Lyppiat and, while taking the ring from his dead hand, plays with the idea of replacing him so as to protect the baby, saviour of the world.

The Twilight of Briareus and *The Children of Men* end with an unexpected birth, in both cases delivered within the context and symbolism of Christianity. Other details such as Theo's name, Greek for God, and the Five Fishes, an early symbol of Christians, allude to Christian themes.

IV. Brian Aldiss' *Greybeard*

The sci-fi writer and critic Brian Aldiss was one of the first to envisage the possibility of mass human infertility in a dystopian global setting. *Greybeard*, written in 1964, portrays the cold-war tensions of the time and identifies them as the causes of human infertility. Nuclear bomb testing progressively contaminates the earth, radioactivity affects the entire animal kingdom and the first space explorations conducted both by western and communist countries are used to test nuclear weapons in orbit.[47] Whereas in the two novels previously discussed the writing of journals and accounts emphasises the narrator's limited

46 Ibid., p. 81.

47 Aldiss was almost certainly influenced by the then ongoing United States atomic bomb testing in the Pacific. In 1958, Operation Argus consisted of three separate tests with an explosive yield of 1 – 2 kilotons each, while Fishbowl consisted of five separate tests, the largest of which was 1.4 megatons detonated at a height of 248 miles. See Marc Trachtenberg, *A Constructed Peace: The Making of the European Settlement, 1945 – 1963* (Princeton: Princeton University Press, 1999).

point of view, *Greybeard* is written entirely from an omniscient third person perspective, the action moving primarily through dialogue and characters.

Although Algernon Timberlane (known as Greybeard) and his wife Martha spend some time at Oxford University, he is not an academic, but rather 'an intellectual trouble maker, a spy maybe from London'.[48] In *Greybeard* religious symbolism is not central, but still is evident in allusions and significant names, among which is Martha. However, the emphasis is on life conditions, the physical and psychological effects of an ageing population, and the immanent end of the race.

The United States creates DOUCHE: Documentation of Universal Contemporary History, that will record the end of humanity. Various governments attempt to prolong life through intensive research programs. Initially, malformed[49] babies are not cared for at all in developed countries, while in developing countries they continue to be nurtured. The Western world then rapidly undergoes a paradigm shift whereby the few babies who are born are viewed as a precious commodity, with the hope that on reaching puberty they would be able to breed and breed true. Western forces therefore create the 'Infantop Corps', a military branch entrusted with the collection of children from developing countries and their transfer to hospitals in the West, 'Operation Childsweep'. However, wars are fought over such children and the losers resort to senseless bombing and killing. Epidemics of disease deal the final blow to civilization. In 2018, cholera sweeps through the United Kingdom and martial law is declared. Anarchy sets in and by 2029 human beings are all reaching their dotage and living in small communities in the countryside.

In the late 2020s Greybeard and his wife live in the village of Sparcot, which is run as a gerontocratical dictatorship. He is on guard duty, because a neighbouring community has been overrun by a large pack of stoats. While the lower animal orders such as rabbits and rats have recovered their fertility, mass human infertility has an immense social and political impact. Individuals fail to see the point of going to work, and government slowly begins to break down. Famine is predicted and, as food quality deteriorates, vitamin pills become a common part of meals.[50]

The author stresses the ageing population demographics, with a mean age in

48 Aldiss, p. 66.

49 Mutations are permanent, transmissible changes to genetic material, that is, to cellular DNA or RNA. They can be produced in various ways, such as copying errors or spontaneous mutations in genetic material during cell division, and by exposure to mutagens such as radiation, chemicals, or viruses. Contrary to what happens in sci-fi, most mutations have no significant effect on the organism or the species.

50 The addition of vitamins and other micronutrients to food is a well-established practice where food quality is poor or inadequate, such as in developing countries. See Steven A.

the high seventies. The youngest age group is in their fifties, which makes Greybeard one of the youngest men alive. The vicissitudes of old age in Sparcot are repeatedly highlighted, but there are also hints and rumours of rare births, and sightings of gnomes and goblins, a possible reference to children.

At the end of their journey, the Timberlanes discover a group of small feral children. Their existence is explained by the fact that excess ambient radioactivity has been 'absorbed' by women, who in very biblical matriarchal manner now suddenly begin to conceive and bear children, even though they are in their sixties. Their children run wild and gang together in the forest shunning adult human contact, as a consequence of the fact that pregnant women hide in the forests and give birth there, away from other adults who are potentially their offspring's worst enemies. The apparent explanation is that human nature being what it is, other adults are very likely to exploit both mothers and offspring.

V. Common Endings

In all three novels, medical science attempts to prolong life but with negative results and humanity is seen to drag on as an ageing dinosaur, extinct but not yet quite ready to face the fact. Aldiss depicts most graphically and pragmatically the ravages and tribulations of old age. James mentions them, but not as frequently or pessimistically, and Cowper does so, too, but without dwelling on these aspects, probably due to the optimistic 'new age' influence under which the book was written.

Despite the dystopian scenarios and extreme consequences which feature as recurrent themes, a common sci-fi trope is, surprisingly, the happy ending. The sci-fi novel functions as a cautionary tale in which the dystopian events are resolved due to the agency of a *deus ex machina*. Humanity does eventually regain its fertility and is therefore saved from extinction, having somehow been taught a moral lesson.

Aldiss foresaw more disasters for the medical profession, with outbreaks of epidemic disease caused by the collapse of health care and sanitation services. The Zetas in *Twilight of Briareus* and the Omegas in *Children of Men* are humanity's last hope for fertility and continuation of the human race: both groups are a great disappointment when, on reaching puberty, they are found to be infertile.

Abrams, Alex Mushi, David C. Hilmers, Ian J. Griffin, Penni Davila, and Lindsay Allen, 'A Multinutrient-fortified Beverage Enhances the Nutritional Status of Children in Botswana', *The Journal of Nutrition*, 133 (June 2003), 1834 – 1840.

VI. Infertility and Radioactivity in *Greybeard*

In *Greybeard* Aldiss speculates that orbital nuclear explosions cause the Van Allen belts to oscillate, contracting and shrinking, and in consequence bathing the Earth's surface in radiation. This is impossible for two reasons. Firstly, the Van Allen belts are actually the result of earth's magnetosphere, the magnetic field that surrounds the Earth. Since the earth's magnetic field is generated by its core,[51] no amount of orbital nuclear detonations could affect the earth's magnetic field in this way. Secondly, even if the magnetosphere were to contract, it would only bring the charged particles that comprise the Van Allen belts into contact with the upper reaches of the atmosphere, where the effect would probably be that of aurorae on a massive scale. The upper atmospheric layers would prevent the charged particles from sleeting through the lower atmospheric layers at the earth's surface due to their shielding effects.[52] A more plausible way in which orbital detonations could indirectly affect the earth's surface would be through radioactive fallout, the accidental effects of which are well documented.[53] Moreover, high altitude atomic explosions would cause devastation of electronic equipment from electromagnetic pulse generation (EMP).[54]

Aldiss recounts that women miscarried and that children carried to term were born malformed, an exaggeration that is not borne out in observational studies on Japanese atomic bomb survivors.[55] Miscarriage rates in pregnant women exposed to radiation are low, as are malformation risks. However, the development of the central nervous system *in utero* may be significantly affected.[56]

51 The earth comprises three main layers: the crust, the mantle, and the core, which contains iron and generates its self-sustaining magnetic dynamo. For the geodynamo theory see B. A. Buffett, 'Earth's Core and the Geodynamo', *Science*, 288, 5473 (16 June 2000), 2007 – 2012.

52 Cosmic radiation is a diverse collection of different types of radiation from many different types of sources. See Stefan Roesler, Wolfgang Heinrich, and Hans Schraube, 'Calculation of Radiation Fields in the Atmosphere and Comparison to Experimental Data', *Radiation Research*, 149 (1998), 87 – 97.

53 Ralph E. Lapp, *The Voyage of the Lucky Dragon* (New York: Harper & Brothers Publishers, 1958).

54 EMPs devastate electronic circuits. See Trachtenberg.

55 It was largely assumed that many of the children conceived by the survivors of Hiroshima and Nagasaki would be deformed as a consequence of radiation-induced mutation. However, even at the time experimental data, albeit largely limited to studies of the Drosophila fruit fly, did not support this public impression, as exhaustively reviewed by William J. Schull, 'The Children of Atomic Bomb Survivors: A Synopsis', *Journal of Radiological Protection*, 23, 4 (2003), 369 – 384.

56 Ionizing radiation on the embryo or fetus may cause miscarriage, fetal growth retardation with permanent height impairment, congenital malformations, especially microcephaly, mental retardation, and an increased risk for childhood cancer. See *Pregnancy and Medical Radiation*, ed. by Jack Valentin, Annals of the International Commission on Radiological

Aldiss also depicts acute radiation sickness as a flu-like illness, but this too is incorrect, as respiratory tract symptoms are rare.[57] There is also no evidence that the young are more severely affected by acute radiation exposure in the short term than the elderly.[58] Aldiss considers whether global exposure may have any possible ameliorating effects due to hormesis, according to which there is a benefit to health, or a decrease in biological hazard from toxins, including radiation, as the toxin dose is increased up to a certain threshold.[59] He speculates

Protection, 30, 1, ICRP Publication 84 (Oxford: Pergamon, 2001). Before about two weeks of gestation, radiation-induced non-cancer effects are unlikely to occur, irrespective of the radiation dose, because at this stage the embryo is made up of only a few cells, therefore damage to one cell, the progenitor of many other cells, can cause the death of the embryo and the developing blastocyst will fail to implant in the uterus. For fetuses exposed between 8 – 26 weeks of gestation, atomic bomb survivor data indicate an approximately linear decline in IQ score with radiation dosage, less pronounced at increasing gestational age. See 'Prenatal Radiation Exposure: A Fact Sheet for Physicians', Centre for Disease Control, <http://www.bt.cdc.gov/radiation/prenatalphysician.asp> [accessed 15 June 2011]. There is also a slightly increased risk of childhood cancer and leukemia independent of gestational age at which radiation exposure occurs. Atomic bomb survivor data also suggest a 3 %-4 % reduction of height at age 18 years with significant radiation dosage, especially when the exposure occurs in the first 13 weeks of gestation, and this appears to be dose related. See also William J. Schull, *Effects of Atomic Radiation: A Half-Century of Studies from Hiroshima and Nagasaki* (New York: Wiley-Liss & Sons, Inc., 1995).

57 Early effects of radiation exposure include nausea, vomiting, loss of appetite and diarrhoea, fatigue, itchiness of the skin, inflamed eyes, and cataracts. Later effects include sore skin, hair loss, temporary sterility, areas of skin turned dark brown by beta ray burns, eye and ear discharge, jaundice, liver inflammation. Bone marrow suppression and a fall in white cell count result in immunosuppression, anaemia, and fall in platelets leading to a haemorrhagic tendency. See International Atomic Energy Agency, *What the General Practitioner (M.D.) Should Know about Medical Handling of Overexposed Individuals* (Vienna: International Atomic Energy Agency, 1986).

58 Children experience effects which are unique to their age-group, such as poor linear growth. See Raphaël Rappaport and Raja Brauner, 'Growth and Endocrine Disorders Secondary to Cranial Irradiation', *Pediatric Research*, 25, 6 (June 1989), 561 – 567. In addition, a high enough dose of radiation will induce lifelong sterility and inability spontaneously to progress into puberty. See Scott A. Rivkees and John D. Crawford, 'The Relationship of Gonadal Activity and Chemotherapy-induced Gonadal Damage', *Journal of the American Medical Association*, 259, 14 (8 April 1988), 2123 – 2125. Moreover, although radiation exposure increases the risk of cancer in all age groups, individuals who are older at the time of exposure are more likely to die from intercurrent disease before radiation-induced cancer appears, therefore children have an overall higher risk of developing malignancy. See Douglas G. Gold, Joseph P. Neglia, and Kathryn E. Dusenbery, 'Second Neoplasms after Megavoltage Radiation for Pediatric Tumors', *Cancer*, 97, 10 (30 April 2003), 2588 – 2596.

59 See Klaus Becker, 'Threshold or No Threshold, That Is the Question', *Radiation Protection Dosimetry*, 71, 1 (1997), 35. The theory that a potentially toxic effect acts like a stimulant in small doses and like an inhibitor in large doses goes against the dogma that all ionizing radiation is harmful, an extrapolation based on higher doses of radiation, the so-called linear no-threshold (LNT) hypothesis, according to which at even low doses there is a linear relationship between dose and risk – specifically, the probability of cancer induction, all the way down to zero. For the LNT hypothesis, see *Recommendations of the International*

that reindeer, unlike other mammals, having already been heavily contaminated with strontium from nuclear fallout, readily tolerate extra radiation exposure. This confirms that the hormetic hypotheses are applicable to this scenario, because above a certain threshold the harmful effects of large doses of radiation would unequivocally outweigh any potential beneficial hormetic effects.

Although the psychological effects of infertility have been well studied, the effects of mass sterility are unknown, as real-life data are limited. Mass despair would indeed be likely, potentially leading to a spate of suicides. The closest parallel we can draw is with the 'infertility belt' of sub-Saharan Africa, where up to one-third of all couples are unable to conceive. This is mainly due to infectious diseases acquired sexually, post-partum or post-abortion. Male infertility contributes to more than half of these cases but is rarely acknowledged. In highly pro-natalist cultures infertility can be tragic, especially where parenthood is culturally mandatory and childlessness socially unacceptable. Couples turn not only to traditional doctors but also to faith healers, causing tremendous stress to both partners.

VII. Infertility in Other Science Fiction Novels

Even though infertility is not a recurring theme in science fiction, various scenarios, often on a global scale, do arise. In *Greybeard*, *The Twilight of Briareus* and *The Children of Men* infertility is brought about either by nuclear, chemical or biological causes. Post nuclear-war infertility dystopian scenarios are not uncommon. In John M. Harrison's *The Committed Men* (1971)[60] a future Britain is awash with radioactivity. Sterility is common, and the protagonists, a doctor and several companions, attempt to deliver a mutant baby to a group of its own kind, likely to become the successors of ordinary humanity.

The erroneous belief that high levels of ambient radioactivity would generate a common set of mutations characterizing an entirely new species is most fa-

Commission on Radiological Protection, Annals of the International Commission on Radiological Protection, 21, 1–3, ICRP Publication 60 (Oxford: Pergamon Press, 1991). However, there is an ecologically based argument for hormesis in that humans are best adapted to background low levels of ionising radiation and other naturally occurring potential carcinogens in the environment. A few animal studies have supported this theory, others have not. See Lennart Johansson, 'Hormesis, an Update of the Present Position', *European Journal of Nuclear Medicine and Molecular Imaging*, 30, 6 (June 2003), 921–933. Some support for radiation hormesis has also been gleaned from atomic bomb survivors who received significant but low levels of radiation. See Wolfgang F. Heidenreich, Herwig G. Paretzke, and Peter Jacob, 'No Evidence for Increased Tumor Rates below 200 mSv in the Atomic Bomb Survivor Data', *Radiation and Environmental Biophysics*, 36, 3 (October 1997), 205–207.

60 John M. Harrison, *The Committed Men* (London: Hutchinson, 1971).

mously mooted in J. G. Ballard's 'The Voices of Time' (1960).[61] In Janet Morris's *Returning Creation* (1984)[62] the human colonists on the planet Silistra waged a vicious war that left a legacy of infertility for centuries afterwards. This leads to fundamental alterations in Silistran society in that the most prized abilities become fertility and sexual prowess. The survival of just one fertile man in the entire world as a result of a nuclear disaster is the novum of Pat Frank's *Mr. Adam* (1946).[63]

Biological warfare has also been depicted as a threat to human fertility and one of the first instances in science fiction is Frederic Carrel's *Paul le Maistre* (1901),[64] where the 'Orientals' invade the West by releasing a sterility-inducing plague. Chemical warfare is in the core of D. F. Jones's *Implosion* (1967),[65] where the USSR contaminates Great Britain's drinking water, leading to almost universal and irreversible female sterility.

Infertility caused by pollution features prominently in Margaret Atwood's *The Handmaid's Tale* (1986).[66] Chemical wastes and nuclear accidents have widely contaminated the environment and drastically reduced fertility. Fertile women, 'handmaids', are slaves used for breeding purposes by a fundamentalist governing elite, whose practices are condoned through reference to the Old Testament.

Infertility may also be an involuntary iatrogenic event, as is the flawed cure in Llewellyn-Thomas's *The Douglas Convolution* (1979),[67] *The Bright Companion* (1980),[68] and *Prelude to Chaos* (1983),[69] where 22nd-century humanity suffers from widespread female infertility brought on by the use of a contraceptive agent. A twist on the theme is that of infertility deliberately induced by the government to stop overpopulation. Contraception is imposed by the state in George Orwell's *1984* (1949),[70] and infertility is caused by the deliberate and unconcealed sterilisation of embryos in Aldous Huxley's *Brave New World* (1932)[71], which also anticipates the social impact of improved reproductive technology.

The state decides to limit births according to eugenic principles in Walter M.

61 Ballard, 'The Voices of Time', *New Worlds*, 99, 33 (October 1960), republished in Id., *The Four-Dimensional Nightmare* (London: Victor Gollancz, 1963).
62 Janet Morris, *Returning Creation* (New York: Baen Books, 1984).
63 Pat Frank, *Mr. Adam* (New York: Lippincott, 1946).
64 Frederic Carrel, *Paul le Maistre* (London: John Long, 1901).
65 D. F. Jones, *Implosion* (New York: Putnam, 1967).
66 Margaret Atwood, *The Handmaid's Tale* (New York: Ballantine Books, 1986).
67 Edward Llewellyn, *The Douglas Convolution* (New York: DAW Books, 1979).
68 Llewellyn, *The Bright Companion* (New York: DAW Books, 1980).
69 Llewellyn, *Prelude to Chaos* (New York: DAW Books, 1983).
70 George Orwell, *Nineteen Eighty-Four* (New York: Harcourt Brace, 1949).
71 Aldous Leonard Huxley, *Brave New World* (London: Chatto & Windus, 1932).

Miller's *Conditionally Human* (1962).[72] A chilling and drastic solution to an overpopulation problem is envisioned by Lee Hoffman in *Soundless Evening* (1972),[73] where surplus children are legally and painlessly poisoned. State-devised measures can be even more cruel: in Alan E. Nourse' *Bladerunner* (1975)[74] medical care is granted to those who consent to medical sterilisation, in Joe Haldeman's *The Forever War* (1976)[75] homosexuality is induced in order to limit births and in Alain Doremieux's *The Vana* (1965)[76] human beings are strongly encouraged to mate with aliens.

A spaceship does not permit any sort of 'overpopulation' and in Poul Anderson's *Tau Zero* (1976)[77] contraception is enforced by the ship's medic: infertility is an occupational requirement. Frederik Pohl's *Man Plus* (1976)[78] features NASA converting astronauts into cyborgs where part of the conversion process is castration. The state may, however, feel that it has to enforce infertility on selected high-risk individuals – usually those exposed to radiation – in order to preserve the genetic *status quo:* in Arthur C. Clarke's *Rendezvous with Rama* (1975)[79] the sperm of the astronauts is frozen before sterilisation.

An excess of one or the other gender is a frequently recurring theme which entails homosocial or, more frequently, homosexual issues. While female-only societies are fairly common, male-only societies are much rarer for obvious biological reasons. In Cordwainer Smith's *The Crime and the Glory of Commander Suzdal* (1964)[80] human settlers of an alien planet discover that femininity is virulently carcinogenic to all earthly species and the only solution is to turn all human females into males and to learn how to carry babies to term in a male abdomen. The result is the creation of an entirely male planet.

In John Wyndham's *Consider Her Ways* (1979)[81] males have all been accidentally destroyed by a man-made virus. Women-only worlds arguably represent the ultimate feminist fantasy. While examining the construction and enforcement of gender roles, feminist sci-fi writers maintain that personal identity and socio-political power are not only biologically determined, but also cul-

72 Walter M. Miller, Jr., *Conditionally Human* (New York: Ballantine Books, 1962).
73 Lee Hoffman, *Soundless Evening*, in *Again, Dangerous Visions*, ed. by Harlan Ellison, Book 2 (New York: Doubleday, 1972).
74 Alan E. Nourse, *The Bladerunner* (New York, Ballantine Books, 1975).
75 Joe Haldeman, *The Forever War* (New York: Ballantine Books, 1976).
76 Alain Doremieux, *The Vana*, in *13 French Science-Fiction Stories*, ed. by Damon Knight (New York: Bantam, 1965).
77 Poul Anderson, *Tau Zero* (New York: Berkley Books, 1976).
78 Frederik Pohl, *Man Plus* (New York: Random House, 1976).
79 Arthur C. Clarke, *Rendezvous with Rama* (New York: DelRey, 1975).
80 Cordwainer Smith, *The Crime and the Glory of Commander Suzdal*, in Id., *Under Old Earth* (London: Panther Science Fiction, 1970), pp. 139 – 153.
81 Wyndham, *Consider Her Ways*, in Id., *Consider Her Ways and Other Stories* (Harmondsworth: Penguin, 1979).

turally constructed. Fertility and reproduction play key roles in the utopian world portrayed by Ursula Le Guin in *The Left Hand of Darkness* (1969)[82] or in the dystopian one predicted by Atwood in *The Handmaid's Tale*.

Immortality and infertility are often brought to play upon one another. Sterility thus becomes a form of chastisement for humanity's overreaching ambitions. In Kate Wilhelm's *Welcome, Chaos* (1985)[83] scientists develop a drug that kills half of the individuals who ingest it; and it confers immortality on the extant ones by immunising them against disease, radiation, cellular breakdown, and ageing.

A further variation is infertility inflicted on animals, aliens, and computers. Humanoid creations are infertile, as shown in Mary Shelley's *Frankenstein*, where Victor Frankenstein rejects his creature's request to create a partner, for fear that the monsters engendered by such a couple would overwhelm mankind. Infertility in animals has also been developed in Damon Knight's *Auto-da-Fe* (1966),[84] in which a future humanity modifies dogs, making them intelligent and able to speak, but their fertility is at a complete standstill because of contraceptive drugs that are dripped into their food at the behest of the last surviving human.

Furthermore, infertility is also depicted as the inevitable consequence of races evolving and becoming less 'vital'. Sci-fi authors invariably neglect the fact that such advanced races would be in possession of equally sophisticated reproductive aids and techniques. In *Twilight* (1976)[85] Campbell portrays aliens who, after having depleted their resources, want to conquer the Earth like the Martians famously portrayed in H. G. Wells's *The War of the Worlds* (1898).[86] Frightening scenarios and a frequent happy ending: it is the coexistence of fear for and projection towards the future that makes science fiction a popular genre in today's world, a panacea that simultaneously fans and soothes our visions of where scientific society's *hubris* may lead us.

82 Ursula K. Le Guin, *The Left Hand of Darkness* (New York: Ace, 1969).

83 Kate Wilhelm, *Welcome, Chaos* (New York: Berkley, 1985).

84 Damon Knight, *Auto-da-Fe*, in *Turning On*, ed. by Id. (New York: Ace, 1966).

85 John W. Campbell, *Twilight*, in Id., *The Best of John W. Campbell* (London: Sphere, 1976). For an opposite proposed ending to a future humanity, wherein humanity degenerates back to subhuman cavemen along with decreased fertility, see Ballard, 'The Voices of Time.

86 H. G. Wells, *The War of the Worlds* (London: Heinemann, 1898).

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Vita Fortunati / Claudio Franceschi

The Quest for Longevity and the End of Utopia

> You know, it's really very peculiar. To be mortal is the most basic experience, and yet man has never been able to accept it, wholly grasp it, and behave accordingly. Man doesn't know how to be mortal. And when he dies, he doesn't even know how to be dead.
>
> Milan Kundera, *Immortality* (1991)

I. An Interfaced Approach to Ageing

This chapter takes the form of a dialogue between a scholar of utopia and a scientist who has been reading utopian literature and science fiction for many years and whose research concerns the biological basis of ageing and longevity. Three issues will be addressed: longevity from an evolutionary point of view; representations of the body, age, and illness in past utopias; longevity in a globalised world.

II. Longevity, the Body, and Evolution

Longevity involves the body and disease as well as their conceptualisation and historicity from an evolutionary point of view. Classical and Judaic-Christian conceptions provide inadequate knowledge of the body and illness. Despite a few significant modifications in the Middle Ages, the scenario remained fundamentally unchanged up to the seventeenth century.

An evolutionary perspective emerged a hundred and fifty years ago. Since the publication of Charles Darwin's *On the Origin of Species* (1859) the bio-evolutionary framework has widened enormously our temporal perspective and our historical vision of biological phenomena. Today we know that *Homo sapiens* is the result of a long evolutionary history of life on earth which began around four billion years ago and saw the appearance of primates about five million years ago. The most probable dating sets the advent of *H. sapiens sapiens* about three

hundred thousand years ago, but some of his history's fundamental stages occurred much more recently: about fifty thousand years ago the acquisition of language; ten thousand years ago agriculture and the domestication of animals; around five to seven thousand years ago the development of writing.

A couple of centuries ago an extraordinary evolutionary acceleration deeply modified the planet's environment and resulted in significant changes in life expectancy, at least in what we refer to as the most economically advanced countries. Demographic data, despite limitations such as the paucity and fragmentariness of the sources, suggest that until the end of the eighteenth century, even in the most prosperous countries and regions of the world, average life expectancy of the species remained around 35 – 40 years, i. e. not very different from what it had been in the preceding centuries and even millennia.[1]

After 1840 a demographic revolution took place, which in less than two centuries brought life expectancy from 40 to more than 80 years, with a gain of about three months a year for the past 160 years. In the European Union average life expectancy is increasing at the rate of more than 2 years per decade, a regular and progressive phenomenon that shows no sign of declining and that has, amongst its major causes, a definite decrease of mortality after 65 and especially after 80 years of age.

Demographers have differing opinions about the significance of this phenomenon: 'futurists' believe immortality is within our grasp, 'optimists' consider it plausible that in this century life expectancy at birth will reach 100 years, and 'realists' (also known as 'pessimists') reckon average life expectancy will not be able to go beyond 85 years unless drastic medical and biological steps forward are achieved.[2]

Evolutionary medicine,[3] which sees our body as a biological object, the fruit of evolution and genetics/genomics (a grouping of disciplines that seeks to identify all the information of evolutionary history) is opening up broad vistas on health and longevity. High expectations have been raised by reparative medicine, which uses stem cells as tools for fighting (and winning, perhaps decisively) the battle against ageing and disease. It seems that in every organ and tissue of our body there are cells which not only have a much lower rate of

1 *Exceptional Longevity: From Prehistory to the Present*, ed. by Jean Bernard and James W. Vaupel, 2 vols (Odense: Odense University Press, 1995), Monographs on Population Aging, II, pp. 1 – 169.

2 Claudio Franceschi, Luciano Motta, Massimo Motta, Mariano Malaguarnera, Miriam Capri, Sonya Vasto, Giuseppina Candore, Calogero Caruso, and IMUSCE, 'The Extreme Longevity: The State of the Art in Italy', *Experimental Gerontology*, 43, 2 (February 2008), 45 – 52.

3 Gilberto Corbellini, *Medicina basata sull'evoluzione. Le lezioni italiane* (Bari: Laterza, 2007); Rita Ostan, Laura Bucci, Miriam Capri, Stefano Salvioli, Maria Scurti, Elisa Pini, Daniela Monti, and Claudio Franceschi, 'Immunosenescence and Immunogenetics of Human Longevity', *Neuroimmunomodulation*, 15, 4 – 6 (2009), 224 – 240.

damage and error accumulation, but also retain an ancestral capacity to originate new cells and tissues, thus almost completely repairing damage caused by the injuries of age and the environment. According to some, the foreseeable perspective in the short term is that of constituting banks of stem cells for each individual, to be used in a systematic way to regenerate deteriorating parts of the organism such as teeth, muscles, heart, and brain. This prospect is revolutionising medicine and all aspects of human life, including diseases and death. It is easy to imagine what an enormous upheaval will be caused by the capacity to heal diseases which significantly impair the quality of human existence (tumours, cardiovascular diseases, dementia, diabetes, osteoporosis, osteoarthritis among others), including the possibility of 'producing' *in vitro* spare organs, an idea first envisaged by scientific utopian writers such as Aldous Huxley. Such diseases are currently the greatest 'killers' and this prospect will have an immediate impact on lifespan whose current limits could well be overstepped by a wide margin.

III. Humanistic Tradition and Utopia

To what extent can theories of the body and disease developed in the humanities be helpful to interpret the results of scientific research today? Philosophical, ethical, and religious frameworks appear ill suited to the rapidity of the changes science is posing. There is a serious mismatch between the large body of scientific knowledge now available and humanistic conceptions which are based on quite 'primitive' sources dating back to when data on the human body and its evolutionary history were still largely unknown and unpredictable. Nonetheless, this is the knowledge upon which contemporary cultural responses are founded. The question to be addressed is whether philosophical, ethical, and religious elaborations on the human body can adequately assimilate (and respond to) the impact of scientific knowledge, which has substantially modified the length of human life, procreation, disease, and physical suffering.

As an example of the difficulty of reconciling our humanistic tradition with current scientific findings and trends we will examine the conceptualisation of human finitude.[4] In its acceptance the ancients identified the zenith of wisdom.[5] Our philosophical and religious legacy is best exemplified and refracted through

4 See Vita Fortunati, 'Pienezza dell'Essere e paura del Nulla in Utopia', in *Perfezione e finitudine. La concezione della morte nell'utopia in età moderna e contemporanea*, ed. by Vita Fortunati, Marina Sozzi, and Paola Spinozzi (Torino: Lindau, 2004), pp. 31 – 55.

5 Ivano Dionigi, 'L'inconveniente dell'immortalità', *Bollettino delle Scienze mediche*, Anno CLXXX (2008), 39 – 46 (the issue is dedicated to 'Il mito dell'eterna giovinezza tra biomedicina e umanesimo' ['The myth of eternal youth between biomedicine and the humanities']).

utopian literature. Viewed within classical and biblical frameworks, the body, death, and finitude reveal the contradictions and antinomies on which utopian constructions are based.[6] Old age has always constituted a puzzle because the problem of ageing is tightly associated with illness and death.

The utopian project of a land where harmony and perfection have been attained is dominated by a reason that wants to check and control everything. Old age, illness, and death have always been problematical precisely because they represent the failure of the enterprise undertaken by the utopian writer, who aims at simplifying and reducing the anthropological complexity of man. Human limits are uncanny signs indicating the impossibility of reconciling the oppositions between nature and nurture, body and mind, which structure our understanding of the human condition. In utopia a series of strategies is enacted in order to hide aspects of reality that produce instability and disorder, or, where these aspects are indeed confronted, a normative and rigid approach is adopted.

'Nowhere' (ou-topos) also presupposes an unalterable, incorruptible nature, unscarred by the effects of time. In this sense, utopia's genealogy from the myth of Eden appears evident. However, the archetype of the genre, Thomas More's *Utopia* (1516 in Latin, 1551 in English), also reveals that perfection is unattainable because man has been stained by original sin. The pagan myth of the Golden Age has been contaminated by the chastisement of Adam and Eve banished from the earthly paradise.

Utopias are characterised by a double tension: on the one hand, an aspiration to purity and a return to primordial origins imply the nostalgic concept of a benevolent and fertile Nature; on the other, the concern for regulation and planning is obsessive. This tension reveals that the relationship between the myths of paradise and the ideal city is dialectical and affects the attitude utopia adopts towards elderly people. The old person is revered, honoured as the one whose wisdom is connected to a cyclical conception of time. The rhythm of the seasons, 'the works and days' repeat themselves: those who have seen more, know more. For this reason, 'to know is to remember', as Plato maintains in *Meno*, and old people, for their heap of memories, are rich in knowledge. Nevertheless, the elderly are also disquieting figures because they bear a body which has deteriorated and become corrupted. An ageing body is no longer the vehicle of being 'in the world' but an obstacle that requires overcoming in order to remain in the world. From this perspective, old age is an element of disorder in

6 Fortunati, 'Ageing and Utopia through the Centuries', *Aging*, 10, 2 (1998), 77 – 82; Id., 'Vecchiaia', in *Dizionario dei temi letterari* (Torino: Utet, 2007), pp. 109 – 120. See also *Histoire transnationale de l'utopie littéraire et de l'utopisme*, coordonnée par Vita Fortunati et Raymond Trousson, avec la collaboration de Paola Spinozzi (Paris: Honoré Champion, 2008), in particular 'Utopia', pp. 81 – 96, 'Gulliver's Travels', pp. 345 – 356, and 'News from Nowhere', pp. 677 – 687.

utopia, a stain to be cleansed from a world that strives to be perfect and harmonious. Indeed, this ambivalence explains the reason why in utopia the myth of longevity is tightly connected to nourishment and food, which acquire a clear moral meaning. A healthy life is frugal, sober, and requires a rigid diet. Thus, in utopia, physicians, physicists, and botanists work out a diet which is often vegetarian, based on milk and wheat.[7]

Western utopia reflects ambivalent social attitudes towards the elderly who, over the centuries, have always been double figures. Representations of the elderly are extreme, because they are subject to the law of everything and nothing, an ambivalence which permeates the great myths on which imagery of old age is founded, and the thinking of Plato and Aristotle.

Plato idealises old age: in *The Republic* Cephalus becomes the model of the old man who is happy because he is virtuous. Old age constitutes a serene conclusion to the life of an honest person, whose enjoyment of spiritual pleasures is enhanced by freedom from disquieting passions. Both in *The Republic* and in the *Laws* Plato foresees a type of government presenting all the features of a gerontocracy. In his ideal republic old men hold a position of honour because 'there can be no doubt that the elder must rule the younger' (Plato, *The Republic*, III, 412 cs.).

Aristotle, instead, deconstructs the ideal model of the old person and in his *Rhetoric* describes an old man who is the exact mirror image of Plato's Cephalus.[8] All the negative aspects of old age are staged: avarice, cowardice, egoism, pessimism, impotence, and rigidity of spirit. At the basis of this negative vision there is the Aristotelian concept of the tight interdependence between soul and body: the decrepitude of the one inevitably touches the other. For this reason, old people must be kept away from the government of the city and the Gerousia of Sparta becomes a typical expression of bad government: for Aristotle, old age is neither a guarantee of wisdom nor of political ability.

The great debate on old age pervading the history of Western medicine begins with Aristotle: is old age a disease characterised by involutional phenomena or is it a natural phenomenon itself? According to him, Hippocrates and later on Galen, old age is itself a disease, a marasmus ('morbus'), an inevitable affection invading the body. Aristotle's biological model was determined by two processes, the first evolutionary, the second involutional, the passage from the first to the second being marked by a disequilibria of two fundamental physical qual-

7 The relationship between food and longevity first appears in the utopian works of the sixteenth and seventeenth centuries, such as *Il mondo savio e pazzo* (1552) by Anton Francesco Doni, *Città del sole* (1602) by Tommaso Campanella, and *New Atlantis* (1624 in Latin, 1627 in English) and *History of Life and Death* (1623) by Francis Bacon.

8 Georges Minois, *Histoire de la vieillesse en Occident. De l'Antiquité à la Renaissance* (Paris: Fayard, 1987).

ities, caloric energy and humidity. With age it is very important to economise bodily heat and, in particular, humidity; it is thus essential that in old age male semen be carefully saved, because every ejaculation constitutes a loss and a detraction which results in a shortening of life. According to Aristotle, women live longer than men because, unlike men, they are less dedicated to lust.[9]

The quest for longevity in utopia bears evidence to a pervasive obsession with time. Every utopia begins with an act of separation and distancing from historical time, but the creation of a new history does not stop the flowing of time and the ineluctability of the end. Thus the utopian writer devises strategies able to fix, even freeze, the state of perfection and harmony which, once reached, must not know the corruptibility and decay of all things human. The rational principle that rules every aspect of the real is inevitably subject to the *angst* and pressure of time. Setting itself outside history, utopia freezes temporality. Examined through a magnifying glass, perfection reveals cracks and fissures: the aspects of reality subject to ageing and death generate unbearable fear.

A pervasive feeling of finitude haunts *La Terre Australe Connue* by Gabriel de Foigny (1676). The positive model he offers by portraying a universe populated by Australian hermaphrodites, who softly die eating the fruit of a certain tree, is scattered with disquieting signs. At the end the utopian universe is explicitly overturned. The virgin and immaculate androgynous body of the Australians remains pure, neither subject to the biological cycles nor to the signs of transformation. Their body, like that of the androgynous Adam, should mark a reconciliation between physical and cultural antinomies. Physical integrity thus appears to counteract the triumph of corruption and death. However, repressed elements recur in the description of the hermaphrodites' everyday life, characterised by materiality, fear of death and vital combustion. They have a phobic disgust of food, which leads them to eat secretively in order to hide what they judge to be an excessively bestial act. The dichotomies of body/mind and life/death appear again as taboos and vetoes. The abolition of anxiety about the end is only apparent and the tragic opposition between love of oneself and death burst out violently. The hermaphrodites commit suicide because they are victims of their own narcissism: a love founded on nothing that leads to entropy. Their ataraxy reveals a latent but dissimulated restlessness, because the body with its functions still represents an element capable of causing disorder.

In Swift's *Gulliver's Travels* (1726) the senseless lust for immortality is cruelly satirized in the description of the Struldbruggs, the creatures whom Gulliver meets in his voyage to Luggnagg. Common people hate and despise them, because their eternal life does not include endless youth or removal of bodily and

9 Fortunati, 'La vecchiaia in Shakespeare tra mito e scienza', in *Il testo letterario e il sapere scientifico*, ed. by Carmelina Imbroscio (Bologna: Clueb, 2003), pp. 177 – 190.

mental decay, but entails a grim existence, weighed down by their eternal decrepitude and all its attending evils.

The chilling description of the Struldbruggs anticipates an idea that will become central to the conception of old age in modern times. By means of a skilled ironic technique, in these pages Swift deconstructs the concept of immortality by using the myth of Tithonus who through the intercession of his bride Aurora received from the gods immortality, but not eternal youth. Tithonus became so decrepit and wrinkled that he turned into a cricket. Similarly, as the years pass not only do the Struldbruggs lose their teeth and hair, but they also become incapable of distinguishing the different tastes of food, thus turning into fearful individuals.

> They were the most mortifying sight I ever beheld, and the women more horrible than the men. Besides the usual deformities in extreme old age, they acquired an additional ghastliness in proportion to their number of years, which is not described.[10]

Swift realized that in a world dominated by a progressive conception of time, in a world that continually changes and rejuvenates itself, old age is no longer a repository of knowledge but turns into an element of delay, inadequacy, and anxiety about the novelties that cannot be controlled in their rapid and harassing succession. The old man lags behind, alone, deprived of everything that passes by. Old age is thus not only a condition of decrepitude, but also a lonely exile. The scenario Swift envisions will later be defined as 'cultural ageing'[11], a period of life characterised not only by biological decadence, but also by difficulty in finding one's way in a system of unknown signs and new symbols.

William Morris's positive utopia contains a few important anticipations of concerns which science would also tackle in the second half of the twentieth century. In *News from Nowhere* (1890) Morris presents the idea that old age is not only a biological, natural fact, but a cultural event significantly shaped by the lifestyle and attitudes of the whole social community.[12] Ageing is thus strictly related to the environment in which one lives. Nowhere is peaceful and unpolluted, because social conflicts have been overcome and factory waste eliminated, the atmosphere is clear, the waters of the river Thames are clean and people age in the best of ways. In line with the great utopian tradition of Plato and More, Morris posits a society in which old people are not only held in high esteem because they are the repository of wisdom and historical memory, but also play a specific role. In his journey across the London of the future William

10 Jonathan Swift, *Gulliver's Travels* (London: Penguin, 1967), p. 258.

11 For the notion of cultural ageing see Jean Améry, *Über das Altern: Revolte und Resignation* (Stuttgart: Klett, 1968).

12 *Vivere a lungo e bene. Dalla vita sobria di Alvise Cornaro ai giorni nostri*, ed. by Renzo Scortegagna (Padova: Marsilio editore, 2004).

Guest meets two antithetical elderly people: the first, Old Hammond, is the guide who tells the traveller about the historical events that led to the new socialist society; he preserves the sense of history, being a living witness of both the old and the new society. The figure of Old Hammond is positive since he is not 'aged' culturally: he is not backward and knows perfectly how to get around in the new society. Unlike the elderly who do not know how to adapt to the new, because they can no longer control it, Hammond has fully understood the sense of change. The positive figure of a wise and intelligent old man still looking to the future is opposed to the grandfather of young Ellen, who is unhappy and irritable. He belongs to the small number of 'grumblers', the malcontents who miss the old epoch because they have aged culturally. While stressing the disconnection between this old man and the surrounding environment, Morris underlines the important relationship between ageing and the social and political milieu. When the Utopians estimate how old William Guest can be, it is emphasised that age is a relative concept; it is the age which we act and demonstrate that matters. The Utopians maintain that ageing is strictly related to the environment. Therefore, although William Guest is only fifty-six years old, to the Utopians he appears to be eighty, precisely because he has lived in a society which is profoundly sick, both socially and morally. At the end, when William Guest's dream comes to an end, he meets a beggar, whose body bears the signs of decrepitude, a figure juxtaposed to the harmonious and fascinating creatures he left behind. This old man is an allegory of capitalist society in which life conditions are inhuman and devastating.[13]

IV. Longevity and Globalisation: the End of Utopia?

Nowadays the issue of longevity entails viewing a globalised perspective.[14] As regards human lifespan, the planet is highly heterogeneous: lengthening of lifespan is mainly the concern of the most economically developed countries, but according to demographic projections it has already begun in China and India, and will bring about huge consequences in the next fifty years. Unfortunately, a large number of countries have populations with a short average lifespan, little longer than a few centuries ago in Europe. Such inequality raises political, ethical, and philosophical issues related to heterogeneous globalisation. There are controversial connections between scientific discoveries and the capitalist

13 Fortunati, 'Il mito dell'eterna giovinezza e il tema della vecchiaia nell'opera di William Morris', in *Pellegrini della speranza (Scritti in onore di E. Schulte)*, ed. by Adriana Corrado (Napoli: CUEN, 1998), pp. 173 – 187.

14 Franceschi, 'Invecchiamento e longevità nel terzo millennio: prospettive utopiche con qualche problema', *Bollettino delle Scienze Mediche*, Anno CLXXX (2008), 47 – 68.

market with its ruthless logic, which does not encourage the understanding of research on longevity. Patents on anti-ageing medicine represent a huge commercial business which favours the renewal of the myth of eternal youth and the discovery of the elixir of long life. Phenomena such as the culture of fitness, fuelled by the American adoration of all things young, of trans-humanism, of New Age, are not only functional to the capitalist system, but also promote an ideology aimed at banning death. As Marchesini says in a recent book on the notion of post-human:

> The elixir appears today under different guises, from plastic surgery, allowing bodies to maintain a state of temporal suspension […] to expensive cures based on integrators, antioxidants, vitamins, and so forth, capable of transmitting fantastical perspectives aimed towards the universe of youth.[15]

On the contrary, the actual reasons that urge researchers to study, for example, the genes of longevity and the mechanisms they control, have nothing to do with the exterior aspects of youth. The aim of biogerontologists is to identify such genes and understand their biological role as tools to avoid, or significantly postpone, major pathologies and disabilities associated with old age. Scientists are neither re-proposing the myth of eternal youth nor searching for the elixir of long life; rather, and more modestly, they are combating disease and premature death.

An alliance between scientists and humanities scholars is fundamental to the development of a new human ontology which takes into account the prospects of life prolongation foreseen by scientific progress. By deconstructing stereotypical representations of old age, it will be possible to re-conceptualise this phase of life informed by new scientific paradigms.

Ageing can no longer be defined as a monotonic decrease of performances; it is a much more complex phenomenon of remodelling where loss and gain of functions occur. From a biological point of view, ageing reflects the continuous adaptation of the organism to reach ever new balances between accumulation of damage and continuous repair.[16] This dynamic view of ageing has a counterpart in Jung's conception of the third age as a new period of development in which the

15 Roberto Marchesini, *Post-human. Verso nuovi modelli di esistenza* (Torino: Bollati Boringhieri, 2002), p. 488, our translation.

16 Franceschi, 'Le basi biologiche della longevità', *Le scienze*, 311 (1994), 52–61; Giovanna De Benedictis and Claudio Franceschi, 'The Unusual Genetics of Human Longevity', *Sci Aging Knowledge Environ 2006*, New Series, 10 (28 June 2006), PE20-PE30; Miriam Capri, Stefano Salvioli, Federica Sevini, Silvana Valensin, Laura Celani, Daniela Monti, Graham Pawelec, Giovanna De Benedictis, Efstathios S. Gonos, and Claudio Franceschi, 'The Genetics of Human Longevity', *Annals of the New York Academy of Sciences*, New Series, 1067 (May 2006), 252–263.

psyche is also subject to continuous remodelling.[17] Nowadays old age is no longer considered a disease, rather it is understood to be a dynamic global process during which both body and mind undergo continuous adaptations to the changes occurring internally and externally.

It is worthwhile stressing that *Homo sapiens* has to face another mismatch. Ageing has not been foreseen by evolution, as most creatures in the wild die precociously as a consequence of famine, predators, and accidents, without reaching old age. Thus the human body has to cope with the ageing process using 'tools' and 'tricks' (biological mechanisms) which have not been selected for survival to old age. This mismatch is at the root of a variety of oddities regarding the phenotype of aged organisms and unexpected findings about the biological basis of (evolutionarily unpredicted) age-related diseases.[18]

The complexity of this scenario accounts for the difficulties encountered in what has been called 'the anthropology of old age'. The term was first suggested by Ursula Le Guin, who responded to the new scientific attitude towards old age by exploring various non-traditional attitudes. In her novels – *Planet of Exile* (1966), The *Day Before the Revolution* (prologue to the novel *The Dispossessed*) and the trilogy comprising *The Wizard of Earthsea* (1968), *The Tombs of Atuan* (1971), and *The Farthest Shore* (1972) – she does not impress the stereotypical signs of physical and spiritual decadence upon old people: far from being garrulous, forgetful, irascible, stoop-shouldered, and hard-of-hearing, they are creative and dynamic thinkers, strong individuals who can operate on and

17 Alberto Spagnoli, *… e divento sempre più vecchio. Jung, Freud, la psicologia del profondo e l'invecchiamento* (Torino: Bollati Boringhieri, 1995); James Hillman, *The Force of Character and the Lasting Life* (New York: Random House, 1999).

18 Peter Gluckman and Mark A. Hanson, *Mismatch. The Lifestyle Diseases Timebomb* (Oxford: Oxford University Press, 2006); Miriam Capri, Stefano Salvioli, Daniela Monti, Calogero Caruso, Giuseppina Candore, Sonya Vasto, Fabiola Olivieri, Francesca Marchegiani, Paolo Sansoni, Giovannella Baggio, Daniela Mari, Giuseppe Passarino, Giovanna De Benedictis, and Claudio Franceschi, 'Human Longevity within an Evolutionary Perspective: The Peculiar Paradigm of a Post-reproductive Genetics', *Experimental Gerontology*, 43, 2 (February 2008), 53–60; Enzo Ottaviani, Davide Malagoli, Miriam Capri, and Claudio Franceschi, 'Ecoimmunology: Is There Any Room for the Neuroendocrine System?', *Bioessays*, 30, 9 (September 2008), 868–874; Claudio Franceschi, Fabiola Olivieri, Francesca Marchegiani, Maurizio Cardelli, Luca Cavallone, Miriam Capri, Stefano Salvioli, Silvana Valensin, Giovanna De Benedictis, Angelo Di Iorio, Calogero Caruso, Giuseppe Paolisso, and Daniela Monti, 'Genes Involved in Immune Response/inflammation, IGF1/insulin Pathway and Response to Oxidative Stress Play a Major Role in the Genetics of Human Longevity: The Lesson of Centenarians', *Mechanisms of Ageing and Development*, 126, 2 (February 2005), 351–361; Armand M. Leroi, Andrzej Bartke, Giovanna De Benedictis, Claudio Franceschi, Anton Gartner, Efsthatios S. Gonos, Martin E. Feder, Toomas Kivisild, Sylvia Lee, Nesrin Kartal-Özer, Michael Schumacher, Ewa Sikora, Eline Slagboom, Mark Tatar, Anatoli I. Yashin, Jan Vijg, and Bas Zwaan, 'What Evidence Is There for the Existence of Individual Genes with Antagonistic Pleiotropic Effects?', *Mechanisms of Ageing and Development*, 126, 3 (March 2005), 421–429.

change the future of their world. In their last moment of life they are not reminiscing about the past but looking ahead to the morrow. For them old age is a dynamic interplay of opposites in which death heralds new beginnings. In the societies Le Guin sets in outer space and on other planets the elderly are not segregated and still have dialogues and profitable interchange with young people. Le Guin adapts Jung's Puer/Senex archetype in the difficult but possible attempt to restore it psychologically. Even in their final stages of life, old people are able to make important contributions, initiate change and offer innovative viewpoints. Le Guin's fantasy and science fiction suggest that the negative manifestations of old age can be prevented by actively living. She also stresses that ageing is a complex phenomenon from a biological point of view, one that reflects the continuous adaptation of the body in order to constantly reach a new general equilibrium.

Successful ageing as defined by the well-known zoologist and ethologist Desmond Morris in 'Perché l'uomo potrebbe essere immortale' ['Why Man Could be Immortal'] disregards either fashionable fitness regimens or scrupulously balanced diets; it entails eating well and possessing irony, a sense of humour, and a lively interest in the world at large. Morris found these qualities years ago, when he visited the famous centenarian Madame Calmant, one of the longest lived persons ever, who died at the ripe age of one hundred and twenty two years. He then comments on scientific advancement:

> It is improbable that in the immediate future genetic manipulation will reach levels allowing the swindling of death itself, and certainly this will not happen during my existence. What I mean to say is not that it should happen, but that it could. The progress of science is so rapid that what today may seem science fiction in a few decades could be an acquired fact.[19]

Morris observes that science has accepted the challenge of finitude which so frightened ancient wisdom. The core of the problem is the capacity man may have to modify himself. One of the most advanced yet disquieting questions is what will remain of the *Homo Sapiens* handed down to us by biological evolution. It would seem that the findings and perspectives of science have finally surpassed utopia. Paradoxically, science now represents both the completion and end of utopia.[20]

19 Desmond Morris, 'Perché l'uomo potrebbe essere immortale', *La Repubblica*, 10 Aprile 2008, p. 1.

20 Franceschi, 'Utopie et Science', in *Histoire transnationale de l'utopie littéraire et de l'utopisme*, pp. 1087 – 1095.

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Stefano Salvioli

Sci-fi Quests for Longevity and Immortality

I. Everlasting Youth

The quest for everlasting youth is a theme that perpetually recurs in human cultures. In western Christian civilisation it attains an almost obsessive pitch, where the ancestral fear of ending is not soothed by the thought, shared by many oriental cultures, that time is cyclical and birth and death are connected in a circular motion. If time is regarded as linear, birth is nothing but the beginning of an ineluctable descent towards death, which humans can forever try to retard by remaining eternally young.

In *Gulliver's Travels* (1726) Jonathan Swift describes a race of immortals, the Struldbruggs, representing a minority of the population of Luggnagg. These immortals live indefinitely but are afflicted by all the ailments of old age, starting with dementia. Nowadays the elderly live in a condition very similar to that of the Struldbruggs. Medical science and better environmental conditions have enormously increased the average lifespan, but the chance of living a longer healthy life has not increased as significantly. For many diseases such as Alzheimer's the age of their appearance has not changed, so the prospect of a long unhealthy old age, similar to the one exemplified by Swift's Struldbruggs, continues to beckon.

Ageing, longevity, and the possible means of modifying them have aroused the interest of alchemists, physicians, and physiologists. It is not surprising, then, that the quest for eternal youth has been a well-trodden literary and artistic theme. If in novels such as Oscar Wilde's *The Portrait of Dorian Gray* (1890) and Goethe's *Faust* (1808, revised 1828 – 1829), or in the myth of the Wandering Jew, the rejuvenation, or non-death, is achieved by supernatural means, in science fiction the goal of a progressive longevity is almost always the result of technological progress. Several authors have dealt with this theme, highlighting that extreme longevity is not an end point but, as often happens in sci-fi, a condition already acquired, which bears witness to the belief that over the years scientific knowledge will enable humankind to live much longer. Between the end of the 1960s and the beginning of the 1970s notions of biology and genetics began to

circulate, which allowed sci-fi writers (especially those without a specific background in physical sciences) to tackle the theme of human longevity in completely different ways. In 1968 Philip K. Dick's *Do Androids Dream of Electric Sheep* appeared, better known as *Blade Runner*, the title of the 1982 movie by Ridley Scott. A year later, in 1969, Robert Silverberg, one of the most important authors of New Wave sci-fi, published *To Live Again.* In 1973 Robert Heinlein, one of the best known authors of classical sci-fi together with Isaac Asimov and Arthur C. Clarke, published *Time Enough for Love.*

II. Robert Heinlein's *Time Enough for Love*

Heinlein is a prominent representative of the so-called 'hard' sci-fi, and one who possesses a solid scientific knowledge. The main character, Lazarus Long, a.k.a. Woodrow Smith, owes his longevity to a genetic inheritance resulting from careful selection by the Howard Foundation, whose aim it is to create a new type of man endowed with super-longevity. Born towards the end of the nineteenth century (his childhood name, Woodrow, honouring a US President of the same name), Lazarus Long is to be the progenitor of a new race of Methuselahs and will live for more than 2,300 years. Although the novel was published in 1973, Heinlein's intuition about the importance of genetics in human longevity was not unique to it. Genetics finds a place in previous novels belonging to the cycle of 'Future History', in which the author draws a grandiose picture of the future of the human race. *Methuselah's Children*, originally serialized in *Astounding Science Fiction* in the July, August and September 1941 issues and expanded into a full-length novel in 1958, suggests that longevity is hereditary: the children of Methuselah, who according to biblical tradition lived more than 600 years, will themselves be extremely long-lived. Nowadays this intuition is supported by science. We know that the offspring of subjects who live longer than their birth cohorts have a higher chance of living longer than their contemporaries, because they show a lower incidence of age-associated diseases and better physical and cognitive performance.[1] It has been calculated that approximately 20 – 30 % of the overall variation in lifespan is caused by genetic differences and that this

1 Dellara F. Terry, Marsha A. Wilcox, Maegan A. McCormick, Jaemi Y. Pennington, Emily A. Schoenhofen, Stacy L. Andersen, and Thomas T. Perls, 'Lower All-cause, Cardiovascular, and Cancer Mortality in Centenarians' Offspring', *Journal of the American Geriatrics Society*, 52, 12 (December 2004), 2074 – 2076; Dellara F. Terry, Marsha A. Wilcox, Maegan A. McCormick, and Thomas T. Perls, 'Cardiovascular Disease Delay in Centenarian Offspring', *The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences*, 59, 4 (April 2004), 385 – 389.

percentage increases in proportion to the age of subjects examined, in elderly people reaching 50 %.[2]

Lazarus Long and long-lived people like him reach an impressive age owing not only to their genetic inheritance, but also to a series of rejuvenating treatments not further specified in the novel. Pragmatically, Heinlein perceives that genetics on its own cannot explain attainment of such advanced age and thus introduces artificial treatments based on sophisticated technology. One of these therapies, referred to as very primitive, consists in replacing old blood with new blood cultured *in vitro*. The importance of blood as a factor bringing life is a founding concept of our religious culture and has been often appropriated by literature: *Dracula* (1897) by Bram Stoker is only one example amongst many. Unlike other authors, Heinlein suggests that young blood can rejuvenate old organisms in a way which sounds scientific in a period before scientific evidence on the matter had appeared. Recently this anticipatory idea has been confirmed: experiments termed heterochronic parabiosis have shown that when the circulatory systems of two genetically identical mice of different ages are connected, 'environmental signals' (in the form of cytokines and hormones) carried in the blood of the younger mouse enhance the proliferative capacity of muscle satellite cells and liver stem cells of the older mouse.[3]

The awareness that longevity is not simply a hereditary gift to be enjoyed permeates the whole novel and deeply affects Lazarus Long. A long life is a privilege to be gained and defended tooth and nail; only those who manage to do this by prevailing over weaker people will survive. Though not *prima facie* obvious, even in the wild, competition for food, reproduction, and a position in group hierarchy is stronger between members of the same species than between different species. Humans are not different: socialist and egalitarian societies trying to stop fratricide wars can be viewed as experiments against natural laws.

Lazarus Long claims that survival does not depend on the goodwill of neighbours but on how hard we can fight against each other in order to gain advancement in the world. As regards social interactions, Heinlein is a convinced Darwinist. His bio-political discourse sounds dangerously similar to Nazi and Fascist super-man theories, but it is tempered by a moral conscience and an

2 Jacob vB. Hjelmborg, Ivan Iachine, Axel Skytthe, James W. Vaupel, Matt McGue, Markku Koskenvuo, Jaakko Kaprio, Nancy L. Pedersen, and Kaare Christensen, 'Genetic Influence on Human Lifespan and Longevity', *Human Genetics*, 119, 3 (April 2006), 312 – 321; David Karasik, Marian T. Hannan, L. Adrienne Cupples, David T. Felson, and Douglas P. Kiel, 'Genetic Contribution to Biological Aging: The Framingham Study', *The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences*, 59, 3 (March 2004), 218 – 226.

3 Irina M. Conboy, Michael J. Conboy, Amy J. Wagers, Eric R. Girma, Irving L. Weissman, and Thomas A. Rando, 'Rejuvenation of Aged Progenitor Cells by Exposure to a Young Systemic Environment', *Nature*, 433, 17 February 2005, pp. 760 – 764.

intellectual honesty which shuns degeneration. Cynical wisdom is the outcome of Lazarus Long's millenarian experience, as explained in the part of the novel dedicated to the thoughts and reflections of the Progenitor, Lazarus Long himself. Darwinian overtones are amplified by the fact that *Time Enough for Love* tells frontier stories in which human beings must continuously measure themselves against uncountable difficulties and confront other humans or extra-terrestrial life forms usually not well disposed towards the coloniser. Only a strong race will be able to face and overcome these difficulties. Perhaps it is not by chance that Darwin was born in England, a country which from 1600 and for onwards of three hundred years pursued a colonial policy and it is not by chance that in the United States, the nations of the Great Frontier, Darwinian theories have had the widest circulation. Although Heinlein can be, and has been, accused of displaying veiled Fascism in his writings, the idea that natural selection is (and always was) important for longevity is supported by modern science.

Our present genetic inheritance stems from variants selected across thousands of years and is adapted for attaining the age for successful reproduction. The question we might ask ourselves is: are these the same variants that enable us to attain an elderly age? Not necessarily. It seems, on the contrary, that many genetic variants essential to juvenile fitness can cause diseases in post-reproductive age. This contrasting behaviour of the same genetic variant has been defined as 'antagonistic pleiotropy'.[4] In short, the same variant of a gene (allele) should be able to determine two or more different and contrasting outcomes, according to the moment in which it operates, for example, by favouring fertility in youth but being a risk factor for some diseases in later life. However, since natural selection does not have an effect on post-procreative period, it is possible that genetic variants affecting longevity might be positively selected for and transmitted to successive generations. Thus, those who survive longer may not be the strongest and fittest, but rather those endowed with variants less useful for youthful fitness, but lacking negative effects (or even conferring protective effects) on post-procreative functioning. The theory of antagonistic pleiotropy developed by Williams in the 1950s is validated by recent data, which strongly suggest that longevity is a totally unpredicted by-product of Nature.

What has natural selection affected, then? Probably not so much the longevity of any single individual, but rather the lifespan that typically characterises the average length of life of each species. As regards *Homo sapiens*, it is well known that it is the most long-living amongst the great apes and its peculiar lifespan can have been affected by different selective processes such as the occurrence of few

4 George C. Williams, 'Pleiotropy, Natural Selection, and the Evolution of Senescence', *Evolution*, 11, 4 (December 1957), 398 – 411.

mutations in a limited number of genes controlling lifespan.[5] Another possible explanation for the particularly long post-reproductive survival of humans is the cooperative breeding of the offspring.[6] This aspect, together with other characteristics typical of primates (and of our own species in particular) such as bipedism, has certainly been important in determining the longevity of the species.

According to Heinlein, longevity requires the right genetic heritage, a series of technological interventions and a stringent Darwinian selection. This three-stage process takes into account all the factors that nowadays gerontology regards as fundamental for longevity, that is genetics, environment, and chance. The genetic component is prominent in the whole cycle of 'Future History' and in *Time Enough For Love* in particular: many characters descend from Lazarus Long, since the Howard Foundation crossbreeds naturally long-lived individuals like him in order to create human beings with genetic pools enriched by alleles favourable to longevity. The second variant, environment, is represented by the Rejuvenating Clinics (rigorously reserved for members of the Howard families). Culture is a fundamental variant of environment: the most significant environmental changes, which have allowed for a spectacular increase of life expectancy in Western countries over the last century, have been largely determined by cultural phenomena, rather than by natural conditions. The third variant, chance, is the most undetermined, but in Heinlein's view the consequences of an accidental event are always modulated by man's capacity to cope with chance and successfully adapt to changes and upheavals. In particular, for him it is fundamental to understand the moment when it is better to abandon everything and to start again somewhere else, on another planet, in a typically sci-fi version of the Great Frontier. When a society reaches the brink of catastrophe and can no longer be saved, it is better to abandon the ship before it sinks.

The future longevity of the human race which Heinlein hypothesises still appears to be up-to-date. One of the immediate consequences of the views which he developed in 'Future History' is the opposition between the many individuals who measure time in years and the fewer ones who measure it in centuries. Epidemiologists calculate that, as a result of environmental changes, if current conditions remain stable, in 2070 female life expectancy will be between 92.5 and 101.5 years.[7] However, life expectancy is still lower than 50 in developing countries. The 'racial' strife between rich and poor for the right to cheap

5 Gustavo Barja, 'The Gene Cluster Hypothesis of Aging and Longevity, *Biogerontology*, 9, 1 (February 2008), 57 – 66.

6 Shannen L. Robson and Bernard Wood, 'Hominin Life History: Reconstruction and Evolution', *Journal of Anatomy*, 212 (2008), 394 – 425.

7 Jim Oeppen and James W. Vaupel, 'Demography. Broken Limits to Life Expectancy', *Science*, 296, 5570 (10 May 2002), 1029 – 1031.

medicines is already under our eyes, exemplified by the treatments for AIDS and other infectious diseases. In future, the contest may involve even more basic necessities, such as access to clean water and food, and it is possible that clashes between the 'long-lived' rich and the 'ephemeral' poor will grow more bitter. Those who are born and live in conditions that do not support long life will nevertheless strive for it and Heinlein plays out how the ephemeral become aggressive towards the long-lived.

III. Philip K. Dick's *Do Androids Dream of Electric Sheep?*

What would our reaction be if the possibility of living longer was denied to us? In *Do Androids Dream of Electric Sheep?* by Philip K. Dick the topic of longevity is explored at the beginning of chapter 17. The plot is well known: bounty hunter Rick Deckard must eliminate ('retire' is the euphemism) a group of rebel Nexus-6 androids so similar to human beings that they can only be identified by means of an empathy test (as they completely lack this quality). In a scene taking place before the elimination of the fugitive androids, Rick Deckard and Rachael Rosen talk about the short span of life – little more than four years – allotted to androids: an unspecified perpetual or semi perpetual problem in the turnover of cells prevents them from living longer. When Dick's novel was published, it was only just beginning to be understood beyond scientific domains that terminally differentiated cells constituting organisms are not able to grow and divide indefinitely, but rather stop growing and senesce.[8] Dick perceived one of the causes of organic ageing to be the senescence of the cells of all our tissues, requiring their substitution by undifferentiated stem cells, endowed with an almost unlimited capacity for self-renewal. The scientific aspect is tackled with a certain propriety of language in *Blade Runner*, the movie taken from *Do Androids*, filmed in 1982, 14 years after the publication of the novel: this is not a particularly long interval, but it was crucial for the development of biological sciences such as genetics and molecular biology.

Just like normal household appliances, androids have a limited duration, but they are more alive and have a lust for life stronger than most humans, as demonstrated by the fact that they yearn for liberty and independence and, like human beings, do not want to die. This last motif becomes even more prominent in the *Blade Runner* screenplay by Hampton Fancher and David Webb Peoples. Here the all too human desire to extend lifespan urges the group of androids led by Roy Baty (Batty in the film credits) to rebel. Various classes of androids are

8 See Leonard Hayflick and Paul S. Moorhead, 'The Serial Cultivation of Human Diploid Cell Strains', *Experimental Cell Research*, 25, 3 (December 1961), 585 – 621.

endowed with different lifespans and Roy (Rutger Hauer) tries to obtain more life not so much for himself, but for his companion Pris Stratton (Daryl Hannah). In a pivotal scene (missing in the novel) Roy meets the creator of the androids, the president of the corporation, and asks him to modify the biological program that condemns them to wane after such a short life. However, the creator (or Creator?) cannot or will not change things (he claims 'we made you as best as we could') and is thus killed. It is difficult not to empathise with Roy and avoid seeing a metaphor of the human condition, in which the creator is recognised as impotent, or worse, and assassinated more out of frustration caused by a betrayal of hope than for the desire to take his place. In the novel, the religious element is accentuated; the film deliberately ignores it, but the hint at the sorrow ensuing from the realisation that all hopes are vain perfectly catches the sense of nihilism that Dick wanted to suggest. Mercerism, a saving religion based on the empathic participation in an incessant Calvary which almost all the population on Earth believes in, reveals itself to be a television hoax.

Do Androids conveys a sombre message and although it was published in 1968, the year of the great Utopia, it is fundamentally a dystopian novel. In the future imagined by Dick – 1992, only 24 years after publication of the novel – the world is a desolate land and the few survivors of a nuclear holocaust are continuously exposed to the fall of radioactive dust which endangers both their mental and reproductive capacities. In this apocalyptic scenario, the characters have no hope of a longer life, as in Heinlein's novel, but rather they harbour the certainty that if they remain in that environment they will live shorter and shorter lives. In the movie this theme is expressed through the character of J. F. Sebastian, J. R. Isidore in the novel. While in the novel Isidore is mentally semi-deficient (a 'chicken-head') as a result of radiation, in the film Sebastian (William Sanderson) suffers from a precocious ageing syndrome very similar to progeria, which condemns him, like androids, to a much shorter life.

Dick's dystopia should be considered very seriously as epidemiologists' predictions of life expectancy in the future are dependent on assuming stable current conditions, which may well be unwarranted. A centenarian today has lived his/her childhood in an environment completely different from the present one. It is not granted that ours is an environment in which the factors which enhance longevity (availability of effective medical care, abundance of food, hygienic conditions, etc.) are superior to factors which hinder it, such as growing physical, chemical, and biological pollution. Furthermore, there is no guarantee that the interplay of such factors will remain unvaried in the future.

IV. Robert Silverberg's *To Live Again*

To Live Again by Robert Silverberg, published in 1969, is less interesting from a literary point of view but presents an original approach to immortality. Drawing on the Christian idea of the soul and the Buddhist idea of reincarnation, Silverberg imagines there to be a procedure (the Scheffing process) which enables the soul to be 'photographed' and recorded in 'Imagines' (plural of Imago) and implanted into the minds of other living people. In this way, it is not the survival of the body that is attained, but of the incorporeal part, unique to each person and including their character, memories, and their psychic sphere. These 'imagines' continue to live as conscious guests in the brain of other people who, after having them voluntarily implanted, show them off as *dernier cri* status symbols. The core of this novel, unlike those of Heinlein and Dick, is life after the biological death of the body. Silverberg explores the idea of two different souls cohabiting the same mind, a condition of actual schizophrenia. He solves the situation by assuming that the transplanted imago is subordinate to the host's will, becoming little more than a spectator. Nevertheless, the imago can prevail over the host and gain control over the body, generating what Silverberg calls a 'dybbuk'. This happens if the personality of the guest is stronger than that of the host, as in the case of the imago of a general implanted into a soldier's mind. In order to avoid such dissonance, the experts of the Scheffing Institute are careful to perform transplants only between compatible personalities; indeed, the killing of a mind (especially if not yet recorded at the Institute) is considered as the only true crime of murder and for this reason criminal dybbuks must be eliminated. Problems arise when the imago to be caught is that of one of the most powerful and rich men on the planet.

The novel develops a social critique of the upper bourgeoisie and includes quotations from *Bardo Thödol*, the Tibetan Book of the Dead. The most interesting aspect is to be found in the least explored consequences of imago transplantation. Successive recordings of the same personality are kept at the Scheffing Institute, only the most recent one being authorised for transplant use, since that is the richest in memories. However, it would be possible in theory to transplant the same imago in two different people using different recordings. In this way, the conflict between two contestants for millionaire Paul Kaufmann's imago can be resolved, but who, now, is Paul Kaufmann? – the one reborn in his nephew Mark or the one whose imago should go to his enemy, Roditis? Or is he both? And would we feel less terrified at the prospect of dying, if we knew that there will be more than one copy of us? The Kaufmann being reborn in Roditis wants to prevail over the Kaufmann reborn in Mark, because each clone, although identical to the original down to the last synapse, does not consider itself a copy of the other and tries to survive, even at the expense of its matrix. This

trait seems to be one of the basic features of living organisms and is acknowledged in sci-fi. Android Rachael Rosen says: 'If I die, […] maybe I'll be born again when the Rosen Association stamps out its next unit of my subtype'.[9] This is similar to our hopes for resurrection and yet neither Rachael nor the other androids are consoled by it.

A partial exception to this rule is constituted by the Borgs, one of the alien life forms described in the Star Trek TV series. These aliens consider themselves to be part of a single super-entity and are not interested in their own individuality, in favour of a superior Gestalt constituted by the collective structure of all the Borgs in the Universe. Only the Borg queens are endowed with individual thought. This socio-biological model drawn from the observation of the world of social insects (the Borg collective structure is actually called a 'hive') has strongly influenced cellular biology. For many years it was thought that the success of multi-cellular organisms is due to the fact that each cell is subject to the superior interest of the whole organism, which, in its entirety, attains a longevity far superior to the cells composing it. This interpretative model takes account of marked specialization of tissues, the threat to the life of the organism represented by 'anarchic' (cancer) cells, and the discovery that all eukaryotic cells, once their life cycle has ended, can actively commit suicide, thereby making way for new cells. This phenomenon of programmed death is known as apoptosis. However, the 'altruistic' theory about the life of cells is being questioned by recent theories which hypothesise that the whole interior milieu of the organism could be an immense battlefield, where cells try to survive even at the expense of their neighbours, according to a principle of Darwinian selection. Because Borgs are cybernetically modified subjects, the assumption that living creatures are characterised by a marked individualism is not totally denied by the figure of the Borg, a partially artificial being. According to the Russian scientist Vladimir P. Skulachev, the phenomenon of altruistic death can take place even at the level of the organism, a phenomenon he names 'Phenoptosis'.[10] On this account, the death of an aged, no longer competitive individual should be seen as a biologically positive phenomenon, since it makes room for younger individuals and thus promotes the survival of the species. However, in human terms, death in principle should be postponable (for ever), but despite such

9 Philip K. Dick, *Do Androids Dream of Electric Sheep?* (New York: Ballantine Books, 1982), pp. 165 – 166.

10 Vladimir P. Skulachev, 'Aging Is a Specific Biological Function rather than the Result of a Disorder in Complex Living Systems: Biochemical Evidence in Support of Weismann's Hypothesis', *Biochemistry (Mosc)*, 62, 11 (1997), 1191 – 1195; Id., 'The Programmed Death Phenomena, Aging, and the Samurai Law of Biology', *Experimental Gerontology*, 36, 7 (July 2001), 995 – 1024.

aspiration, longevity of *all* individuals would be negative for species from an evolutionary point of view.

It is almost impossible to think that old age could be selected for by Nature, at least in mammals. In the natural world, where less fit individuals are immediately killed off by factors such as infections, predators, or competition, old age as humans know it is absent. Where there is already an effective *external* system of elimination, *internal* auto-elimination would become superfluous, a conclusion supported by the fact that there are no known mammals that meet death willingly.[11]

Though Silverberg is not explicit, it can be inferred that the imagines deposited at the Scheffing Institute, a sort of 'soul bank', are neither biologically nor transcendentally alive; they are like electronic software waiting to be installed in a hard disk drive, a potential form of consciousnesses. The fusion of two or more personalities in the same mind presupposes that the imagines are not alive *per se*, but only become alive when re-implanted into another brain. There is no life or consciousness in *To Live Again* outside an organic body, so the only way of keeping one's own individuality, given the impossibility of indefinitely prolonging the life of one's own body, consists in 'parasiting' someone else's. Imagines relighting in other brains are not asked if they accept the host who chooses them. Human beings are never masters of their own destiny, not even after death, but have to accept the choices of authority. The imagines lack all memories of events occurring after their last recording, thus death cannot be recollected. As they are reborn, they think they are people in their own body, living the moment at which their last memory ends, when they were recorded at the Scheffing Institute. Unlike the classical tradition, according to which after drinking from the river Lethe the soul forgets all its past life, here everything is retained except the memory of the supreme fear. It is not possible to know if this is a conscious choice by the author, since recording (or, keeping the electronic comparison, the backup of the soul) would be possible even post mortem and memory of the end could thus be retained. Perhaps, guessing that it might be unbearable, Silverberg chooses amputation of this memory.

11 Other living beings such as some insects and salmons die suddenly after reproduction as a result of a precise evolutionary strategy. This phenomenon, which appears to be genetically controlled, does not apply to mammals that generally have a low reproduction rate and highly dependent offspring; they cannot die off soon after reproduction, as the offspring need parental care to survive.

V. Deadly Boring?

The three different approaches to the theme of longevity are correlated: if human beings want to live longer, they must do it at the expense of what they are now. They must sacrifice part of themselves and evolve. According to Dick, what makes humans different from biological machines is empathy. These novels show that the capacity to see a bit of ourselves in what is before us can be extended to what is not human and thus humanity does not run the risk of being diminished, but is actually increased. After all, the Nexus-6 androids are described as better and more evolved than certain degenerate humans, and Rick Deckard ends up falling in love with one of them, Rachael.[12] In Heinlein, the distinction between human and machine is blurred. In *Time Enough for Love* supercomputers are self-aware and at a certain point some of them decide to become people in flesh and blood. Dick's fear of the non-human does not exist in Heinlein: Lazarus Long will have a child from his ex-computer. In Silverberg's *To Live Again* Elena Volterra falls in love with an incorporeal imago and protects it when it takes over the mind of its host and becomes a dybbuk.

The three authors are ready to acknowledge humanity in androids, computers, dead people or abstract entities. Even a mainstream maestro such as Steven Spielberg can convey the message that the protagonist of *AI* is not a robot but a child (and he is played by a child, Haley Joel Osment), not to mention Collodi's *Pinocchio.*[13] Whether this extension of empathy and human citizenship is positive remains doubtful (Dick seems to hint at a negative answer), but if it helps us to live, so much the better. The ongoing bioethical debate on the moral acceptability of medical treatments exceeding the natural order of things and modifying organic humanity has already been solved by our authors, at least as regards the problem of longevity. Is a human being with an artificial heart (do you remember Pink Floyd's *Atom Heart Mother?*) less human than one with a normal heart? If we recognise the atom heart mother as human, any treatment which extends life (without harming others), including Silverberg's imago, might be considered legal. The final message seems to be that if humans want to live longer and even attain immortality, they should extend their human qual-

12 In the 'director's cut' version of Ridley Scott's *Blade Runner* Deckard is suggested to be an android himself, an idea which is completely absent in the novel, where it is obvious that he is a man who, by falling in love with an android, commits an almost abominable act.

13 On the opposite corner there is HAL 9000, the computer endowed with artificial intelligence in *2001 Space Odissey* by Stanley Kubrick, who also originated the project for *AI*, inspired by a tale by Brian Aldiss, 'Super Toys Last all Summer Long' (1969). HAL 9000, an almost 'metaphysical' machine which is not visible except for its red 'eyes', is not considered 'human' in the movie. Nevertheless, it is difficult not to feel pity for it when it is progressively 'turned off' by Dave Bowman.

ities and accept diversity, including animals and the inanimate, without preconceptions. In *La Possibilité d'une Île* (2005) by Michel Houellebecq an opposite view is taken: humans have become immortal through cloning, but progressively lose their humanity while they are transferred from one clone to another, as viruses lose their virulence in successive passages of *in vitro* cultures. Moving through different bodies causes a deterioration of those characteristics that make human beings human. For Houellebecq the desire for immortality involves the refusal to pass on power to future generations, which after all is the brilliant way invented by Nature to preserve life, since time-proof bodies are unattainable. Moreover, generational renewal by means of sexual reproduction also allows species to adapt to possible environmental changes. As in the other novels, in *La Possibilité d'une Île* humankind must acquire specific traits in order to reach immortality, among which is a series of genes for photosynthesis, typical of plants, which confer capacities to benefit from sources of nourishment which include sunlight.

The quest for longevity is a prominent theme in sci-fi literature. In Kurt Vonnegut's *Slaughterhouse 5* (1970) the hero, immersed in a temporal funnel, is obliged endlessly to relive different periods of his life. The idea of the so-called chronosynclastic funnel, a distinctive sci-fi plot device, first appeared in Vonnegut's second novel, *The Sirens of Titan* (1959). In *This Immortal* (1966) Roger Zelazny introduces Conrad Nomikos, who is immortal because his nature is divine, or semi divine. Robert Silverberg himself faced the topic of the quest for longevity once again in the short tales 'Going' (1971) and 'Born with the Dead' (1974). These suggest that Silverberg had a kind of obsession with death and life after death. As with *To Live Again*, in these tales the persistence of thought is more important than that of the body. Indeed, in 'Born with the Dead' the reawakened dead are no longer interested in humans, so Silverberg seems to reject the idea that the body could survive without its original mind.

In a more recent novel by Sten Nadolny, *Ein Gott der Frechheit* (1994), the Greek gods are still around, being immortal, as are the Egyptian gods imagined by Enki Bilal in the science fiction graphic novel *La Foire aux Immortels* (1980). These authors reach the conclusion that eternity must be a real drag. Nadolny's Zeus plays golf and his Apollo is a poet and an art critic, while Bilal's Egyptian gods kill time playing Monopoly – such a hassle to reach immortality, then to discover that to be immortal is deadly boring!

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Nicoletta Vallorani

The Plague Years. Borderland Narratives on AIDS in the '90s

I. Killer Language

> In 1984, having known about AIDS for little more than one year, I began to realize that there is language that can kill me or, more insidiously, language that can persuade me to kill myself.[1]

Any writing on AIDS and its representations unavoidably stumbles upon a full set of proliferating paradoxes. They are grounded in the ambiguity of the pathology itself as well as in the process through which AIDS-as-an-actual-disease has copied itself into British – and to some extent Western – culture like a virus, positing itself not only as a definite pathological condition but also as an entrenched, proliferating text. However, though often defined as an event that does not exist apart from its representations[2] or as something that was not born, but made,[3] AIDS *does* exist apart from its representation even when – or specifically while – it goes through the inexorable contingencies of representation *within* language.

Representations assume the responsibility for making the invisible visible (biomedically, socially, and/or artistically) and defining and confining a condition that is called forth by language but not exhausted by it.[4] AIDS inhabits therefore what may be called a borderland – if not a wasteland – where the signifier, be it human being or text, or both, is doubled, made ambiguous, relocated, and displaced by the infection. The victim him/herself is marked by a dual destiny, combining a *physical* and a *social* death, and producing a com-

1 Ellis Hanson, 'Undead', in *Inside/Out. Lesbian Theories, Gay Theories*, ed. by Diana Fuss (London: Routledge, 1991), pp. 324 – 340 (p. 324).

2 Leo Bersani, 'Is the Rectum a Grave?', *October. Art Theory Criticism Politics*, 47 (Winter 1987), 196 – 222.

3 Donna Haraway, 'The Biopolitics of Postmodern Bodies: Determinations of Self in Immune System Discourse', *Differences. A Journal of Feminist Cultural Studies*, 1 (1989), 3 – 43.

4 Robert Burns Neveldine, *Bodies at Risk. Unsafe Limits in Romanticism and Postmodernism* (New York: State of New York Press, 1998).

mitment to life to be articulated through the tools of both the sciences and the humanities.

The acknowledgement that language is a key issue invites an inquiry into the multifarious interactions and overlappings between the lexis of science and the metaphors of art. They give body – and a body of sorrow – to the AIDS victim's real suffering, emphasizing his/her marginalization and social isolation whilst prospecting unavoidable death. Paula Treichler acknowledges this double-sided aspect of the disease when she states that:

> AIDS is not merely an invented label, provided to us by science and scientific naming practices, for a clear-cut disease entity caused by a virus. Rather, the very nature of AIDS is constructed through language and in particular through the discourses of medicine and science; this construction is 'true' or 'real' only in certain specific ways – for example in so far as it successfully guides research or facilitates clinical control over illness. The name *AIDS* in part *constructs* the disease and helps make it intelligible. We cannot therefore look 'through' language to determine what AIDS 'really' is. Rather we must explore the site where such determinations *really* occur and intervene at the point where meaning is created: in language.[5]

For reasons which will soon become clear, the diachronic development of feelings, stereotypes, social beliefs and cultural and artistic representations concerning PWA – Person With Aids – seems to reach a peak in Great Britain between the end of the 80s and the beginning of the '90s.[6] 1986 was marked by fear and ignorance, but also by a great flourishing of bottom-up activism from gay groups. The public health campaigning of 1986 – 1987 was the response made by the Conservative Government which faced the AIDS crisis as if it were mobilization in wartime. In his 1988 introduction to *V for Vendetta* the graphic novel artist Alan Moore observed:

> Margaret Thatcher is entering her third term of office and talking confidently of an unbroken conservative leadership well into the next century. My youngest daughter is seven and the tabloid press are circulating the idea of concentration camps for persons with AIDS.[7]

While the field of politics was basically dominated by Thatcher's style, medical professionals gradually showed a form of liberal consensus acknowledging that some discrimination was actually operated towards PWA. The '90s themselves

5 Paula Treichler, 'Aids, Homophobia, and Biomedical Discourse: An Epidemic of Signification', *Cultural Studies*, 1, 3 (October 1987), 263 – 305 (p. 263).

6 On the implications of AIDS in the '90s with specific reference to the UK see Virginia Berridge, *Aids in the UK. The Making of Policy 1981 – 1994* (Oxford: Oxford University Press, 1996) and Philip Gatter, *Identity and Sexuality: AIDS in Britain in the 1990s* (London: Cassell, 1999).

7 Alan Moore, 'Introduction' (1988) to Alan Moore and David Lloyd, *V for Vendetta* (New York: DC Comics, 1990), pp. 6 – 7 (p. 6).

were a period of normalization in a number of areas, though it also became increasingly visible that a number of people were dying, and they produced reflections and meaningful artistic representations of their disease and of the implied social sanctions. In 1993 Judith Butler published *Bodies at Risk* and Amanda Phelan issued *Unmarked*. In January 1994 Derek Jarman died after filming *Blue*, unanimously considered to be his final meditation on life, death, and art in times of plague.

Therefore, Jarman's work after he was diagnosed HIV positive (December 1986) will be examined to see how AIDS as a deathly physical and social destiny has suggested strategies of selfhood. The new signs of identity articulated in art and culture have shown the unavoidable permeability between science (i. e. biomedicine) and narration. What makes Jarman's reflections meaningful is that they are shared by an increasing number of artists giving voice to the marginalization, social discrimination, isolation, and paradoxes suffered by any PWA in this period. Again, Treichler's position on the matter is seminal:

> Whatever else it may be, AIDS is a story, or multiple stories, read to a surprising extent from a text that does not exist: the body of the male homosexual. It is a text that people so want – need – to read that they have gone so far as to write it themselves. AIDS is a nexus where multiple meanings, stories and discourses intersect and overlap, reinforce and subvert one another. Yet clearly this mysterious male homosexual text has figured centrally in generating what I call an epidemic of signification.[8]

The passage is drawn from an essay first published in 1987 and then widely mentioned and referred to. The definition of AIDS as an 'epidemic of signification' proves peculiarly effective, because it identifies the central issue of any reflection on AIDS. Viral infectious diseases are to be seen not only as practical conditions invoking medical solutions, but as occasions for an ontological remoulding of identity and its representations in art, literature, cinema, and popular culture. As Catherine Waldby explains:

> They are an ontological threat because they challenge the status of the human, because viral infection involves the colonisation of human genetic identity with viral genetic identity. Viruses are understood to replicate themselves through their annexation of the reproductive apparatus of human tissue cells, forcing the human cells to manufacture alien viral cells, forcing human identity to participate in its own infectious defeat.[9]

This process has a strong impact on the sociological concept of normality, which becomes the hub for revising social dialectics. In other words, more strongly than ever, the *normal* is felt as the *normative* and, in times of plague, it defines

8 Treichler, p. 269.

9 Catherine Waldby, 'Introduction. Total War', in Ead., *AIDS and the Body Politics. Biomedicine and Sexual Difference* (London and New York: Routledge, 1996), pp. 1 – 17 (p. 1).

the social values to stick to in order to escape infection and death. Waldby points out that the distinction between the normal and the pathological is prone to overlap with other determinations (clean/unclean; innocent/guilty; sexually normal/perverted) which soon evade the field of science to support a kind of political violence functional to the maintenance of various kinds of social power and relationships.[10] Science – and biomedicine in particular – claims to be transparent in its relation to its object, but in concerning AIDS it is not; transparency in viral infectious diseases is simply not sustainable. More than in any other scientific field, the usual scientific lexis tends to become figurative and to work through metaphors and other tropes in the attempt to signify verbally the clinical gaze.

Any description of AIDS should thus address at least three different issues. Firstly, AIDS is a pathology of the immune system, it is of viral origin and therefore spreads through infection. Secondly, understood as a sexually transmitted disease associated with particular sexualities, AIDS is linked to the ideal concept of health both at the physical *and* at the moral level; in other words, you are infected because you are sinful. Thirdly, being a plague – or defined as such – it affects the community and frames itself as the narrative of a social order bordering on its own breakdown. This complexity of AIDS as a topic has produced an implicit ambiguity, resulting in a particular cultural atmosphere and a new, very disturbing gay subject. Looking for a way to make sense of a world which forces them to feel like outsiders, gay artists use familiar genres as instruments to expose the deletion of their personal identity in a community where AIDS is commonly perceived as *the* homosexual plague, even though this hypothesis has never been confirmed by biomedicine. That is why the words of biomedicine are the ones from which we should start.

II. Science and Narration: Poetic Definitions

> My subject is this body, glanced at by language. It refers to the past, like a living artefact; and points forward into the future, like a prophecy unaware of the full power of its desire.[11]

Biological science as a discourse cannot be separated from the instability and duplicity inherent in the way language operates. Therefore the purported neutrality of scientific representations is not only untenable, but also functional for a

10 Ibid., p. 6.

11 Robert Burns Neveldine, 'Chapter Five. Skeletons in the Closet: Paradox, Resistance, and the Undead Body of the PWA', in Id., *Bodies at Risk. Unsafe Limits in Romanticism and Postmodernism* (Albany: State University of New York Press, 1998), pp. 141 – 161 (p. 142).

social policy apparently grounded in science, but actually exploiting the status of science for political purposes. Whenever science becomes a discourse, it works through language which, far from being neutral, is deeply ingrained in the creation and maintenance of a definite social order. This is all the more true where epidemiology is involved. As Waldby claims:

> epidemiology habitually conceptualises social order as analogous to organic order, while the technical discourses of the physiological body (immunology, endocrinology) figure it as a social microcosm. This confusion has a long history and many variations, but within the historical and cultural particularity of the AIDS Body Politic the sexuality and ascribed boundaries of bodies take on particular political significance, determining who is and is not a threat to 'public health'.[12]

Curiously enough, texts concerning viral infection of cells tend to be literally soaked in linguistic metaphors. While reflecting on the multiplication of viruses, Bernard Roizman explains that:

> Viruses have developed several strategies to deal with (a) encoding and organization of viral genes, (b) expression of viral genes, (c) the replication of viral genomes, and (d) assembly and maturation of viral progeny. The active work of viruses is conceived of as a strategic organization resulting in the production of a 'viral progeny'.[13]

This conveys the impression that in the diseased body an evil invasion is taking place and therefore a sort of military reaction is called for. When referring to HIV infection, the matter becomes increasingly complex, in that we are dealing with what scientists define as a retrovirus reproducing through an enzyme called reverse transcriptase. In the infected body, therefore, the virus literally copies 'its genetic information into a form that can be integrated into the host cell's own genetic code. Each time a host cell divides, viral copies are produced along with more host cells, each containing the viral code'.[14] The process itself and therefore the way in which it is described seem inherently metaphoric. Quite openly, the progress of disease involves a highly symbolic – though real – process of inscription and transcription: the moulding and remoulding of a text in the physical body of the victim. Therefore Edelman is right when he states that:

> The virus endangers precisely because it produces a code, or speaks a language, that can usurp or substitute for the genetic discourse of certain cells in the human immune system. AIDS thus inscribes within the biology of the human organism the notion of parasitic transcription. And this metastatic or substitutive transcription of the cell is

12 Waldby, p. 14.

13 Bernard Roizman, 'Chapter 5. Multiplication of Viruses: An Overview', in *Fundamental Virology*, ed. by Bernard N. Fields, David Mahan Knipe, and others (New York: Raven Press, 1985, 2nd edn), pp. 87–94 (pp. 89–90).

14 Johns Hopkins University, *AIDS – A Public Health Crisis*, Population Information Program, Population Reports, Issues in World Health, L, 6 (July-Aug. 1986), pp. 194–228 (p. 198).

> particularly difficult to counteract because HIV, like metaphor, operates to naturalize, or present as proper, that which is improper or alien or imported from without.[15]

Current scientific theories define AIDS as a disease developed through infection with the HIV virus that attacks the cells of the immune system and therefore strongly impairs the body's capacity to defend itself against any viral and parasitic infections. David Black uses an openly ontological concept to describe the immune system as 'the body's complex and still imperfectly understood defense mechanism. Its job is to tell the difference between Self and Not-Self'.[16] Here the distinction between Self and Not-Self becomes the semantic hub of the description of the infection.

A borderland is therefore sketched out, taking the shape of a blank space on the map of medicine, because of the way in which HIV infection develops. AIDS in fact implies the idea of a perverse reversion and take-over of the way in which genetic information normally flows. Metonymically transmitted through contiguity, the virus is to be feared because it appears in disguise, as a friend, and, operating on the meaning of the cellular code, it invades the body through a version of metaphoric substitution.[17] Obviously this does not mean that AIDS is either and/or primarily a metaphor. Its sorrowful reality in the bodies of diseased people and in their death makes the kind of argument Susan Sontag develops in *AIDS and Its Metaphors* (1989)[18] unfair and untenable. Nevertheless, it is precisely the impact of metaphoric language on scientific descriptions of AIDS that gives a clear-cut idea of how much the social, political and to a certain extent moral order is affected by the AIDS epidemic. The way AIDS is represented linguistically has an impact on the cultural relationship with the disease and may determine the political reactions to it.

It is significant, for example, that both the scientific description of how HIV infection develops in the diseased body and the statements of theorists and activists rely heavily on military language. While mentioning the most familiar graphic description of HIV – 'virus as grenade' – Treichler specifies that this metaphor is devised to lead us to see it 'as a perfect inorganic military mechanism, primed for detonation'.[19] In an article published in the *New York Times* in 1990 Natalie Angier refers to 'invasion strategies' put into operation by the HIV

15 Lee Edelman, 'The Plague Discourse: Politics, Literary Theory, and AIDS', in *Displacing Homophobia: Gay Male Perspectives in Literature and Culture*, ed. by Ronald R. Butter, John M. Clum, and Michael Moon (Durham and London: Duke University Press, 1989), pp. 289 – 305 (p. 302).

16 David Black, *The Plague Years: A Chronicle of AIDS, the Epidemics of Our Times* (New York: Simon and Schuster, 1986), p. 80.

17 Lee Edelman, pp. 302 – 305.

18 Susan Sontag, *AIDS and Its Metaphors* (New York: Farrar, Strauss and Giroux, 1989).

19 Treichler, p. 278.

virus that literally incorporates the victim's genetic material, modifying his/her genome. The concept of body-snatching is openly implied when Angier refers to the host cells being fooled into believing something that is not true:

> Just when they thought they knew most of the nasty parasitic manoeuvres of the viruses, researches are now finding a new and exceedingly devious way that the microbes exploit their hosts. They have discovered that viruses can pirate away copies of genes that control the health and well-being of the host and then turn those genes against the host species.[20]

The same concepts appear in *The Body Victorious* (1986), where Lennart Nillson describes the process of infection using a highly metaphoric mode of expression. Starting from the assumption that each cell possesses 'proof of identity' and that 'the cell's identity papers [protect] it against the body's own police force, the immune system', he concludes that 'the human body's police force is programmed to distinguish between *bona fide* residents and illegal aliens'.[21] Here the language is clearly moulded on the recurrent biomilitary metaphors often used to give shape to the biomedical lexicon, which defines some immune system cells as 'Killer T cells' and viruses as 'foreign antigenes'. The idea of sharp, military opposition between Killer T cells and foreign antigens is very clear. It is therefore true, as Waldby maintains, that

> within the terms of biomedical representation, for example, scientific knowledge and technology occupy one side of the AIDS war & the virus occupies the other. […] Scientists regard themselves as the true opponents of the virus because only they command the necessary knowledge and technology required to fight it.[22]

Treichler quotes a biomedical scientist as stating that we are facing 'an impending Armageddon of AIDS, and the salvation of the world through molecular genetics'.[23] Even one of the acronyms currently used to designate AIDS victims – PWA – echoes some military metaphors. As Philip Gatter points out:

> The first time I read the acronym for Person with AIDS, I was reminded of P.O.W. (Prisoners of War); a coincidence maybe, a simple resemblance, but then, as Susan Sontag has argued, the language of illness is replete with military metaphors.[24]

Sontag herself, while struggling to define what is indefinable – at least under a medical perspective – points out the 'dual metaphoric genealogy' AIDS has

20 Natalie Angier, 'Viruses Said to Pirate Host's Genetic Material in Invasion Strategies', *New York Times*, 3 July 1990, p. 3, <http://www.nytimes.com/1990/07/03/science/viruses-said-to-pirate-host-s-genetic-material-in-invasion-strategies.html> [accessed 15 June 2011].

21 Lennart Nillson, *The Body Victorious: The Illustrated Story of Our Immune System and Other Defenses of the Human Body* (London: Faber, 1986), p. 21.

22 Waldby, p. 2.

23 Treichler, p. 283.

24 Gatter, p. 45.

acquired in our cultural context, as an invasion – just like cancer – and as pollution – as happens for syphilis.[25] The idea of an enemy which is not to be easily understood and defeated probably accounts for the repeated occurrence of warfare analogies in describing AIDS symptoms.

In the light of this analysis, what Treichler means by 'epidemic of signification' appears wholly clear: 'there is a continuum, then, not a dichotomy, between popular and biomedical discourses'[26] and it is quite true that a borderland is thereby created.

III. Jarman: Science into Art

> 'To die', 'to have sex' – that coupling has always been figurative, metaphorical, sophisticated wordplay, a literary conceit, one of those outrageous paradoxes dear to the heart of a racy divine like John Donne. Outrageous no longer. The coupling isn't figurative any more. It's literal.[27]

Derek Jarman was diagnosed HIV positive in December 1986, while editing his film *The Last of England*. The diagnosis was never hidden or denied by the artist. On the contrary, it soon became part of his poetics. In other words, right from the beginning, Jarman started to look for the right words to represent the disease that would eventually kill him, artfully combining the semantics of medicine and the metaphors of art. While he was filming *The Last of England*, he started to work on *Kicking the Pricks*, a collection of diary entries, interviews, and notes on the script. The volume includes a very precise report of his first weeks with the virus:

> It was almost with relief that I listened to the doctor's catalogue of do's and don'ts – shaving, hairdressing, all the little details (soap and water it seemed eliminated the virus outside the body). But for all of medicine you might as well wash your mouth out with carbolic. The sword of Damocles had taken a sideways swipe, but I was still sitting in the chair.[28]

So, for Jarman, disillusion moulds the ability to build – from the moment of diagnosis to the moment of death (1994) – a nexus of ideas linking linguistic coherence and incoherence to health and disease. In his conscious effort to define the borders of his own living and surviving, nitpickingly documented in his wealth of autobiographical writings, language mediates between life and death, the 'natural' and the 'artificial', control and chaos, borrowing words both from science and the humanities, and devising the most suitable code for the borderland he will

25 Sontag, p. 17.
26 Treichler, p. 265.
27 Lee Grove, 'The Metaphor of AIDS', *Boston Globe Magazine*, 28 February 1988.
28 Derek Jarman, *Kicking the Pricks* (New York: Overlook Press, 1997), p. 179.

inhabit from 1986 to 1994. Gradually, the artist develops a personal awareness of a collective fear and a shared marginalization. As Eve Kosofsky Sedgwick explains:

> [One] of the many echoes resounding around the terrible accident of HIV and the terrible nonaccident of the overdetermined ravage of AIDS is the way it seems 'naturally' to ratify and associate – as unnatural, and unsuited to survival, as the appropriate objects of neglect, specularized suffering and premature death – the notionally self-evident 'risk-group' categories of the gay man and the addict.[29]

Particularly in the UK in the early '90s people who had been infected with AIDS were openly said to be 'swirling around in a cesspit of their own making'.[30] The implicit and explicit blame on homosexuality crucially revised the gay profile and the social and cultural interactions defining it. In Western culture being queer meant positing oneself as a soon-to-be AIDS victim, and this had very deep social, cultural, and symbolic consequences. Therefore Jarman's words on his own experience with AIDS are relevant because they actually testify to the impossibility of limiting any discourse on AIDS to the biomedical approach.

The late 80s were actually steeped in the awareness – in the UK and abroad – that, as Jan Zita Grover wrote, 'AIDS is not simply a physical malady; it is also an artefact of social and sexual transgression, violated taboo, fractured identity – political and personal projection'.[31] Significantly, Grover's essay, entitled 'AIDS: Keywords', appeared in 1987. Starting from Raymond Williams's statement that 'some important social and historical processes occur within language, in ways which indicate how integral the problems of meanings and relationships really are',[32] Grover identifies and challenges some of the assumptions underlying our current knowledge of AIDS, and she does so by reflecting on the key-terms normally describing, defining, and delimiting the disease and its victims. Two key-definitions provided by Grover are as follows:

> AIDS … the disease. The popular press, politicians, physicians regularly move from 'acquired immune deficiency syndrome … AIDS' to 'AIDS … the disease'. What are the consequences of this shift? Diseases, we are taught, are often communicable, the general term applied to both infectious and contagious diseases. In discussions of AIDS, because of distinctions *not* made – between syndrome and disease, between infectious and contagious – there is often a casual slippage from *communicable* to *contagious*.[33]

29 Eve Kosofsky Sedgwick, *Epistemology of the Closet* (London: Penguin, 1994), p. 136.

30 Derek Jarman quotes these words by James Anderton on a BBC Radio 4 Sunday program on AIDS in his *At Your Own Risk. A Saint's Testament* (London: Vintage, 1992), p. 105.

31 Jan Zita Grover, 'AIDS: Keywords', *October. Art Theory Criticism Politics*, 43 (Winter 1987), 17–30 (p. 18).

32 Raymond Williams, 'Introduction' to Id., *Keywords: A Vocabulary of Culture and Society* (1976) (New York: Oxford University Press, 1983), p. 22.

33 Grover, p. 19.

> AIDS virus. A seemingly ineradicable term – Aids virus – is almost universally employed by the popular press and is increasingly used by physicians, scientists, and public health planners. The effect of this usage, which conflates HIV with a terminal phase of HIV infection – AIDS – is to equate infection with death. It also supposes that the invariable outcome of HIV infection is death […]. AIDS virus, then, is a term more projective than descriptive. It imposes a mortal sentence on anyone infected with HIV, a projection of hostility and fear that bespeaks another's death in order to quell one's own anxieties.[34]

Obviously enough, a strong responsibility in determining PWA's marginalization is given to the gross misunderstanding of some medical terms: a 'syndrome' is equated to a 'disease', 'communicable' is taken for 'contagious', 'HIV infection' is wrongly considered as a synonym of 'AIDS virus'. Of course scientists are not consciously promulgating a homophobic interpretation of the molecular biology of HIV and AIDS. Semantic confusion is fed by the media, where language is more or less marked at the outset by ideologies of gender and sexuality. As a result, AIDS is given an ambiguous status and in the early '90s, while the need for a deeper and clearer understanding of what this disease implied was felt and voiced at several levels, the process of hiding or censoring infected people – even when artists – was still the most frequent reaction to AIDS as an actual disease. In 1992, Granta published an issue totally devoted to the body. There were plenty of references to marked bodies, overwritten bodies, tattooed bodies but, astonishingly enough, only one reference to AIDS – among 15 pieces – in a short story by Abraham Verghese ('Soundings'). One year before, in one of his diaries which reports more closely on his dawning awareness and acceptance of the AIDS infection, Jarman wrote:

> […] today my dear friend Joany Hunt died, and sweet Paul. As I left the flat this evening I was accosted by a middle-aged man who stared at me intensely and said: 'You've lost weight, you've definitely lost weight' and then disappeared clutching a sheaf of papers.[35]

On a personal level and starting from a very specific personal experience – a neighbour noticing he has lost weight – Jarman pointed out the symbolic loss of weight homosexuals were experiencing (also) at the social level, too, precisely because of AIDS and on the grounds of a widespread inability to replace prejudicial positions and language with a real knowledge of the virus and how it worked. In 1992 Jarman exhibited a work called *Blood*. Originally, he wanted to use his own blood to paint it, but after learning that the Ministry of Agriculture

34 Ibid., p. 21.

35 Jarman, *Modern Nature. The Diary of Derek Jarman* (London/Sydney/Auckland/ Johannesburg: Century, 1991, p. 37). The quotation refers specifically to Wednesday 17 (Jan. 1990).

would require him to boil it seven times, he simply bought a can of red paint.[36] The fear underlying this specific event is originated by the symbolic nature of infection and by the way it is felt and lived through by a whole community: as a threat to be removed for the sake of the community itself. All the more so when the infection takes the shape of an epidemic so evident as to rule out the need of statistics and numbers. In 1993, shortly before dying, Jarman considers that

> The virus rages fierce. I have no friends now who are not dead or dying. Like a blue frost it caught them. At work, at the cinema, on marches and beaches. In churches on their knees, running, flying, silent or shouting protest.[37]

He empirically but very truthfully defines the conditions of an epidemic, under which the distinction between the natural and the human is actually blurred even in biomedicine's understanding. In a way, the medical gaze is clouded by the popular sense that the infected person is a human host of the virus. Their cohabiting the same body transforms the body itself into a hybrid occupying an indeterminate position between nature and culture, health and disease, life and death. As Waldby states:

> All infection is imagined as hybridisation, in biomedicine, because bacteria or viruses are understood to use human bodies as sites for self-multiplication. They colonise the human body and human subjectivity, making them amalgams of the microbial and the human.[38]

However, in the case of AIDS, this process clearly results in the definite feeling of an invasion, sharply given by Jarman in many descriptions of his own diseased body. The body itself, while observed, is also included in a community of dying people sharing the same symptom and the same medical and social fate:

> It started with sweats in the night and swollen glands. Then the black cancer spread across their faces – as they fought for breath TB and pneumonia hammered their lungs, and Toxo at the brain. Reflexes scrambled – sweat poured through hair matter like lianas in the tropical forest. Voices slurred – and then were lost forever. My pen chased this story across the page tossed this way and that in the storm.[39]

This ability to share and consider his own condition within the frame of a socially authoritative discourse, supported less by biomedicine than by mis-

36 The previous year at the White Cube Gallery Marc Quinn had shown his *Self*, a head cast in his own blood. Over a five-month period, Quinn had had eight pints of blood extracted from his body (the average amount in the human body) and then, inspired by a cast of William Blake's face, he had poured it into a cast of his head, frozen and placed in a Perspex cube attached to a refrigeration unit.

37 Jarman, 'Blue', in Id., *Chroma: The Book of Colour – June 1993* (London: Century, 1994), p. 109.

38 Waldby, p. 19.

39 Jarman, 'Blue', p. 110.

understandings, misinterpretations, prejudices, and a deeply rooted repulsion for homosexuals, makes Jarman spontaneously able to detect the configurations of what Foucault calls 'bio-power'. Its most usual context is to be found in epidemics, which offer occasions and rationales for multiplying the points of intervention into the social as the locus of infection. Obviously enough, Jarman frequently passes through an individual filter. His diaries and autobiographies are forms of personal narrative, though suggesting – with varying degrees of emphasis and political commitment – the ways in which individual illness fits into larger social patterns. The artist is deeply aware, for example, that one of the most relevant difficulties in dealing with AIDS is that little is known about the disease itself and how to cure and/or defeat it. Precisely in 'Blue', Jarman reveals that:

> The worst of the illness is uncertainty. I've played this scenario back and forth each hour of the day for the last six years. Blue transcends the solemn geography of human limits.[40]

In July 1991 Jarman expresses the same feeling in a diary entry written on Thursday 4, linking uncertainty to his own personal experience in hospital:

> Spent the morning at St Mary's. My doctor had returned from an AIDS conference in Florence; Africa is facing huge problems – a health budget of twenty-seven pence per person per annum. Here things are very different, St Mary's one of the finest hospitals, patients live longer. We dwell on a little futurology, three to six years are the best forecast. On the way home I decided to try to make the millennium.[41]

In 1988, in a conversation later included in *At Your Own Risk*, while answering a question on having sex after the diagnosis, Jarman reflects on the feeling of being silenced precisely because HIV-positive:

> I used every excuse for my problems, but the real problem was that I had been hemmed in. […] My mouth is open, but my body is in prison.[42]

Here the body is given a central position. It triggers discrimination and marginalization, but is also the primary victim of AIDS, both at the physical and symbolic level. This happens because it is soon clear that the AIDS virus cannot survive outside the body and therefore infection can only occur as a result of the infected body acting on another body. What happens therefore, at the sociological and symbolic level, is that the infected subject is collectively experienced as an ally of the virus.[43] Jarman reverses this shared opinion, showing also how,

40 Ibid., p. 109.
41 Jarman, *Smiling in Slow Motion*, ed. by Keith Collins (London: Century, 2000), p. 29.
42 Jarman, *At Your Own Risk*, p. 124.
43 Waldby, p. 20.

when linked to artistic practices, AIDS, too, is made into spectacular performance:

> I've had all the opportunistic infections. I've strung them round my neck like a necklace of pearls – and survived them. The reviews of the films as 'another death work by Derek' began to look a bit silly.[44]

At the same time, Jarman is sharply aware of the physical implications of the virus, of their consequences on his artistic practices but also of the reassurance provided by medical words and attitudes:

> (Friday 29) Saw Dr Mark who said I was stoic, this cheered me up. My lungs are a bit shot up, I'm going in again tomorrow to see if there is PCP or TB lurking. My mouth is less sore and I'm sweating myself back to normal. I feel a shadow crossed my path.[45]

The clinical gaze, therefore, seems to provide an intermediary device for describing the body as a thing-in-itself and therefore producing some useful distance between the victim and his/her disease. Biomedical knowledge posits itself as referential and able to represent *objectively* the materiality of the body and its diseases. Nevertheless, in representing AIDS it soon fails to be transparent and generates a multiplicity of ambiguous discourses.

In 'Blue', Jarman lists DHPG's side effects as they appear in the patient information slip:

> The side effects of DHPG, the drug for which I have to come into hospital to be dripped twice a day, are: Low white blood cell count, increased risk of infection, low platelet count which may increase the risk of bleeding, low red blood cell count (anaemia), fever, rush, abnormal liver function, chills, swelling of the body (oedema), infections, malaise, irregular heart beat, high blood pressure (hypertension), low blood pressure (hypotension), abnormal thoughts or dreams, loss of balance (ataxia), coma, confusion, dizziness, headache, nervousness, damage to nerves (peristhecia), psychosis, sleepiness (somnolence), shaking, nausea, vomiting, loss of appetite (anorexia), diarrhoea, bleeding from the stomach or intestine (intestinal haemorrhage), abdominal pain, increased number of one type of white blood cell, low blood sugar, shortness of breath, hair loss (alopecia), itching (pruritus), hives, blood in the urine, abnormal kidney functions, increased blood urea, redness (inflammation), pain or irritation (phlebitis).[46]

Then he goes into more details when touching the fields of vision and sexual intercourse, and the distinction human/animal. The choice of words is meaningful in itself:

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44 Jarman, *At Your Own Risk*, p. 122.
45 Jarman, *Smiling in Slow Motion*, p. 133. The diary entry is dated 1991.
46 Jarman, 'Blue', p. 117. (Note 'peristhecia' should read 'paraesthesia').

> Retinal detachments have been observed in patients both before and after initiation of therapy. The drug has caused decreased sperm production in animals and may cause infertility in humans, and birth defects in animals. Although there is no information in human studies, it should be considered a potential carcinogen since it causes tumours in animals.[47]

He looks for reassurance in the mention of medical practice, suggests that the victim should take his/her own responsibility for both the disease and the cure, but finally admits confusion and therefore the failure of science to clarify:

> If you are concerned about any of the above side-effects or if you would like any further information, please ask your doctor.
> In order to be put on the drug you have to sign a piece of paper stating you understand that all these illnesses are a possibility.
> I really can't see what I am to do. I am going to sign it.[48]

Understandably – given that Jarman was an artist and a painter – the gradual loss of vision is very often mentioned, deliberately interweaving the languages of science and literature:

> My retina
> Is a distant planet
> A red Mars
> From a Boy's Own comic
> With yellow infection
> Bubbling at the corner
> I said this looks like a planet
> The doctor says – 'Oh, I think
> It looks like a pizza'.[49]

Irony is a tool to reveal the often repeated awareness that his vision will never return, but also to express an almost medical observation about the gradual steps this loss takes.

> My sight failed a little more in the night
> H.B. offers me his blood
> It will kill everything he says.[50]

The military metaphor marks the beginning and the end of Jarman's journey. In *Kicking the Pricks* he reports that he 'was jolted out of the first moments of sleep by a spasm which ravaged me like a bomb blast'.[51] In a diary entry dated March 1990, he becomes much more specific:

47 Ibid., ivi.
48 Ibid., ivi.
49 Ibid., p. 109.
50 Ibid., p. 110.
51 Jarman, *Kicking the Pricks*, p. 30.

> I've called my bug General Jaruzelski. The general gave me four bouts of the shits like explosions (Russian tanks). Then, since Citizen Antibiotic had gone on holiday, I did my sweats; but the temperature rose instead of falling. I panicked a little and asked if I could see Dr Jeannie. She put me on a saline drip. […] By 2:00 my temperature was normal, cool. The General retreated to my gut. I do not sleep at night, just doze and dream of Edward II.[52]

In 'Blue' he finally states: 'I shall not win the battle against the virus – in spite of the slogans like "Living with AIDS". The virus was appropriated by the well – so we have to live with AIDS while they spread the quilt for the moths of Ithaca across the wine dark sea'.[53] He closes his journey implicitly mentioning Ulysses and the impossibility of homecoming, symbolically denying the virus a victory that is undeniable from the medical point of view. The victim dies, killed by AIDS; but Jarman survives, resisting death through the metaphors of art.

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52 Jarman, *Modern Nature*, p. 260.

53 Jarman, 'Blue', p. 110.

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Ana Gabriela Macedo

A. S. Byatt's Storytelling Ancestors and Narrations of Science

> Headed towards death, language turns back upon itself; it encounters something like a mirror; and to stop this death which would stop it, it possesses but a single power: that of giving birth to its own image in a play of mirrors that has no limits. […] A work of language is the body of language crossed by death in order to open this infinite space where doubles reverberate.
> Michel Foucault, 'Language to Infinity' (1977)

> Stories are like genes, they keep part of us alive after the end of our story […].
> A. S. Byatt, 'The Greatest Story Ever Told' (2000)

Ventriloquism, liminality, laminations, collage, and connections are expressions frequently used by Antonia Susan Byatt in her fiction, essays, and interviews about the role of language in naming the world. Behind the writer, she argues, the avid reader is always omnipresent, driven by intense curiosity: 'It goes to something very primitive about being a reader, because my early reading was the thing that most excited me, more than my life, my friends and my family'.[1]

Far from being a 'passive pleasure', reading triggers an interior recollection, an intense concentration 'quietly and not aggressively' achieved, close to Keats' formulation of 'negative capability' and Eliot's description of the writer's creative process. In 'Individual Talent' Eliot claims that the poet's mind is 'a receptacle for seizing and storing up numberless feelings, phrases, images, which remain there until all the particles which can unite to form a new compound are present together'.[2] The 'business of the poet', therefore, requires a particular kind of concentration which is not necessarily identified with tranquility (since it does not happen 'consciously or of deliberation') but achieves something new

1 Christien Franken, 'An Interview with A. S. Byatt' (University of Utrecht, 1 March 1991, unpublished).

2 T. S. Eliot, 'Tradition and the Individual Talent', in *Selected Prose of T. S. Eliot*, ed. by Frank Kermode (London and Boston: Faber, 1975), p. 41.

resulting from the concentration in which 'impressions and experiences combine in peculiar and unexpected ways'.[3]

Farce, parody, and pastiche are fundamental features of Byatt's poetics, deeply imbued with the notion that reading is a most reverential act. The perfect reading was accomplished by Borges in the short story 'Pierre Menard, autor del *Quijote*' (1939), in which the protagonist rewrites *Don Quixote* word by word in the twentieth century (a method Borges claims to adopt with all his favourite writers).

By arguing that the novel is a comic genre, Byatt means that it thrives on a perception of reality constructed in opposition to tragedy. As for her own capacity to create humorous situations, self-ironically she declares: 'I always think of myself as a person not with great quick verbal wit, but as a rather stolid Quakerly person'.[4]

The writer is always a fabulator, fabricating stories even when the novel is biographical or autobiographical, such as Virginia Woolf's *Orlando: A Biography* (1928), the allegory of the 'new biography' originating from what Woolf defined as a 'perpetual marriage of granite and rainbow', or metafictional, as John Fowles's *The French Lieutenant's Woman* (1969). Byatt also cites the short story 'Sugar', her only autobiographical fiction, in which it is almost impossible to draw a straightforward distinction between fiction and reality:

> It was as true as it could be. It left out quite a lot of things that could have been put in that would have made it more true. It says that, *'I select and confect'* (I got this perfect word 'confection' from my mother's stories and my grandfather's profession which was making sugared sweets) but it didn't consciously say anything I thought was untrue.[5]

Possession, the novel for which she was awarded the Booker Prize in 1990, thrives on a finely woven web of scholarly quotations and parodies of Victorian poems and letters. The writing of *Possession* is thus not necessarily what Fredric Jameson would call a nostalgic act, but rather a loving one, involving a *deferred passion* for the numerous texts and authors named in her essays 'Fathers', 'Forefathers' and 'Ancestors'.[6] For Byatt being a writer entails a narcissistic and self-referential attitude and a desire to experiment with genres, rhetorical strategies, and narrative processes. The very word possession thus acquires a literal and a metaphoric sense, which the author, eager to achieve a multifaceted view, incessantly dissects and analyses as if it were a true, scientific experiment. The metafictional process defined by Linda Hutcheon as a 'representation of

3 Ibid., pp. 42 – 43.

4 Franken, 'An Interview with A. S. Byatt'.

5 Ibid., ivi, my emphasis. See also A. S. Byatt, 'Sugar', in Ead., *Sugar and Other Stories* (London: Chatto & Windus, 1987), p. 241: 'I make a profession out of fiction. I select and confect.'

6 Byatt, *On Histories and Stories. Selected Essays* (London: Chatto & Windus, 2000).

writing as representation'[7] is the core of Byatt's labyrinthine novel. Her vertiginous mode of writing is described by Frederica Potter, the protagonist of *Babel Tower* (1996)[8] and a surrogate author:

> Laminations. Cut-ups are part of it. It is a form that is made partly by cutting up, breaking up, rearranging things that already exist. […] The point of words is that they have to have already been used, they have not to be new, they have to be only rearrangements, in order to have meaning.[9]

Byatt enunciates a narrative strategy which, although grounded on memory and experience, is not to be confused with a nostalgic mode or a mere craving for the past. It is the avowal of a contemporary poetics, acutely in tune with the disruption of the present mode of existence and, at the same time, well aware of the limitations and the fractured perception of reality that any writer can give. Much of contemporary literature dwells on this paradox. Byatt's statement represents a metaphorical coming to terms with both the aesthetics of realism and postmodernism, creating a self-reflexive ambivalence that is constantly restaged in her writing.[10]

While discussing in detail the genesis and creative process of her novel *Possession*, she offers illuminating clues about the effects of reverberation achieved through her rewriting of fairy tales and mythic narratives. 'Laminations' are here clearly defined as a palimpsest drawing on pastiche, *mise en abyme*, and self-referentiality:

> My fairy stories are postmodern, in that they reflect on the nature of narrative, and of their own narrative in particular. Narration is seen as the goal as well as the medium – the heroines tend to be narrators, not only the Old Lady and the Eldest Princess, who cure the creatures with a fairytale version of Freud's 'Talking Cure', but the youngest princess, too, who is given a Thread by the Old Woman, to follow out of the orchard. *I associate weaving and embroidery and tapestry with the art of narrative*, too – the Tailor sews, and Eva in 'Dragons' Breath' makes carpets. My narrators, Gode, Christabel, Matty, Matty's creation, Miss Mouffet, *narrators within narrations*, resemble each other as self-conscious narrators. But whereas much post-modern, self-reflexive narrative seems somehow designed to show that all narrations are two-dimensional and papery,

7 Linda Hutcheon, *The Politics of Postmodernism* (London and New York: Routledge, 1989), p. 48.

8 Byatt, *Babel Tower* (London: Vintage Books, 1997). On this same topic see Margarida Esteves Pereira, 'Refracting the Past in Praise of the Dead Poets in *Possession:* A *Romance'*, in *Refracting the Canon: Contemporary British Literature and Film*, ed. by Susan Onega and Christian Gutleben (Amsterdam and New York: Rodopi, 2004), pp. 149 – 164.

9 Byatt, *Babel Tower*, p. 384.

10 Elisabeth Bronfen, 'Romancing Difference, Courting Coherence: A. S. Byatt's *Possession* as Postmodern Moral Fiction', in *Why Literature Matters: Theories and Function of Literature*, ed. by Rüdiger Ahrens and Laurenz Volkmann (Heidelberg: Universitätsverlag C. Winter, 1996), pp. 117 – 134.

> that all motifs are interchangeable coinage, what I believe, and hope to have shown, is that *the tale is always stronger than the teller.*[11]

Byatt openly exhibits her creative technique in a relentless self-examination, a sort of 'psycho-drama', as if to leave no doubts concerning the awareness of the symbiotic nature of her own creative process.

Two apparently contradictory, but actually complementary issues epitomise the essays and lectures in *On Histories and Stories. Selected Essays* (2000). In 'Old Tales, New Forms' she claims:

> I said earlier that storytelling was to do with death and biological time, with our own beginnings, middle and ends. I said also that stories, and story-webs, often carry within themselves images of infinity which contradict the linear narrative. There is a particular group of images of infinity, besides tentacles and spider-webs, that suggest a bad infinity, a trap. These are mirrors, which go with one aspect of death.[12]

In 'Ancestors' she associates the narrative technique adopted by George Eliot (one of Byatt's crucial 'ancestors') with that of 'natural histories', a term she gets from Eliot herself. Byatt focuses on the design, the composition, and the 'artistic coherence' of the novels *The Mill on the Floss* (1860) and *Middlemarch: A Study of Provincial Life* (1871 – 1872), to conclude that Eliot observes the human community 'with a Darwinian naturalist's eye'.[13] Eliot's 'natural histories' emphasize the 'gradual operation of natural laws which is her image of time and the comparison, and relation, of human beings to the creatures […]'. Byatt proposes that Eliot sensed *avant la lettre* what DNA shows – 'that all living forms are quite closely related'.[14]

Stories, like mirrors, suggest, or rather, fabricate infinity (while they posit death as a paradoxical limit); observation of human nature in our post-Darwinian world requires a 'naturalist's eye', which produces major effects on the form and content of much current fiction, such as the development of a new kind of 'historical novel', despite a slow process of 'resistance' and 'adaptation'. John Fowles's *The French Lieutenant's Woman*, Graham Swift's *Waterland* (1983) and *Ever After* (1992), Julian Barnes's *A History of the World in 10*$^{1}/_{2}$ *Chapters* (1989) and Ian McEwan's *Enduring Love* (1997) provide outstanding examples of the genre.

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11 Byatt, 'Fairy Stories: The Djinn in the Nightingale's Eye', in *On Herself*, <http://www.asbyatt.com/Onherself.aspx> [accessed 16 June 2011], my emphasis.

12 Byatt, 'Old Tales, New Forms', in Ead., *On Histories and Stories*, p. 148.

13 Byatt, 'Ancestors', in Ead., *On Histories and Stories*, pp. 65 – 90 (p. 66). Here Byatt is also drawing on George Eliot's essays from the collection *George Eliot, Selected Essays, Poems and Other Writings*, ed. A. S. Byatt and Nicholas Warren (Harmondsworth: Penguin Classics, 1990). She refers, amongst others, to Eliot's 'Ilfracombe Journal' (8 May – 26 June 1856) for the detailed observation of human habitations.

14 Byatt, 'Ancestors', pp. 66 – 67.

The new paradigm of the intricacy of 'form and subject' in novel writing is discussed in detail in the already mentioned essay 'Ancestors':

> Recent discoveries about the great extent to which DNA patterns are shared by all creatures have perhaps changed writers' ideas of the natural world, and have certainly modified my choice of *difference* as the important thing to look at.[15]

Byatt's obsession for detail, multi-perspectival analysis, re-proposition of the subject and object of her writing, and almost excruciating addiction to sources and cross-references make her writing not only an easy target of 'the post-modern critic', but also a vivid demonstration of the case she argues for. Evidence can be found in most of her work, from *Possession* (1990) to *Babel Tower* (1996*)* and the *Biographer's Tale* (1999). The novella 'Morpho Eugenia' included in *Angels and Insects* (1992) illustrates the (im)possibility of the dialogue between science and religion, embodied in the text through an explorer and naturalist's view of the world and that of a clergyman and creationist's. The themes of instinct, sexual drive, and desire that traverse this text are crucial allegories of a more subtle argumentation, concerning an entomologist's belief that the concepts of beauty and perfection pertain to the 'natural' world order and not to a divine plan or jurisdiction. This topical confrontation of the world of instincts, reason, common sense, and emotions is shared by many of the writers whom Byatt chooses to name her 'ancestors', such as Eliot and Thomas Hardy, or contemporaries such as Fowles, McEwan, Swift or J. M. Coetzee. In 'Ancestors' Byatt makes a claim against a 'nostalgia for existential crisis' and states instead her praise for scientific curiosity, while she declares (with some theatrical pose): '[…] I write about scientists because they do not spend their time deconstructing the world, or quibbling theologically about abstract terms of value'.[16]

In the tale 'The Djinn in the Nightingale's Eye' from *Five Fairy Stories* (1994) Gillian Perholt, a contemporary narratologist, herself a version of Chaucer's Patient Griselda in *The Clerk's Tale*, Shakespeare's Hermione in *The Winter's Tale*, and ultimately a parodic mirror image of the author/narrator of this story, like Scheherazade weaves her own life in the thread of the story she tells.[17] The labyrinthine plot – achieved again through a complex series of 'laminations' – is thus not just about 'character and destiny and sex in the folktale', as the narrator impersonally flaunts, but more poignantly about 'the lives of women in the frame story', as she adds in a more subdued tone.

Byatt's defence of reading as a greedy practice and the addictive pleasures of language allow for deciphering 'The Greatest Story Ever Told', devoted to *The*

15 Ibid., p. 80, my emphasis.
16 Ibid., p. 79.
17 A. S. Byatt, 'The Djin in the Nightingale's Eye', in Ead., *The Djin in the Nightingale's Eye: Five Fairy Stories* (New York: Vintage Books, 1994), p. 121.

Thousand and One Nights and included as the last chapter of *On Histories and Stories*. Here she develops a narcissistic cross-reference to Scheherazade:

> This story has everything a tale should have. Sex, death, treachery, vengeance, magic, humour, warmth, wit, surprise and a happy ending. It appears to be a story against women, but leads to the appearance of one of the strongest and cleverest heroines in world literature, who triumphs because she is endlessly inventive and keeps her head. The *Thousand and One Nights* are stories about storytelling – without ever ceasing to be stories about love and life and death and money and food and other human necessities. *Narration is as much part of human nature as breath and the circulation of the blood.*[18]

Byatt dedicates the next few pages of this essay to prove her argument. She claims that storytelling, often thought of as a 'vulgar' or primitive form of narrative, is a major literary form, since it is 'intrinsic to biological time, which we cannot escape',[19] and therefore crucial to life. 'Storytelling in general, and the *Thousand and One Nights* in particular, consoles us for endings with endless new beginnings.'[20] Like Scheherazade, we live coping with the imminence of death penalty, and the function of narrative is to create the illusion of life, 'a false eternity, a circular time-loop',[21] and adjourn death, because 'stories are like genes, they keep part of us alive after the end of our story'.[22] There have been many storytellers of perfect or almost perfect stories, who have reshaped Scheherazade's stories, nurturing humankind with that lure of life. 'Scheherazade's tales have proliferated, like germ-cells, in many literatures',[23] in Ovid's *Metamorphoses* (8 AD), Chaucer's *Canterbury Tales* (end of the 14th century), Boccaccio's *Decameron* (1350 – 1351/1353), Cervantes' *Don Quixote* (volume I published in 1805, volume II in 1815), Jean Potocki's *Saragossa Manuscript* (1805 – 1813), in the fiction of Salman Rushdie and Naguib Mahfouz, both under penalty of death for the very power engendered by their stories; in the novels by Marcel Proust, constantly postponing his death for the sake of writing an endless book. 'Narrate or die is the imperative'[24] for Proust's narrator as well as for Scheherazade. In America, first Edgar Allan Poe, later John Barth 'have been tempted to write the *Thousand-and-second Tale*';[25] Italo Calvino and Jorge Luis Borges (the closest of all to Byatt) conjure up 'an illusion of inexhaustibility'.[26]

18 Byatt, 'The Greatest Story Ever Told', in Ead., *On Histories and Stories*, p. 165 – 166, my emphasis.
19 Ibid., p. 166.
20 Ibid., ivi.
21 Ibid., p. 168.
22 Ibid., p. 166.
23 Ibid., p. 167.
24 Ibid., p. 170.
25 Ibid., p. 168.
26 Ibid., ivi.

Byatt ends her essay by recollecting a night different from all others, called 'Scheherazade 2001':

> During the bombardment of Sarajevo in 1994 a group of theatre workers in Amsterdam commissioned tales, from different European writers, to be read aloud, simultaneously, in theatres in Sarajevo itself and all over Europe, every Friday until the fighting ended. This project pitted storytelling against destruction, imaginative life against real death. It may not have saved lives but it was a form of living energy.[27]

Storytelling is thus a form of 'living energy' against stale life, death, war, and destruction, just like the blood circulating in human veins is a pledge of life. Byatt often uses the antinomy 'living energy' and 'stopped energy' to signify the human struggle for survival in adversity, where ice, cold, and numbness are both metaphors and physical symptoms of 'ill health' opposed to vivaciousness, luminosity, and prodigality. 'The Djinn in the Nightingale's Eye' is a perfect illustration of that belief, which finds numerous reverberations in various other tales and fairy stories of hers, such as *Elementals: Stories of Fire and Ice* (1999). Scheherazade's *Thousand and One Nights* is in this sense truly paradigmatic, since through the power of her storytelling she both creates life and defers death, which again explains why her infectious stories 'have proliferated, like germ-cells, in many literatures', as Byatt maintains.

'Scheherazade 2001', the episode narrated by Byatt in the essay tellingly named 'The Greatest Story Ever Told', stands as a new testimony to the endless vitality of Scheherazade's tales, their never-ending power of cross-fertilization and 'contamination'. A true reinvention of the *power of narration*, ephemeral and utopian, as Borges suggests, but not, for that reason, less effective:

> I know of an uncouth region whose librarians repudiate the vain and superstitious custom of finding a meaning in books and equate it with that of finding a meaning in dreams or in the chaotic lines of one's palm. […] They admit that the inventors of this writing imitated the twenty five natural symbols, but maintain that this application is accidental and that the books signify nothing in themselves. This dictum, we shall see, is not entirely fallacious.[28]

Circularity and permanent movement evoke 'images of infinity which contradict the linear narrative'[29] and potentially open up a 'babelean' space of transgression and freedom, a notion constantly explored by Byatt. In that labyrinthine space the rules of language defy death, silence, and timelessness, as noted by Michel Foucault in the essay 'Language to Infinity':

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27 Ibid., p. 171.

28 Jorge Luis Borges, 'The Library of Babel', in Id., *Labyrinths: Selected Stories and Other Writings* (Harmondsworth – New York: Penguin Books, 1981), p. 80.

29 Byatt, 'Old Tales, New Forms', p. 148.

> Writing so as not to die, as Blanchot said, or perhaps even speaking so as not to die is a task undoubtedly as old as the word. The most fateful decisions are inevitably suspended during the course of a story. We know that discourse has the power to arrest the flight of an arrow in a recess of time, in the space proper to it.[30]

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30 Michel Foucault, 'Language to Infinity', in Id., *Language, Counter-Memory, Practice. Selected Essays and Interviews*, ed., with an Introduction, by Daniel F. Bouchard (Ithaca, NY: Cornell University Press, 1980), p. 53.

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Gastone C. Castellani / Enrico Giampieri

Modelling Bistabilities that Link Macro and Microscopic Biological Phenomena

The novella 'Morpho Eugenia' (1992) is set at the time of the publication of *On the Origin of Species* (1859) and contains many points of discussion between evolutionism and creationism, most manifest in dialogues between the explorer and entomologist Adamson and the reverend father of Eugenia. The story thrives on Antonia Byatt's fascination for the naturalistic descriptions of the insect society and its similarities with human society:

> I have been obsessed with insect life for many years – especially with the life of ants, and the way in which human beings have anthropomorphised their societies and natures, making morals out of the 'sacrifice' of the infertile female 'workers' as opposed to the 'powerful' egg-laying queen, for instance, or speculating about where the source of decision-making really lay in an antheap – in the individual or the 'mind of the nest'.[1]

Byatt's remark that some organizational modules of ant behaviour are conserved across insects and humans is particularly relevant. Scientists in the field of biophysics are interested in the search for general laws formulated in a quantitative and mathematical way, capable of predicting behaviour found in nature. Biophysics aims to be a science of fundamental laws underlying the structure, functioning, and development of living systems. Along with experimental methods, it actively uses mathematical models to describe and predict processes in living systems at various organizational levels, starting with biomacromolecules, moving up to the cellular and subcellular level, to levels of organs, organisms, populations, communities, ecosystems, and finally to the level of the biosphere.

One of the principal objectives in contemporary biophysics and systems biology is to link local and microscopic phenomena, such as production of molecules and species growth, to global properties, such as 'social' organization and/or emergence of specialization, tasks subdivision and resources reallocation. This emergence process is dynamic and modular by definition. The sim-

1 A. S. Byatt, 'Angels and Insects', in *On Herself*, <http://www.asbyatt.com/Onherself.aspx> [accessed 16 June 2011].

plest modules from a mathematical point of view are those describing the dynamics of isolated populations. Their specification, we believe, can be used in the description of population dynamics as well as in the description of cellular and biochemical processes.

In the last few years theoretical studies have re-vitalized the classical theory of evolution. The theory of molecular evolution differs from the Darwinian framework in the importance it ascribes to genetic drift as opposed to the selection principle. The neutral theory of molecular evolution (NTME) states that mutations are neutral and their selection (or fixation) is predominantly due to random drift. NTME was introduced by Motoo Kimura in the late 1960s and it attributes a large role to genetic drift and may be derived by elegant mathematics starting from diffusion and Fokker-Planck equations.[2]

Moreover, the NTME assumes that the genetic drift is driven by random sampling of gene variants, as earlier postulated by Sewall Wright, and consequently by fluctuations that are more relevant in a small population than in larger ones. One of the fundamental differences from classical evolution is that there is no selection process, but all the allele frequencies can be variated as a function of time and that some frequencies can become zero.

The probabilistic foundation of the Kimura work permits the use of the Kolmogorov backward equation to allow the calculation of the probability of a gene becoming fixed in a population (an achievement praised by S. Wright and J. B. S. Haldane). The diffusion formulation of the NTME allows patterns of genetic activity to be obtained which are similar to those from the famous Turing morphogenetic equations, also known as reaction diffusion equations.

The mathematical study of animal communities is a classic focus of biophysics and mathematical biology and has been developed by several scientists, including Thomas Malthus, Pierre-François Verlhust, Alfred James Lotka, Vito Volterra, and May. The contribution of animal and human reproduction rates was acknowledged by Darwin in *On the Origin of Species*, in which he made explicit reference to the Malthusian model of population growth. In essence, the Malthus model was an autocatalytic model of growth, resulting in a kinetics without limitation (in principle the population can grow to an infinite size), and in this respect to modern ways of thought it is an unrealistic model; but its merit is that it was the first model of population growth.

The Verhlust version of population growth, a contemporary model, is based on a logistic model and is the first to propose a limitation in population growth. Roughly speaking, the limitation is introduced by a term accounting for the

2 Motoo Kimura, 'Evolutionary Rate at the Molecular Level', *Nature*, 217, 5129, 17 February 1968, pp. 624–626; Id., *The Neutral Theory of Molecular Evolution* (Cambridge: Cambridge University Press, 1983).

density of the population. The Verhulst model can be interpreted in terms of the stability properties of two possible solutions: the solution where the population declines to zero and the solution where the population reaches a saturation value.

The model variable N (N(t)) is a function of time and represents the number of individuals of a given population (the population size), the parameters r and K respectively being the reproduction rate and the 'carrying capacity' of the population, i. e. the size that a certain population, in a given environment with assigned resources, can sustain indefinitely.

$$\frac{dN}{dt} = rN\left(1 - \frac{N}{K}\right) \qquad (1)$$

$$N(t) = \frac{K}{K + CKe^{-rt}} \qquad (2)$$

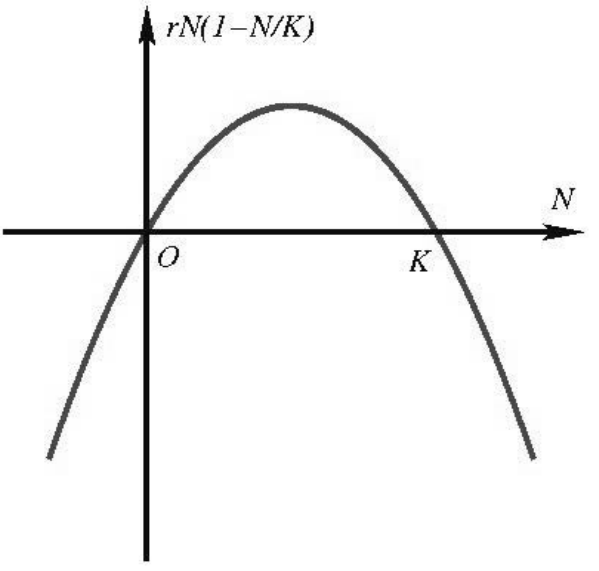
The equations (1) and (2) are, respectively, the evolution law and the time-dependent solution for population growth.

Equation (1) states that the population size increases as a function of its size (the rN term) and decreases as a function of N^2 (the term r/K N^2). The parameter K, the carrying capacity, indicates the maximum population size that can be hosted in a given environment with optimal conditions of food, water, and necessary resources for an indefinitely long time. Equation (2) is the solution of the differential equation (1): C is determined by the initial conditions, the number N at the initial time N(0); the population size N(t), as a function of time, varies in a sigmoidal way and reaches a maximal value K. This kind of behaviour (the sigmoidal trend with a saturation) is of great importance. From a general point of view, several biological phenomena follow a 'saturated dynamics' pattern: the populations cannot increase their size without an upper bound, the physiological responses show a sigmoidal dependence from the stimulus.

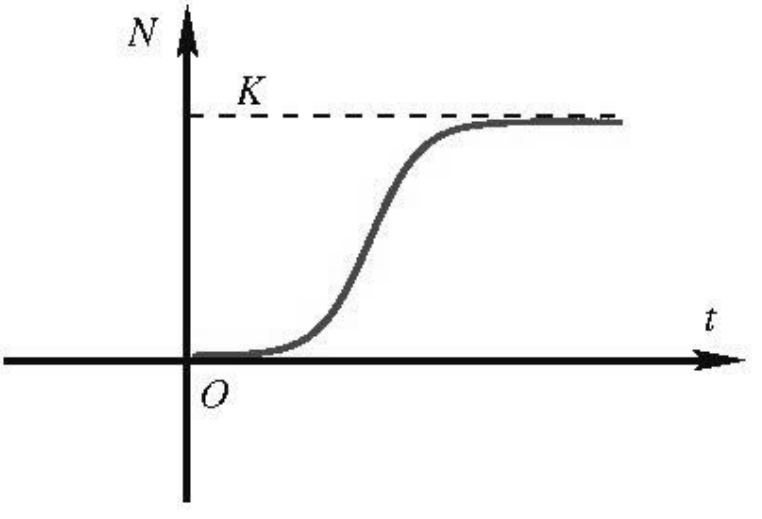
Lotka-Volterra equations extend the Verhulst model by introducing classical predator-prey considerations which provide two principal improvements over Verhulst: 1) The basic Volterra model is for two species whereas the Verhulst model is for a single species; 2) The Verhulst model can, in a Volterrian way, be extended to n species models.

The simplest of these models, the model of selection on the basis of competitive relations, works by considering a number of possible competitive interactions, for example, of biochemical compounds of various types of optical activity, competing cells, species, and populations.

Modifications describing competition in the economy can be applied in the model. For example, let us consider two species, one the prey and the other the predator. Their proliferation rates are different and the model of their temporal evolution can be written as:



Plot of the right member of equation (1), which states that the population size increases as a function of its size (the rN term) and decreases as a function of N^2 (the term r/K N^2).



Plot of equation (2), which shows that the population size N(t), as a function of time, varies in a sigmoidal way and reaches a maximal value K.

$$\begin{aligned} \frac{dx}{dt} &= ax - bxy \\ \frac{dy}{dt} &= cxy - dy \end{aligned} \qquad (3)$$

where
y is the number of some predator (for example, wolves);
x is the number of its prey (for example, rabbits);
dx/dt and dy/dt represent the growth of the two populations over time;
t represents time; and a, b, c and d are parameters representing the interaction of the two species.

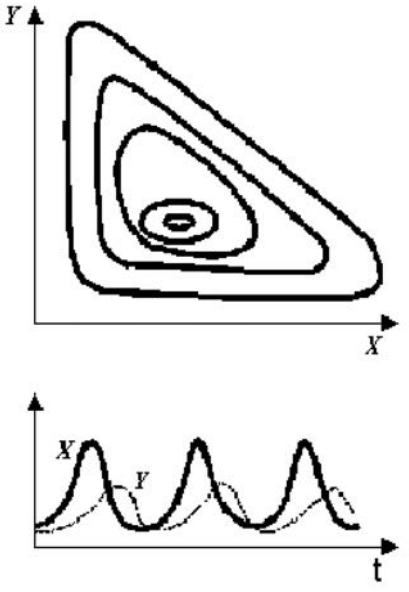
The classic Volterra equation characterises predator-prey interactions as continuous oscillations that cannot be described by simple trigonometric functions. The stability properties of the model can be assessed in linear stability analysis, from which it is possible to see that there are two fixed points, one at a saddle point and the other with purely imaginary eigen values. Stability analysis tells us that one point is unstable but the saddle point indicates that the extinction of both species in this model is unlikely to occur. It takes place only if prey are completely eradicated, causing the predators to die of starvation (if the predators are eradicated, the prey population grows without bounds in this simple model). Fortunately, the system admits a constant of motion, which means that there are closed solutions (closed trajectories) surrounding the fixed points. Consequently, the levels of the predator and prey populations cycle and oscillate around the fixed points.

The Lotka-Volterra equation can be extended to an *n*-species network model which is the basis for applications such as neuronal networks and immune network models.

The *n*-species Lotka-Volterra model can be modelled as a network equation where the i-th species interacts with all other species as shown by the a_{ij} term which reflects what is referred to as the 'connectivity' (i. e. the average number of connections) of the model.

$$\frac{dx_i}{dt} = x_i\left(\sum a_{ij}x_j - m_i\right)$$

where
x_i is the i-th species;
t is time;
$\sum a_{ij}x_j$ is the interaction term with all the other species and depends on the values of the a_{ij} parameters;
m_i is a decay term that represents the death of the i-th species.



Closed trajectories and time-dependent solutions of Lotka-Volterra equations.

From these kinds of considerations and also from more refined versions of the models, it is possible to show that there is an emergence of organisation that is mapped in a connectivity structure. In this case, the connectivity coefficients are no more constant as a function of time, but they are updated by an ad hoc evolution equation.

These kinds of models can be used, with a few adjustments, to describe immune system development, the growth of neuronal synapses, and the formation of neuronal network.

The fact that the mathematical description of these complex phenomena is similar generates a question: what are the commonalities, in terms of basic law, among these processes? In other words, can network structures be described within a common mathematical schema and does such a description evidence some general, universal law? We believe that this is the case and that the basic forces are, among others, nonlinearity, competition, stochasticity, and noise induced transitions (bistability or multistability) between population sizes, which drive the emergence of structures and organization in different contexts, such as ecological, immune, and neural systems.

Concepts of competition and network interaction are now pervasive in biophysics and systems biology, and point the way towards grasping the complexity of biological systems which, applied to a single neuron, are described by a well-

known equation, the Bienenstock-Cooper-Munro model (or BCM theory), which mathematically formalizes competition between a single neuron's synapses:

$$\frac{dw_i}{dt} = \phi(y, \Theta_m)x_i \quad \Theta_m = E_\tau[y^2] \quad with \quad \lim \Theta_m = y^2$$

where the x_i is the activation intensity of each synapse with a connection strength of w_i and y is the total neuron activation function of the whole system of synapse activation.

BCM is focused on a so-called 'moving-threshold' of activation: those synapses which are activated by the stimulus over this threshold are potentiated, while those which are below it are depressed.

The concept of moving threshold of synapse modification offers several advantages:

1. The moving threshold depends on the neuronal past history in a non-linear way. This dependence allows both competition and memory formation in terms of formation of stable states (bistability and multistability).
2. The interpretation is straightforward: when the threshold is on the left (close to zero) it will be easier to obtain synaptic modification (at low frequencies); and when the threshold is shifted to the right, the induction of plasticity will require higher frequency of stimulation.

After a neuron spikes, the threshold adjusts itself to the average of the intensity of the spike and previous spikes. This feedback between synapses and moving thresholds generates a selection between those synapses that maximizes the signal, turning down all the others.

With approximation of two-time scales between activation and learning, we can synthesize the selection rule in a form that is close to a logistic equation:

$$\frac{dx_i}{dt} = x_i\left(x_i - - \sum x_j^2\right) \qquad (4)$$

where the x_i is the synapse intensity and the sum over the x_i squared is a simple form of implementing the moving threshold.

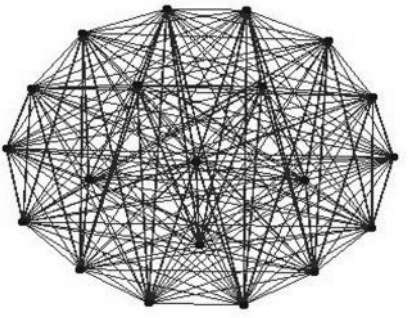
We can now modify this formula using the same approach adopted with the n-species Lotka-Volterra model and introduce an interaction network between each synapse from neuron i to neuron j, where a_{IJ} is a negative symmetric matrix:

$$\frac{dx_i}{dt} = x_i\left(x_i - - \sum a_{ij}x_j^2\right)$$

This equation does not show oscillatory behaviour; instead it exhibits multiple stable configurations, depending on the starting point of the system. The system behaviour is totally determined by the initial conditions and the interaction network.

The absolute values of each of the a_{ij}-a_{ji} pairs uniquely determine the accessible stable configuration of the system, starting from a few points where only one link survives the selection, moving to a large number of stable configurations, when the competition between links is small enough to take account of a greater number of survivors.

The pattern of the non-zero pairs determines the final network topology: similar to the world wide web network or the interaction network of a cell's proteins, a clear example of how much the structure of the interaction in a system determines the final system, as much as it is also determined by the specific interactions between each couple of elements.



Network topology.

By increasing randomly the probability of connections between nodes, it is possible to show there is a critical threshold and that values of connectivity above this threshold are responsible for a transition of the graph from a disconnected to a fully connected phase.

An interesting example of connectivity of the network becomes clear in showing how connectivity can influence its behaviour. A Random Graph is a set of nodes and edges which are connected. The classical temporal evolution of a Random Graph is a process in which links are added randomly between nodes within the graph.

If the number of edges and their nodes attachments is chosen randomly with a certain probability p, it can be shown a critical probability p_c exists for the appearance of a giant cluster (phase transition) $p_c \sim N^{-1}$ (where N is the dimension of the network) and the degree of connectivity distribution (the number of edges of each node) follows the Poisson distribution.

The major statistical results on Random Graphs are summarized by the so called 'Small World' and 'Scale free' graphs. The 'Small World' graphs interpolate between regular lattice and Random Graphs. The 'Scale Free' network is created by two simple rules: network growth and preferential attachment (the most connected nodes are the most probable sites of attachment). Both models give a non-Poisson distribution: the so called Power Law. Moreover, this type of distribution has been observed in real networks, such as the Internet and the brain metabolic network of Caenorhabditis Elegans. Finally, these kinds of models are capable of reproducing, and hence predicting, bistability as a function of numerical parameters that can be measured experimentally.

Bistability behaviour is important and ubiquitous in biological systems and has been invoked as 'switches' capable of triggering the transition between phenotypes, a bistable switch being the prototype of memory at the molecular level. It can also be used for the construction of microscopic models.

Finally, regarding the role of noise, it is important to notice the molecularity of these processes and the low number of molecules in them requiring a stochastic description that goes beyond the formalism of differential equations. In the last few years, a powerful method has been developed called 'Master Equation', a probabilistic equation with a solution that itself has a probability distribution. So the solutions to it carry a probability to be observed, given the number of molecules in a given state. This kind of approach offers new insight into the role of noise in biological systems and provides new tools for the interpretation of the biological variability.

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Patrick Parrinder

Satanism and Genetics: From *Frankenstein* to J. B. S. Haldane's *Daedalus* and Beyond

There is nothing the contemporary media love more than a story about unusual, and preferably 'unnatural', childbirth. In early 2009, for example, an unmarried mother in California gave birth to octuplets, an event described in one British Sunday newspaper as a 'midwinter miracle'.[1] But the miracle became a source of moral panic when journalists discovered that the mother already had six children by different fathers, that she had no visible means of financial support, and that the octuplets had grown from embryos implanted in a fertility clinic. A second story, which induced moral panic not only in the media but among prominent politicians including the Leader of the Opposition, was the birth of a child to a 15-year-old girl and, supposedly (since his paternity was subsequently disputed), a 12-year-old boy. Some of us may have thought that for a 12-year old boy in modern European society to get his act together sufficiently to conceive a child was a bit of a miracle, but that feeling was wholly alien to the British press in one of its proverbial fits of morality. These two examples suggest that public attitudes to procreation hover between the extremes of natural magic and moral panic; but in either case, this essay will argue, our sense of the godlike power of human science is likely to be shadowed by the primitive mythological figure of Satan. In the Western tradition to think about Eve, the Mother of Mankind, is also and inevitably to think about evil.

The process by which the Californian mother of octuplets became pregnant was that of IVF treatment – *in vitro* fertilisation – or, to use an older scientific term, ectogenesis: fertilisation outside the womb. The widespread practice of ectogenesis in the late twentieth and twenty-first centuries was foreseen in a famous and influential short book by the geneticist J. B. S. Haldane, *Daedalus; or, Science and the Future*, first published in 1923. Haldane's *Daedalus* directly influenced the portrayal of genetic engineering in Aldous Huxley's *Brave New*

1 Paul Harris, 'A Bidding War and a Row over Ethics: How the Octuplets Story Turned Sour', *The Observer*, Sunday 1 February 2009, <http://www.guardian.co.uk/world/2009/feb/01/suleman-octuplets-row> [accessed 16 June 2011].

World (1932), where new infants are produced by the 'Bokanovsky process', a form of cloning. Haldane predicted that ectogenesis would be condemned both by the Catholic Church and by an Islamic 'fatwa'. Not only did he expect it to be a cause of moral panic, but he believed that, beginning with dairy farming and the making of fermented liquors, every significant biological innovation in human history must at first have been regarded as 'indecent and unnatural': 'There is something slightly disgusting in the idea of milking a cow electrically or drinking beer out of tea-cups. And all this of course applies much more strongly to the sexual act'. A biological invention such as contraception begins as a 'perversion' but ends as a 'ritual supported by unquestioned beliefs and prejudices'.[2] Not surprisingly, for Haldane the main enemy of biological innovation was established religion. He was a lifelong rationalist and humanist for whom there could be no compromise and 'no truce between science and religion'.[3] (It may be more than a coincidence that his chief present-day successor as a public spokesman for militant scientific atheism is another genetic theorist, Richard Dawkins.)

Haldane, who died in India in 1964, wrote about genetics and the prospect of genetic engineering throughout his life, but, as one of his students has written, the 'passionate and bold imagination […] he displays […] in *Daedalus* was never to be seen again',[4] at least in his scientific non-fiction, since he was also an occasional writer of science fiction.[5] *Daedalus* shows his extraordinary combination of literary and scientific talents. Although a brief essay of less than 12,000 words, it is a fascinating and complex text deserving extensive quotation and commentary. Several pages are taken up with the science-fictional device of an undergraduate essay supposedly written in the year 2074 and summarising the main developments in biology in the previous 150 years. Haldane had read *Literae Humaniores* at Oxford, he was famous for quoting Dante and Lucretius in his scientific papers, and in his last years he wrote an unfinished science-fiction novel which was published posthumously. Titled *The Man with Two Memories*, it is typical in the demands it places on readers. There are quotations in classical Greek, from Milton's Latin verse, and from Dante in the original Italian, all with no translation given. The novel describes a genetically-engineered parallel world based in some way on Blake's prophetic books, and at one point the extra-terrestrial narrator expresses the hope that he will manage to complete a com-

2 J. B. S. Haldane, *Daedalus; or, Science and the Future* (London: Kegan Paul, Trench, Trubner, 1924), pp. 46, 49.

3 Ibid., p. 90.

4 Krishna R. Dronamraju, 'Introduction' to *Haldane's* Daedalus *Revisited*, ed. by Id. (Oxford: Oxford University Press, 1995), p. 1.

5 See Patrick Parrinder, 'Siblings in Space: The Science Fiction of J. B. S. Haldane and Naomi Mitchison', *Foundation*, 22 (1981), 49 – 56.

mentary on Blake.[6] Milton too was one of Haldane's favourite authors from childhood onwards,[7] and he was well aware of Blake's famous comment in 'The Marriage of Heaven and Hell' that Milton was 'a true Poet, and of the Devil's party without knowing it'. When in *Daedalus* Haldane describes the biologist as 'the most romantic figure on earth at the present day', he intends the full sense of the word 'romantic'.[8]

Daedalus originated as a paper read to the Heretics society in Cambridge, but it became well-known as the first volume in an extraordinary series of prophetic essays, the 'Today and Tomorrow' series edited by C. K. Ogden and published by Kegan Paul. These volumes from the 1920s are by writers ranging from Sir James Jeans and Bertrand Russell to Robert Graves and Hugh MacDiarmid. Each volume (with very few exceptions) has a classical title, prefacing an outline of contemporary thought with a certain degree of wit and erudition. *Daedalus*, for example, met with a sceptical response in Number Two in the series, which was Bertand Russell's *Icarus; or, the Future of Science.* (Another memorable title is Graves's *Lars Porsena; or, the Future of Swearing*, in which the implied reader clearly has no difficulty in recalling Macaulay's quotation about Lars Porsena of Clusium.) Why, then, did Haldane choose Daedalus as his emblematic figure? He begins his essay by outlining possible future developments in physics and chemistry, remarking that 'the chemical or physical inventor is always a Prometheus'; we remember, of course, that Mary Shelley's Frankenstein was the 'modern Prometheus'. Nevertheless, Haldane continues, 'the sentimental interest attaching to Prometheus has unduly distracted our attention from the far more interesting figure of Daedalus'.[9]

Whether or what exactly Haldane knew in 1923 about James Joyce's Stephen Dedalus, I wish I could say; however, *Ulysses* (1922) and its characters were already familiar in at least some of the circles to which Haldane had access. For Joyce, who signed some of his first published works with the name Daedalus, the Greek hero was the 'fabulous artificer' and principally the inventor of flying.[10] For Haldane, however, he was a genetic engineer whose greatest triumph was the invention of the wooden apparatus that enabled Queen Pasiphae of Crete to copulate with Poseidon's white bull. Haldane admittedly does not put things as crudely as this. Instead, we read that Daedalus's 'interest turned to biological problems, and […] posterity has never equalled his only recorded success in experimental genetics. Had the housing and feeding of the Minotaur been less

6 J. B. S. Haldane, *The Man with Two Memories* (London: Merlin, 1976), p. 91.
7 Ronald Clark, *J. B. S.: The Life and Work of J. B. S. Haldane* (London: Hodder & Stoughton, 1968), p. 33.
8 Haldane, *Daedalus*, p. 77.
9 Ibid., pp. 44, 46.
10 See Parrinder, 'Dedalus (Thus Spelt)', *James Joyce Broadsheet*, 63 (October 2002), 1.

expensive it is probable that Daedalus would have anticipated Mendel'. Haldane adds that this 'most monstrous and unnatural action' escaped unpunished by the gods.[11] Prometheus may have been the last of the Titans, yet it is not Prometheus but Daedalus and his heirs whom Haldane associates with the twilight and, indeed, the slaughter of the gods.

Charles Darwin, whose bicentenary was celebrated in 2009, is the nearest thing we have to a godlike figure in the field of modern science; so it is significant that Haldane set Darwin among the 'wreckers of outworn empires and civilisations, doubters, disintegrators, deicides' whom he saw as the heirs of Daedalus.[12] The word 'deicides' strikingly recurs at the conclusion of Haldane's essay. When *Daedalus* was reissued in 1995 with a series of commentaries by leading scientists including Max Perutz and Freeman Dyson, none of the contributors cast any light on this extraordinary conclusion with its long (and characteristically unattributed) verse quotation:

> The scientific worker of the future will more and more resemble the lonely figure of Daedalus as he becomes conscious of his ghastly mission, and proud of it.
>
> "Black is his robe from top to toe,
> His flesh is white and warm below,
> All through his silent veins flow free
> Hunger and thirst and venery,
> But in his eyes a still small flame
> Like the first cell from which he came
> Burns round and luminous, as he rides
> Singing my song of deicides".[13]

The closing eight lines of verse are deliberately mysterious, and to my knowledge their authorship has not previously been identified. They are taken, perhaps slightly misquoted from memory, from 'Homunculus, or the Song of Deicides', part of *The Book of Orm* (1870) by the Scottish poet Robert Buchanan (1841 – 1901). The speaker in the poem is Satan. His is the 'song of deicides', and in the context of the quotation Haldane himself seems to identify with Satan. Small wonder that, as he became known as an essayist, Haldane's postbag began to include letters from correspondents denouncing him as the Devil incarnate.[14]

I will return to Robert Buchanan, but the connection between Satanism and genetics is very much older than him, and in fact it is inherent in the *Book of Genesis* itself. One of the things that shocked readers of Haldane's *Daedalus* is

11 Haldane, *Daedalus*, pp. 47, 49.
12 Ibid., p. 78.
13 Ibid., pp. 92 – 93.
14 J. B. S. Haldane, *The Inequality of Man and Other Essays* (London: Chatto & Windus, 1932), p. 84.

that he wrote enthusiastically about the coming separation of sexual intercourse from human reproduction; in the society of the future the sexual act would be enjoyed for its own sake. The fact is, however, that in the religions of the West human fertility does not begin until the intervention of the serpent, as Satan is called in *Genesis*. In his 1894 poem *The Devil's Case* Buchanan puts Eve back into Paradise, sleeping in Adam's arms and safe from temptation by the Devil: 'Eve, that ne'er shalt be a mother'.[15] There is, there must be, the joy of sex in Paradise – certainly Milton thought so – and God in *Genesis* (in the first of two barely compatible accounts of the creation of woman) has told the first human beings to 'Be fruitful, and multiply'. But before the Fall they have not managed to obey His injunction. The reason for this is that paradisal sex cannot lead to human reproduction since it is essential for Cain and Abel, the first human children, to be conceived in sin. Otherwise, the fact that they and their heirs have to suffer the consequences of their parents' disobedience would be manifestly unjust. God makes this clear when, after the Fall, he tells Eve that she will bring forth children in sorrow. Genesis, in other words, is prior to genetics; whatever the beasts (including the serpent) may have got up to, the scene of creation does not include human procreation. The knowledge of good and evil that Eve ingests with the apple includes new insights into sex and the sexual act, as we know from the fact that she and Adam become ashamed of their nakedness.

The serpent persuades Eve to eat from the forbidden tree by means of the Satanic promise, which Milton formulates in *Paradise Lost* as follows:

> [God] knows that in the day
> Ye Eate thereof, your Eyes that seem so cleere,
> Yet are but dim, shall perfectly be then
> Op'nd and cleered, and ye shall be as Gods,
> Knowing both Good and Evil as they know. (9: 705 – 709)

Satan's promise of godlike immortality is seen as a direct threat by God himself, who closes the gates of Eden and appoints angels with flaming swords to guard the 'Tree of Knowledge' which is also called the 'Tree of Life'. We have seen that the 'knowledge of good and evil' includes procreation as the consequence of the sexual act, which is within every human being's power, but the Satanic promise to make us like gods includes the opposite of the act of sex: the power of creation rather than procreation. This is also the ultimate goal of genetic engineering, a consideration which takes us from Adam and Eve to Victor Frankenstein.

In his study of the Frankenstein myth, Chris Baldick quotes a *New York Times Magazine* headline from 1972 announcing a breakthrough in genetic en-

15 Robert Buchanan, *The Devil's Case*, in Id., *Complete Poetical Works*, 2 vols (London: Chatto & Windus, 1901), II, p. 276.

gineering: 'The *Frankenstein* Myth Becomes a Reality: We Have the Awful Knowledge to Make Exact Copies of Human Beings'.[16] If Victor Frankenstein had been able to make an exact copy of humanity rather than a monstrous one, the myth would have been very different from what it is. But Frankenstein does not even try. He dreams of creating a 'new species',[17] and to make sure that his creature is a new species he builds it one and a half times as tall as the average human being of his day. It is not clear whether the creature, any more than Adam, knows the facts of sex when he asks Frankenstein for a mate, since what he begs for is a companion, not a source of offspring. But Frankenstein himself seems to be terrified of his creature's procreative potential, since he recoils (as he tells the monster) from creating 'another like yourself, whose joint wickedness might desolate the world'.[18]

Baldick points out the entirely materialistic basis of Mary Shelley's tale and plays down the idea that Frankenstein sees himself as possessing godlike powers.[19] The story teems with Satanic references, but they are there as literary allusions (thanks to the creature's early reading) and are to be metaphorically, not literally, read. The monster is not really a devil although both he and his creator frequently describe him as one. It all begins with Frankenstein's horrified revulsion from his creation: 'Oh! No mortal could support the horror of that countenance'; it is 'a demoniacal corpse', a 'thing such as even Dante could not have conceived'.[20] There are a number of loose ends in Shelley's text, and how exactly the monster was constructed is one of them. (Night-time visits to charnel-houses apparently play an essential part, but when Frankenstein begins work on a female creature he is quite happy to situate his laboratory on a remote and uninhabited island in the Orkneys.) Is the monster's ugliness a consequence of the way it was galvanized into life – since its 'shrivelled complexion and straight black lips' could be the result of electrocution – or is it a sign that we are confronted by a living corpse, as is suggested by its 'yellowy skin' and 'watery eyes'?[21] At any rate, critics have frequently denounced Frankenstein for his cowardice and moral blindness in turning away from his creation, even though his revulsion from it is plainly instinctive and may even be genetically determined. Is Shelley's scientist very different from the child (later revealed to be Frankenstein's younger brother) who instantly recoils from the monster and

16 Chris Baldick, *In Frankenstein's Shadow: Myth, Monstrosity, and Nineteenth-Century Writing* (Oxford: Oxford University Press, 1987), p. 7.
17 Mary Shelley, *Frankenstein, or, The Modern Prometheus* (New York: New American Library, 1965), p. 52.
18 Ibid., p. 138.
19 Baldick, *In Frankenstein's Shadow*, p. 43.
20 Shelley, *Frankenstein*, p. 57.
21 Ibid., p. 56.

calls him an ogre? What is clear is that both Frankenstein and his creature believe they are in hell, and that the creature sees in his own deterioration the very process that Milton had traced in his Satan: 'the fallen angel become a malignant devil', as Shelley's character puts it.[22]

Frankenstein by no means exhausts the theme of Satanism in nineteenth-century scientific romance, since time and again writers take up back to some perverted version of the Garden of Eden. *The Island of Doctor Moreau*, which its author H. G. Wells called a 'theological grotesque',[23] is one such example, even if the demonic Dr Moreau is a vivisector and transplanter rather than a full-blown genetic engineer. Moreau's island is clearly a parody of the Garden of Eden, as we learn when, at the moment of landing, Montgomery releases a bunch of rabbits onto the island telling them to 'increase and multiply'.[24] God himself, if we take the second Biblical account of the creation of woman, was the first vivisector, since he removed Adam's rib in order to make Eve. Both Moreau and Montgomery (whose introduction of the rabbits tempts the Beast Folk to break one of their commandments by eating meat) vie for the role of Satan.

Another Satanic scientist is the creator of the poisoned garden in Nathaniel Hawthorne's fable *Rappaccini's Daughter* (1844). The beautiful Beatrice Rappaccini is the Eve of the poisoned garden, although her poisonous breath is apparently the result of nurture, not nature. Where her father, the evil scientist, can be described as a genetic engineer is in his creation of the experimental vegetation which fills this Eden of poisonous flowers. Rappaccini, we are told, would 'sacrifice human life […] for the sake of adding so much as a grain of mustard seed to the great heap of his accumulated knowledge', but this is said by his deadly enemy Baglioni, who shares some of his Satanic characteristics.[25]

Mary Shelley and her successors seem to be at one in viewing Satan himself as necessarily evil. We have to turn to the Romantic poets, including her husband Percy Shelley, for some inklings of a defence of Satan as the justified rebel against a tyrannical God and as the Promethean champion of oppressed and benighted humanity; but it was Robert Buchanan, the late nineteenth-century Romantic, who most fully took up the Satanic invitation to become 'the Laureate of the Devil'.[26] For Buchanan, if ignorance is what holds men in thrall to God, then Satan is by definition the first scientist.

22 Ibid., p. 210.

23 Parrinder, 'Note on the Text', in H. G. Wells, *The Island of Doctor Moreau*, ed. by Id. (London: Penguin, 2005), pp. xxx-xxxiv (p. xxxiii).

24 Wells, *The Island of Doctor Moreau*, p. 30.

25 Nathaniel Hawthorne, *Rappaccini's Daughter*, in *The Road to Science Fiction: From Gilgamesh to Wells*, ed. by James Gunn (New York: New American Library, 1977), p. 185.

26 Buchanan, *The Devil's Case*, p. 251.

As Archibald Stodart-Walker wrote in *Robert Buchanan: The Poet of Modern Revolt* (1901), the Devil in Buchanan is 'the spirit of Revolt […] the spirit of Science as opposed to the spirit of Theology, the inspirer of research as opposed to the upholder of authority and tradition'.[27] In *The Devil's Case* the Prince of Darkness does indeed re-brand himself as the Prince of Pity (for humanity) and, moreover, as the 'father of all Science'.[28] Buchanan admired Thomas Hardy, Walt Whitman, T. H. Huxley, George Bernard Shaw, and Olive Schreiner, and had he lived long enough he would doubtless have approved of J. B. S. Haldane. Nevertheless, the Satan of Buchanan's 1890s poems is somewhat different from the Satan of *The Book of Orm*, the sequence from which Haldane quoted. Before moving to *The Book of Orm*, I will quote Buchanan's recent interpreter John A. Cassidy on the general outlines of his religious philosophy: 'Satan is the biblical counterpart to the pagan Prometheus; […] he represents man's intellectual powers and progress but has been stigmatized by priests and tyrants through the ages because they have realized that the only way to keep man in slavery was to forbid intellectuality'. Satan has been 'cast into Hell by God', but 'he is intrinsically good and may one day be released and forgiven'.[29]

The *Book of Orm*, though something of a ragbag, contains the revelations of a supposed Celtic visionary whose name, as it happens, is the Swedish for a 'serpent' or 'snake'. In 'Homunculus, or the Song of Deicides' Satan is a biologist who views the growing 'Homunculus' (the spirit of man) through a microscope:

> It seems but yesterday the dim
> And solitary germ of him
> Glimmer'd most strangely on my sense,
> While, with my microscope intense,
> I search'd a Beast's brain-cavern dark: —
> A germ – a gleam – a cell – a spark –
> Grown to Homunculus, who rides,
> To my sad Song of Deicides.[30]

Satan, the 'last of the gods', living in his own twilight, is also a jealous god who turns against humanity, in a rhyme worthy of Buchanan's contemporary Alexander McGonagall:

> Homunculus! Homunculus!
> Not ever shalt thou conquer us![31]

27 Archibald Stodart-Walker, *Robert Buchanan: The Poet of Modern Revolt* (London: Grant Richards, 1901), p. 253.
28 Buchanan, *The Devil's Case*, p. 254.
29 John A. Cassidy, *Robert W. Buchanan* (New York: Twayne, 1973), p. 101.
30 Buchanan, *The Book of Orm*, in Id., *Complete Poetical Works*, I, p. 288.
31 Ibid., p. 287.

He is like Frankenstein, wishing he had killed the 'feeble cell' he saw in his microscope since it is now too late. He prepares grimly for his last battle, the battle with humanity. In the poem's final lines, Homunculus like a knight in armour is riding towards him:

> Hither he rides!
> Cold fall the dews, chill rise the tides,
> To this still Song of Deicides![32]

Here the echoes of Frankenstein's pursuit of the monster through the Arctic wastes are palpable. *The Book of Orm* has an ironic Miltonic epigraph, 'To vindicate the ways of God to men'.[33] Satan, having at last regained his godlike powers, will not willingly resign them to humanity. He is not yet the wholly anthropomorphic, liberal-humanist Prince of Pity of the later Buchanan. It seems significant that Haldane preferred Buchanan's earlier conception of Satan as the eternal antagonist of both God and humanity, since Haldane's 'scientific worker of the future', the geneticist 'conscious of his ghastly mission, and proud of it', is another figure eternally riding into battle and just spoiling for a fight.

Such a fight would eventually reach Haldane from an unexpected quarter, in science fiction by the Christian apologist and scholar of medieval English Literature C. S. Lewis. Lewis's villain Weston in *Out of the Silent Planet* (1938), the first of his space fiction trilogy, is a distinguished physics professor. In the second novel *Perelandra* (1943; later retitled *Voyage to Venus*), Weston has become a biologist and is literally possessed by the Devil. The third volume, *That Hideous Strength* (1945), is a wholly earthbound thriller in which a secret scientific research organisation is planning a fascist takeover of British society in order, as one of its proponents says, to 'take over the human race and recondition it, make man a really efficient animal'.[34] This dream or nightmare of taking over the human race and reconditioning it, or what Brian Aldiss in his 1982 rewriting of *The Island of Doctor Moreau* calls the 'Frankenstein process', is the classic stuff of paranoid science fiction; in Aldiss's novel, the Dr Moreau figure is predictably funded by the US State Department.[35] The 'new species'[36] in *That Hideous Strength* consists of bodiless brains which are artificially kept alive, so that immortality is a real possibility; the brains are chosen on supposedly eugenic grounds, but genetic research has been bypassed. However, Lewis also draws heavily on the Arthurian legends, with a resurrected Merlin and a small group of modern Christians defeating the evil scientists. Lewis's fantasy might have

32 Ibid., p. 288.
33 Ibid., p. 257.
34 C. S. Lewis, *That Hideous Strength* (London: Pan, 1955), p. 25.
35 Brian Aldiss, *Moreau's Other Island* (London: Triad/Panther, 1982), p. 156.
36 Lewis, *That Hideous Strength*, p. 117.

seemed laughable, but Haldane, now a member of the Communist Party, took it sufficiently seriously – and personally – to write a scathing review of the trilogy in 1946 in the Marxist journal *Modern Quarterly*. The one light-hearted element in Haldane's review is its title, taken from an old Scottish name for the Devil: 'Auld Hornie, F. R. S.'

According to Haldane, Lewis believes that 'The application of science to human affairs can only lead to Hell'.[37] Haldane and his successors like Richard Dawkins are therefore the modern devils, but we should remember that Haldane had begun *Daedalus* by warning, in Percy Shelleyan idiom, of the terrifying power of modern science: 'Has mankind released from the womb of matter a Demogorgon which is already beginning to turn against him, and may at any moment hurl him into the bottomless void?'[38] Haldane thought not, but by 1945 he and Lewis must have been becoming aware of the hideous excesses of Nazi eugenic policies; indeed, Haldane had denounced Nazi eugenics in his book *Heredity and Politics* back in 1938. The British scientists in *That Hideous Strength* are engaged in an even darker eugenic conspiracy. If we go back to the 'Today and Tomorrow' series in the 1920s we shall find that several of the contributors were rabid eugenicists, and many more reflected the contemporary anxieties about what was called the 'rapid multiplication of the unfit'. In *Icarus* Bertrand Russell, far from the radical liberalism of his later years, explicitly advocated racist eugenics. Haldane was much more cautious, both in *Daedalus* and throughout his life; at a 1964 International Congress on Genetics, we are told, 'among all the major biologists who discussed future eugenic possibilities, Haldane was unique in emphasizing the inadequacy of our technological knowledge'.[39] He also comes very well out of Daniel J. Kevles' 1995 history of the eugenics movement, *In the Name of Eugenics: Genetics and the Uses of Human Heredity* (1995), and it is with Kevles that I will end, since his concluding chapter bringing the history of human genetics up to the present is entitled 'Songs of Deicide'.

Kevles writes that in Haldane's view,

> led by the scientist with his songs of deicide, man might slay his inner demons, come to terms with the seeming perversions, and transform unnatural innovations into natural, humanly advantageous customs.[40]

37 J. B. S. Haldane, 'Auld Hornie, F. R. S.', *Modern Quarterly* (Autumn 1946), pp. 32 – 40. See also <http://www.marxists.org/archive/haldane/works/1940s/oncslewis.htm> [accessed 16 June 2011].

38 Haldane, *Daedalus*, p. 4.

39 Dronamraju, 'Introduction', p. 16.

40 Daniel J. Kevles, *In the Name of Eugenics: Genetics and the Uses of Human Heredity* (Cambridge, Mass., and London: Harvard University Press, 1995, 2nd edn), p. 298.

This paraphrases a passage in *Daedalus*, but, as we have seen, the 'songs of deicide' are themselves demonic.[41] Kevles goes on to speak of the ethical challenges posed by present-day biotechnology and genetics:

> the more masterful the genetic sciences have become, the more they have corroded the authority of moral custom in medical and reproductive behaviour. The melodies of deicide have not enabled contemporary men and women to remake their imperfect selves'.[42]

Do we even wish, or dare, to remake ourselves by genetic means? In small matters, perhaps, yes: for example, we are told that genetic engineering may soon make dentists redundant by relieving us of the possibility of toothache. In Britain the Human Fertilisation and Embryology Authority has a remit to 'strengthen the authority of moral custom' and, presumably, to distinguish between benign questions of dentistry and the hideous possibilities of the Frankenstein process. So what are the current prospects for wholesale human refashioning? According to a report from the meeting of the American Association for the Advancement of Science in Chicago in February 2009, the first humanoid being to be created from scratch by cloning its genetic code may not be a superhuman, or an Identikit version of present-day humanity, but a reconstituted Neanderthal Man – the very ogre that young William Frankenstein may have been reacting to when, terrified, he first set eyes on his brother's creature.[43]

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41 Haldane, *Daedalus*, pp. 81 – 82.

42 Kevles, *In the Name of Eugenics*, p. 301.

43 Ian Sample, 'Scientists Unravel Neanderthal Genome', *The Guardian*, 12 February 2009, http://www.guardian.co.uk/science/2009/feb/12/neaderthal-genome [accessed 16 June 2011].

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Jorge S. Burns

Stem Cells: Heroes with a Thousand Faces

I. Introduction

One way to gain an instant impression of the public face of contemporary bioscience is to walk along a one-way road named Gower Place in London, enjoying a street level view. Decorating the rear façade of the Wellcome Gibbs Building, headquarters of the largest independent sponsor of scientific research in the United Kingdom, broad posters caption their announcements. In August 2009 one could read 'Stem Cell Renewal', 'Genome-wide Associated Studies', 'Informing Government Policy', 'Science against the fake medicine trade', 'Starch additive reduces Diarrhoea', and 'Inspiring Science Teachers'.

The Wellcome Building at 183 Euston Road, built in 1932 in Portland stone, houses the Wellcome Collection. The juxtaposed Gibbs Building at 215 Euston Road, built in glass and steel and inaugurated in 2004, is the administrative headquarters of the Wellcome Trust. Credit: Wellcome Library.

The stem cell poster added: 'Wellcome Trust-funded research suggests that embryonic stem cells renew themselves – and their ability to form any type of cell – by default, without the need of external signals'. It is a statement that raises

many questions. Is this information important for the general public? Does it reach them in a helpful way? Indeed, is the statement correct?

Before addressing such questions, let us consider what is at stake. Organizations that sponsor research impacting on health have a responsibility to report back to society in an open, clear way. Yet, describing issues in the world of bioscience is not always easy. Laboratory researchers deploy a technical language that enables them to communicate with each other in specific, precise ways, so that they can describe experiments and compare observations and results. Eavesdropping on a bioscience meeting one might overhear something like this: 'We find the CMV promoter worked best'. 'Great, done any Tet work?' 'We're trying, but inducibles can be leaky'. 'Have you tried humanised versions, some say they can be tighter?', all said in quickfire succession with an intense gaze. If you can understand it, you are 'locked in' to the conversation, keen to pick up clues and nuances of phrase. If you do not understand it, you are 'locked out'. Should the posters at street level fail to communicate effectively the endeavours and benefits of science to the general public, those feeling locked out are the very people whose support of science keeps research afloat.

A recent article in *The Scientist* entitled 'Fate of Science "Hero" Uncertain'[1] might conjure up images of a maverick genius at the bench, who is having a hard time being funded. Yet the hero in question is not a scientist at all, rather the politician Arien Specter, one of the US Congress's most celebrated champions of biomedical research, who now found himself fighting to remain a senator in Pennsylvania. It was his petitions that were instrumental in adding billions of dollars to the 2009 National Institutes of Health budget and the article served as a reminder that scientific research has many heroes in the community, literally thousands of voters ordinarily unsung in the pages of research journals.

For centres such as The Wellcome Trust, having to communicate science to the general public echoes the concern of a London tube train announcement exhorting 'Mind the gap!' as passengers board carriages from a curved platform. The communication gap between a scientist and a non-scientist can be huge, so this chapter modestly aims to bridge that gap by discussing science in a figurative, narrative style. The story line concerns the publication of a manuscript; how it came to be written, accepted for publication by a research journal; deemed worthy of broader communication by a popular science magazine and ultimately by the highly pervasive medium of the press.

The story might be considered up-to-date given the highly topical subject of stem cells, yet it fits into an ancient classical model for almost all stories, coined

1 Kerry Grens, 'Fate of Science "Hero" Uncertain', *The Scientist*, 17 May 2010, <http://www.the-scientist.com/news/display/57406/> [accessed 20 June 2011].

The Hero with a Thousand Faces by the mythologist Joseph Campbell[2] who expressed a Jungian view that narratives reveal the working of the human mind. Psychologically valid and realistic, they spring from a collective unconscious source touching on universal concerns. In summary, the hero is introduced within an ordinary world, whence he/she receives the call to adventure. Though perhaps reluctant at first, the hero is encouraged by a wise old man or woman to cross a threshold involving tests and helpers of sorts, and reaches the innermost cave, where the supreme ordeal is encountered. A sword or treasure is seized and the hero pursued on the road back to the conventional world. Deeply transformed by the experience, the hero returns with a treasure, boon or elixir to benefit mankind.

One should be aware that contemporary narratologists have shifted their attention towards less structured, or purposeful modes of telling a story. In contrast, a rigorous principle of scientific writing is that it should be telic, describing the aim of the study and how the experimental results have met their goal. Like juxtaposed styles of architecture belonging to different epochs, one has ancient stories narrated in new ways and new science narrated in archetypal ways. There is an intriguing outcome in choosing a mythological narrative style to articulate scientific arguments which ordinarily require secure foundations and clear, linear patterns of argumentation. Unexpectedly, resorting to an ancient mode of narration to describe contemporary science can trigger novel ways of representation.

II. The Hero Is Introduced in His Ordinary World

Once upon a time a research scientist was invited to a distant land, 'with no meaning in the voices'[3] and encouraged to do what he knew best: culture human cells very carefully so that they may be used in experiments seeking to understand processes that govern life-threatening situations, such as cancer of the breast or colon. What attracted the scientist to this exotic task was the technology that had evolved in the little town of Odense, Denmark. According to a distinguished professor from Manchester UK, Proteomics in Odense was 'like country music in Nashville' thanks to the vision of world-renowned scientists within the field of mass spectrometry. This technology has earned five researchers the Nobel Prize over the course of recent history, culminating in 2002

2 Joseph Campbell, *The Hero with a Thousand Faces* (Princeton: Princeton University Press, 1973).

3 Rupert Brooke, 'Finding', in *The Collected Poems of Rupert Brooke*, with an Introduction by George Edward Woodberry and a Biographical Note by Margaret Lavington, <http://www.gutenberg.org/files/262/262-h/262-h.htm#2H_4_0042> [accessed 20 June 2011].

when the award was made for showing that fast atom bombardment ionization with Tandom Mass Spectrometry could be applied to the identification of protein sequences.[4] New ionization methods, precision engineering, fast integrated circuits and vast computing power have all conspired in the quest to match detailed understanding of the human genome (a working draft in 2000 and a complete version in 2003), with an equivalent understanding of the protein component of a cell, its 'proteome'. This challenging aim has not yet been fully met, but the pace of improvement has been dramatic and one can point to an abundant series of articles in leading journals, trumping each other with the depth of knowledge they display. Unlike the relatively unchanging genome, the proteome changes very responsively and dynamically, providing a 'rubber meets the road' perspective for understanding mechanisms governing disease processes and pharmacological interactions.

From mundane hardship to exotic reward, our hero is to be found cycling in all weathers, enthralled by demanding experiments that regrettably consume many weekends. In contrast, conferences in Siena[5] and Chicago[6] plus an invitation to the NASA Johnson space centre to discuss new ways of characterising cells grown in bioreactors led our hero to share his knowledge in privileged environments, rubbing shoulders with the jet set, and even stepping into an office where Neil Armstrong once stepped. A new employment in a private company aiming to establish functional proteomics for drug discovery introduced a most stimulating environment. Yet circumstances beyond the realms of science, including economic pressures from the tragedy of the September 11 2001 terrorist attack on the United States world trade centre, forced the company to restructure. Our hero's setting changed to an Odense University Hospital research department, focused on how bone marrow stem cells differentiate to become bone-forming osteoblasts. With over 200 million people worldwide estimated to be suffering from osteoporosis, the laboratory was geared to answering the question: can stem cells be used as therapeutic tools to regenerate bone?

4 *The Nobel Prize for Chemistry 2002*, <http://nobelprize.org/nobel_prizes/chemistry/laureates/2002/illpres/mass.html> [accessed 20 June 2011].

5 *From Genome to Proteome*, 3rd Siena 2D Electrophoresis Meeting, Siena, Italy, 31 August – 3 September 1998.

6 *Second Annual Lynn Sage Breast Cancer Symposium*, Chicago, USA, 15 – 17 September 2000.

III. Encouraged by the Wise Old Man or Woman

Competition between research groups is intense and the accreditation accompanying the first key discoverers can bring rich rewards. Hence, patents, confidentiality agreements, and competitive attitudes abound, but science is always a team effort, humming with the sound of a beehive rather than the chirp of a single cricket. Many helped our hero on his path.

Certainly he looked to mentors: the school teacher who stimulated and encouraged the pupil in school science; the professor who personally drove the young neglectful student to an exam, ensuring it was not missed; the professor who took the time to help work through six drafts of a key grant application, honing it down to essentials that met with funding; the ex MIT group leader mentoring the young postdoctoral scientist, employing him after they had met at a poster in a scientific meeting in Cold Spring Harbour, New York; the many collaborators who sent free 'gifts' of unique reagents and cells; an inspirational associate director of the international Ludwig Institute for Cancer Research; the knighted professor who shared valuable time and candidly disclosed events which had shaped his stellar career; the professor who, learning of troubled times, could point to a once wilted plant in his office as an example for revival, whilst accepting, guiding, encouraging; the human resources manager at the biotechnology company, a woman who encouraged our hero to write; the generous professor who nurtured our hero with wisdom from the desert. These sages come from England, Wales, India, China, Finland, Scotland, USA, Denmark, Canada and Egypt, reflecting the global reach of science education, training, research and translation. Recollecting such benefactors evokes a sentiment of immense appreciation and gratitude in our hero, who is ennobled and emboldened by them.

The reader is invited to share in the sentiment of appreciation, setting a happy benevolent stage for the start of the story. The mention of renowned acquaintances may betray a desire to enhance self-importance and gain favour, but gratitude certainly extends to young wise friends and past giants. For our hero facing vicissitudes, the fact that Sir Peter Medawar wrote four books after suffering a stroke was poignantly inspirational.

IV. Tests and Helpers

The laboratory at Odense University Hospital had stumbled upon a world first situation. To describe fully the preceding events would exceed the scope of this chapter, but key circumstances were as follows. Human bone marrow-derived mesenchymal stem cells (hMSC) can be grown outside the body as cells that

attach to the bottom of culture flasks. Once attached, the cells divide with a 'proliferative burst' to form small colony-forming units that can be pooled and transferred to another flask as a donor-specific mixed population of cells. However, within a relatively short time the cells irreversibly lose both their ability to divide and some of their potential function, becoming what scientists term 'senescent'. Whether similar changes occur to such cells in our body as we age is under debate, yet certainly growth in a culture flask is normally limited. This imposes constraints on experimental procedures and may also restrict the stem cell population's potential therapeutic usefulness. Before our hero joined the laboratory, scientists had already performed a remarkable set of experiments to overcome such constraints. Using modified retroviruses to facilitate genetic transfer, a stable human 'immortalising' gene was successfully introduced into a population of human bone marrow stem cells. This gene, encoding a 2009 Nobel prize-worthy enzyme subunit called telomerase,[7] can evoke unrestricted growth of human cells, so the population can effectively be expanded in culture indefinitely. As shown by two independent laboratories, telomerase gene expression enhanced rather than interfered with the cells' ability to mature via 'differentiation' into a specialized osteoblast cell in experimental model systems and ultimately form bone.[8]

When the cells in a culture flask divide sufficiently to fully coat the bottom surface, the situation is described as 'confluent'. Enzyme treatment can detach the cells allowing them to be transferred or 'passaged' as free-floating individual cells to a new empty sterile flask. The sub-portion of cells introduced into the new flask defines the 'split ratio', e. g. when transferring only half of the cells, the split ratio is 1:2. This detail was of utmost importance in our hero's story. A substrain of the cells was passaged with a higher 1:20 split ratio so as to encourage the cells expressing the telomerase gene to exploit their growth advantage. Landing further apart on the flask surface and thus being more isolated from each other, cells with a greater potential to grow autonomously were favoured. It was of interest to compare the growth of the cells when transferred using different split ratios. Technicians passaged the cells continuously over the course of three years, keeping constant split ratios of 1:2, 1:4 or 1:20 for each

7 *The 2009 Nobel Prize in Physiology or Medicine – Illustrated Presentation*, Nobelprize.org. 20 Jun 2010, <http://nobelprize.org/nobel_prizes/medicine/laureates/2009/illpres.html> [accessed 20 June 2011].

8 Songtao Shi, Stan Gronthos, Shaoqiong Chen, Anand Reddi, Christopher M. Counter, Pamela G. Robey, and Cun-Yu Wang, 'Bone Formation by Human Postnatal Bone Marrow Stromal Stem Cells Is Enhanced by Telomerase Expression', *Nature Biotechnology*, 20 (2002), 587 – 591; Janne L. Simonsen, Cecilia Rosada, Nedime Serakinci, Jeannette Justesen, Karin Stenderup, Suresh I. S. Rattan, Thomas G. Jensen, and Moustapha Kassem, 'Telomerase Expression Extends the Proliferative Life-span and Maintains the Osteogenic Potential of Human Bone Marrow Stromal Cells', *Nature Biotechnology*, 20 (2002), 592 – 596.

population strain. It is perhaps not surprising that subtle changes emerged. A mutation or inheritable change that encouraged the cells to divide more rapidly provided a dominant growth advantage. Regular counting of the cells at each passage revealed that there were some 'kinks' in the resulting growth curve which indicated distinct accelerations in the rate of cell division. Canonically, these cell populations could differentiate and become bone in the experimental model system. However, after a very prolonged period of continuous culture, over 250 population doublings, everything changed for the population passaged with a 1:20 ratio. The routine procedures produced not bone but instead a tumour from cells that had now lost control of cell division.[9] Of special note, cellular strains passaged with 1:2 or 1:4 split ratios did not show such tumorigenic change over an equivalent period of time. What might ordinarily be considered a mundane procedural detail, the split ratio at passage, was inadvertently creating a deterministic selection pressure with dramatic difference in outcome. Despite examples of telomerase-mediated immortalization of human cells from numerous laboratories around the world, this was the first occasion noted when such telomerized human cells, without further intervention, had spontaneously acquired tumorigenic potential. This had implications for the safe development of stem cell therapeutics and experimental models of tumour development.[10]

The telomerised human mesenchymal stem cells were generated for research purposes, advantageously allowing the laboratory to perform large scale, highly reproducible experiments. So these hMSC eventually became tumorigenic within the context of a highly artefactual situation, not one imagined for clinical cellular therapy. Nonetheless, after the initial report was published in 2004 our hero wanted to understand the situation in more depth. The hand of innocence was holding a smoking gun.

V. Reaching the Innermost Cave

Just as one bad apple spoils the barrel, a rogue subpopulation of cells might suffice to cause a tumour. What if individual cells were plucked, allowed to expand as a cloned population and then tested to see if they formed tumours? Would they all be tumorigenic or would just a subset have full tumorigenic potential? These questions were addressed by deriving single cell clones, se-

9 Nedime Serakinci, Per Guldberg, Jorge S. Burns, Basem Abdallah, Henrik Schrøder, Thomas Jensen, and Moustapha Kassem, 'Adult Human Mesenchymal Stem Cell as a Target for Neoplastic Transformation', *Oncogene*, 23 (2004), 5095 – 5098.

10 W. Nicol Keith, 'From Stem Cells to Cancer: Balancing Immortality and Neoplasia', *Oncogene*, 23 (2004), 5092 – 5094.

lecting six at random and testing how they behaved in culture. All six clones looked very similar in the flat culture dish, grew at similar rates and showed a reduced ability to differentiate in culture. This was a disappointing start, since many weeks of work had led to a conclusion equivalent to taking an orange, isolating its segments and declaring that each segment tastes of orange: hardly remarkable and consequently hard to publish. At this point our hero will be forever grateful that his supervisor accepted the appeal to test *in vivo* the ability of the clones to make tumours. If all six clones behaved in the same way, the project would go no further. Contrary to what might be expected from the preliminary experiments in the culture dish, there was a striking difference. Four clones made fast growing tumours, one clone made tumours after a relatively prolonged latent period and one clone did not make any tumours. Why did all the six clones look very similar when grown on a dish, yet were very different when tested *in vivo?* The microenvironment of the cells when they are *in vivo* must involve different selection pressures to when cells are growing on a flat culture plate. One clear difference is that when forming tumours *in vivo*, cells grow in three dimensions (3D), forming multicellular spheroidal aggregations of millions of cells. Would it be possible to demonstrate that this difference was significant?

Serendipity prevailed over what started out as bad news. The laboratory ran out of a required reagent, namely an antibody. Antibodies that function as part of a complex immune defence mechanism in our bodies can also function outside the body. Under carefully controlled laboratory conditions, including specific exposure times, antibodies can bind tightly and with exquisite specificity in order to target proteins on cells. Colourful staining procedures can be used to indicate when this happens, so the researcher obtains a marker indicating where in a cell such a protein is expressed and, to a good approximation, the extent of its expression. Specific staining patterns, combining chemicals with antibodies, have been guiding scientific thought for centuries and new staining chemistry can bring about revolutions in our understanding. Ask Camillo Golgi.[11] For the experiments under consideration here, the binding of the antibody to its target protein in the cell would be shown by a brown stain seen when looking at a thin section of the cells under the microscope. Ordinarily, one would simply obtain the required antibody from a commercial source, placing an order that would usually be met within a week. Yet some antibodies work better than others, being more specific or recognising a particularly relevant portion of a protein. In this case, the best place to obtain the antibody in question was as a gift from a

11 See 'Camillo Golgi. The Impossible Interview with the Man of the Hidden Biological Structures', Interview by Paolo Mazzarello, *Journal of the History of the Neurosciences*, 15 (2006), 318 – 325.

collaborative researcher in Finland. Providentially, the Finnish laboratory produced another antibody also used to study the proteins of cells making bone.[12] Upon request they included this additional antibody as part of a combined cost-effective shipment. Though the initial idea was to use just one of the antibodies on the cells, it was convenient to test both of the recently shipped antibodies to ensure they worked. The results were most unexpected. It was the second antibody, the one tested only because it arrived as a co-shipment, which showed a dramatic difference among the tumor-forming cell clones. Comparing the thin sections of cells grown as spheroidal aggregates, stained in parallel under identical conditions, one could tell even with the naked eye that the antibody targeting pro-collagen type III had reacted particularly strongly to only one out of the six clones. The stained circle of cells on the slide was as black as a cave. Even though one might ordinarily be cautious about the semi-quantitative nature of the experimental procedure, the problem was what to make of this result.

Published with auspicious timing, a commentary in the journal *Cancer Cell*[13] caught our hero's attention. The authors pointed to a publication in the sister journal *Cell*[14] about an enzyme produced by cancer cells which could efficiently degrade a closely related protein, namely, collagen type I. Collagens are self-assembling structural proteins; the most abundant protein in mammals, they constitute about a third of all the proteins in our body. With function following form, these proteins organise themselves as microfibrillar triple helical molecular chains. Affecting cell-cell and cell-matrix communication, these rope-like structures form a fundamental scaffold determining how tissues are constructed in growth and repair. The *Cell* manuscript provided solid evidence from 3D cultures that cancer cells could produce an enzyme which proteolytically cut collagen molecules and that if this did not happen, a collagen cage-like entrapment of the cancer cells limited their ability to grow. Perhaps this was relevant to our results. However, an important incongruous point was that all our cell clones expressed the gene for this enzyme, even the clone with strongly stained collagen type III that made latent tumours. Why did this clone resist the collagen cutting enzyme?

12 Michaela K. Bode, Ylermi Soini, Jukka Melkko, Jari Satta, Leila Risteli, and Juha Risteli, 'Increased Amount of Type III pN-collagen in Human Abdominal Aortic Aneurysms: Evidence for Impaired Type III Collagen Fibrillogenesis', *Journal of Vascular Surgery*, 32 (2000), 1201 – 1207.

13 Kenn Holmbeck, Paolo Bianco, and Henning Birkedal-Hansen, 'MT1-mmp: a Collagenase Essential for Tumor Cell Invasive Growth', *Cancer Cell*, 4 (2003), 83 – 84.

14 Kevin B. Hotary, Edward D. Allen, Peter C. Brooks, Nabanita S. Datta, Michael W. Long, and Stephen J. Weiss, 'Membrane Type I Matrix Metalloproteinase Usurps Tumor Growth Control Imposed by the Three-dimensional Extracellular Matrix', *Cell*, 114 (2003), 33 – 45.

A couple of sentences in an independent Japanese study published six years earlier provided a possible clue.[15] That study showed that collagen type III was digested four times less effectively than the enzyme's preferred substrate, collagen type I. Since it was less sensitive to the degrading enzyme's action, collagen type III could form a dense network and entrap the clustered cancer cells. Alternatively, strong staining for type III collagen might indirectly indicate that some other matrix molecule was temporarily entrapping the cells.

For the purposes of the story here, the above illustrates at least five points. Firstly, the virtue of generosity in science: it was generous for the Finnish researcher to share her reagents and generous for our hero to make sure the antibody worked for others in the laboratory. Secondly, serendipity certainly plays a part in science, yet 'in the fields of observation chance favours only the prepared mind'.[16] Thirdly, detailed descriptions in publications are enormously helpful for bringing sense to observations. A Japanese laboratory studying very basic enzyme kinetics of collagen digesting enzymes could by no means predict that several years later in Denmark this might be useful for explaining a result concerning slowly growing tumours derived from human mesenchymal stem cells. Fourthly, there is a need to be cautious when drawing conclusions from simple observations. As described beautifully by Pirsig with regard to a motorcycle,[17] inductive and deductive logic needs to be applied carefully. Fifthly, simple observations often serve to reveal how much there is to understand about experimental data accumulating like tessellated pieces in jigsaw puzzles. When one has completed the twenty-piece version, a twenty-thousand-piece version is presented. An individual's contribution might extend to a whole piece, more often just the determination of the size of a single hole or tab. Describing results with authenticity and careful quantitation is key; and the constant challenge is what to deem worthy of publication and what to leave out, given stringent page limitations. In the jostling of ideas surrounding the need to explain an observation, crucial clues can be subtle. A narrative style often highlights detail and can be especially revealing. Though exciting through surprise, the results described above formed only a small part of the overall study.

15 Eiko Ohuchi, Kazushi Imai, Yutaka Fujii, Hirosho Sato, Motoharu Seiki, and Yasunori Okada, 'Membrane Type 1 Matrix Metalloproteinase Digests Interstitial Collagens and Other Extracellular Matrix Macromolecules', *The Journal of Biological Chemistry*, 272 (1997), 2446–2451.

16 Louis Pasteur, 'Dans les champs de l'observation le hasard ne favorise que les esprits préparés', Lecture University of Lille, 7 December 1854, <http://en.wikiquote.org/wiki/Louis_Pasteur> [accessed 20 June 2011].

17 Robert M. Pirsig, *Zen and the Art of Motorcycle Maintenance: An Inquiry into Values* (New York: Quill, 25th Anniversary Edition, 1999).

VI. The Supreme Ordeal

Publish or perish is the mantra of researchers. Harsh though this may sound, such a policy has stood the test of time and provided a metric ultimately deemed fair. It is worth emphasizing that with a distractingly adventurous history, including a non-publishing time in industry, our hero was in urgent need of producing a published manuscript upon returning to academia. Fortunately, results were beginning to reveal an important message. Soon the manuscript, though not perfect, was of sufficient substance to submit to a high impact leading cancer journal entitled *Cancer Research.*

Where one's work gets published is a highly emotive issue. Much strife surrounds the debated true worthiness of the apparent pecking order of journals, each given an impact factor proportional to the number of citations attributed to the journal. It is a science community code with huge potential implications. Publishing in a high impact factor journal increases chances that one's work will be read and referred to, it indirectly influences one's standing among thousands of peers and serves as accreditation and leverage for research funding. Sponsors welcome being acknowledged in highly regarded journals.

The ordeal encountered by our hero upon submitting to the scientific journal included peer review: maintaining high impact factor stringencies, it is typical for 75 % of the articles submitted to *Cancer Research* to be rejected. After a few weeks, the review arrived containing good and bad news. The good news was that the manuscript had not been rejected. The bad news was that it was not accepted for publication either, at least not in its present form. The reviewers had been very fair and any frustration at not receiving immediate acceptance, in any case extremely rare, was balanced by acknowledging that to address their concerns would improve the quality of the manuscript. A timeline of two months was granted for a reply with amendments and corrections. Additional experiments were required. Timelines were drawn up, at which point our hero realised that one of the experiments would take about two months to complete. Putting cells immediately into culture dishes that same day meant that experiments were completed just two days before the deadline. Among the reviewers' concerns was the justified opinion that the study provided only one example and, as such, could be viewed as largely anecdotal. We did not have another example of such cells, it had taken three years to get to this stage and so this seemed to be a supremely difficult point to address.

Serendipity occurred again when a poster was presented by a research group from Spain at a conference in Cyprus.[18] A similar situation was described: tu-

18 British Association For Cancer Research (BACR) Special Conference, *Stem Cells & Telome-*

mours arose from cultured human mesenchymal stem cells, yet this time the cells did not come from the bone marrow, but from discarded adipose tissue from non-oncogenic surgical interventions. We spoke to each other in shorts, a term describing attire for warm environments as well as our conversational bursts of information exchange. Their independent study was similar to ours in the sense that cultured hMSC had become tumorigenic, but there were important differences. It was agreed that we might try and publish both our manuscripts concurrently in the same journal, thus providing the further example requested by the reviewer. Their results seemed very unusual, since we had never seen such spontaneous transformation when culturing primary mesenchymal stem cells taken directly from a donor. Nonetheless, our results, though born from the artefact of immortalized cells, seemed to indicate that changes leading to spontaneous transformation of mesenchymal stem cells after protracted growth in the laboratory were possible. Certainly there was an ethical responsibility not to withhold information on the basis that it might be undesirable. The journal editors of *Cancer Research* saw fit to publish both research manuscripts in April 2005.[19] For our hero, the supreme ordeal of years without a lead author publication in a high impact journal was over.

VII. Seizing the Treasure

Treasure Island[20] opens with the narration of Jim Hawkins, young son of the owners of the Admiral Benbow Inn. There, a mysterious sailor named Black Dog visited their lodger Billy Bones. In a similar setting, a London pub, a much more agreeable encounter took place in 2004 between our hero, an editor of *New Scientist* and a mutual friend who helped organise the meeting. For us, a 'black spot' was not a pirate's message of impending doom, but the way cells stained on a slide. Though details were not disclosed, it was clear that if the experiments went well, the outcome might be newsworthy. A year after that happy tryst, with news that the manuscript was accepted for publication in *Cancer Research*, our hero saw fit to contact *New Scientist* again. Yes, there would be interest in writing

rase, Salamis Bay Hotel and Conference Centre Famagusta, North Cyprus, 12 – 16 October 2004.

19 Daniel Rubio, Javier Garcia-Castro, María C. Martín, Ricardo de la Fuente, Juan C. Cigudosa, Alison C. Lloyd, and Antonio Bernad, 'Spontaneous Human Adult Stem Cell Transformation', *Cancer Research*, 65 (2005), 3035 – 3039; Jorge S. Burns, Basem M. Abdallah, Per Guldberg, Jørgen Rygaard, Henrik D. Schrøder, and Moustapha Kassem, 'Tumorigenic Heterogeneity in Cancer Stem Cells Evolved from Long-term Cultures of Telomerase-immortalized Human Mesenchymal Stem Cells', *Cancer Research*, 65 (2005), 3126 – 3035.

20 Robert Louis Stevenson, *Treasure Island* (London: Cassell & Company, 1881 – 1882), <http://www.gutenberg.org/files/120/120-h/120-h.htm> [accessed 20 June 2011].

a short account of the results. Accepting an embargo not to publish anything before *Cancer Research* published the manuscripts, the *New Scientist* editor phoned our hero for comments. Such phone calls, where anything one says could be written down and published, evoked careful consideration of every word said. Ultimately, a balanced article entitled 'Old Stem Cells Can Turn Cancerous',[21] described how both manuscripts contributed to the broader issues of stem cell therapy, perhaps tempering the popular excitement about the potential of such stem cells to provide cures. It mentioned that researchers had long known that stem cells taken from very early embryos had a propensity to become tumorigenic, but that this was widely assumed not to be the case with stem cells taken from adult tissue.

The studies now indicated that growing the cells outside the body for too long might introduce a tumorigenic risk. The challenge would be how to know where to draw the line between safe and unsafe expansion of cells. The studies underscored a need for extensive safety testing before any type of stem cell is used for medical therapy. *New Scientist* issues press releases, thus its articles have the potential to enter mainstream news, which is the way the wider world conventionally hears about scientific findings.

VIII. Pursued Back to a Conventional World

Within the context of a news article, narrative needs to be conspicuous to grab the attention of a fiercely sought-after audience. Sometimes scientists can read of their work in the press with some chagrin, since the style of narrative might be overtly biased with an emotive slant. The headlines chosen for the report on *BBC News* was 'Adult Stem Cells "Cancer Threat"'.[22] Furthermore, a whispers situation, whereby information is gleaned not first-hand but by indirect questioning, can lead to factual errors. For example, the name given for the institute to which our hero was affiliated was incorrect. Mentioning 'they found that the cells that became cancerous had started making an enzyme, called telomerase' was potentially misleading, since this only applied to one of the two studies. As mentioned above, when we first introduced expression of telomerase in our mesenchymal stem cells we had cells that were not at all cancerous, on the contrary, they showed an enhanced potential to differentiate and form bone. The statement 'Also, stem cells stored for years in banks might not be safe, they said' was not a statement made by our hero. It was biased towards expressing a fear,

21 Andy Coghlan, 'Old Stem Cells Can Turn Cancerous', 2496, 21 April 2005, p. 18.

22 'Adult Stem Cells Cancer Threat', *BBC News*, 20 April 2005, <http://news.bbc.co.uk/2/hi/health/4465717.stm> [accessed 20 June 2011]. Author's name not mentioned.

perhaps a response to a pressing question from a journalist. Certainly this was not an entirely authentic reflection of what was shown by the studies, neither of which explored whether the carcinogenic changes in the long-term cultured cells could also occur over similar time frames in cells frozen in banks (extremely unlikely). Further media titles, including 'Stem Cells Cancer Fear' in *The Guardian*[23] and 'Cancer Risk Raises Stem Cell Doubts' in *The Australian*,[24] indicated not only distant media coverage, but also narrative distance from the original data. Independent observers noted this, discussing the issues from a different perspective. An article in a pro-life forum *Lifenews.com* promptly appeared with the title 'Media Bias Seen in Story on Adult Stem Cell Research and Cancer'.[25] One criticism pointed out that it was not until the middle of such news articles that moderating sentences were found. It took the reader a while to apprehend that such cells would not be directly transplanted into humans and that risks were hypothetical. Furthermore, the *Lifenews.com* article highlighted that a stem cell company which expanded mesenchymal stem cells using NASA-created techniques did not support the idea that the cells would become cancerous. Their scientific studies showed that the expanded cells had a normal arrangement of chromosomes (chromosome abnormalities, including losses and rearrangements, are often seen in cancer cells with an altered division process) and did not create tumours when transplanted.

By this stage, we are reading about a scientific pursuit in a web article (*Lifenews.com*) chasing a news article (*BBC news*) chasing a magazine article (*New Scientist*) chasing a publication in a scientific journal (*Cancer Research*). Notably, the last article of the chain discussed the manner in which the media narrated the story, but referred to a stem cell company not involved in the original study and failed to point out scientific inaccuracies in the reporting. It was no longer narrative tackling science, but narrative tackling narrative.

23 Colin Blackstock, 'Stem Cells Cancer Fear', *The Guardian*, 21 April 2005, <http://www.guardian.co.uk/science/2005/apr/21/stemcells.cancer> [accessed 20 June 2011].

24 Mark Henderson and Leigh Dayton, 'Cancer Risk Raises Stem-Cell Doubts', *The Australian*, 22 April 2005, p. 7.

25 Steven Ertelt, 'Media Bias Seen in Story on Adult Stem Cell Research and Cancer', *Lifenews.com*, 25 April 2005, <http://www.lifenews.com/2005/04/25/bio-933/> [accessed 20 June 2011].

IX. Transformed, with Boon to Benefit the World

Unyielding time has transformed our hero's story in dramatic ways. Now, five years on, echoing a prophetic phrase in a verse from Longfellow's insight into life, 'Things are not what they seem'.[26] Perhaps one should not be surprised, given more famous examples.

When the German chemist Friedrich August Kekulé elucidated the benzene ring structure, he apparently dreamt of a snake devouring its own tail. The image clearly echoes Ouroboros, a symbol for the unity of nature tracing back to Ancient Egypt, circa 1600 B.C.. The mythological Ouroboros may have been inspired by the *Cordylus Cataphractus*, an African lizard which protects its vulnerable underside by curling into a circle. Its shape, which reminds one of self-reflexivity, suits the persona of a hero or a stem cell.

Cordylus Cataphractus, the Armadillo Lizard in curled up defensive position.

Yet historical scrutiny by John H. Wotiz would suggest that other scientists, including Auguste Laurent of France, Archibald Scott Couper of Scotland and Johann Joseph Loschmidt of Austria had already described the concept of a benzene ring.[27] Could it be that Kekulé's metaphorical dreams serve as an example whereby the power of individual narrative to convey originality may mask the sharing of due credit? Is not the chirp of a stirdulating cricket louder than the hum of a beehive? 'There's no such thing as originality anyway, just authenticity',

26 Henry W. Longfellow, 'A Psalm of Life', *Knickerbocker Magazine*, October 1838, <http://www.potw.org/archive/potw232.html> [accessed 20 June 2011].

27 John H. Wotiz and Susanna Rudofsky, 'Herr Professor Doktor Kekulé: Why Dreams?', in *The Kekulé Riddle: A Challenge for Chemists and Psychologists*, ed. by John H. Wotiz (Vienna, IL: Cache River Press, 1993), pp. 247 – 275.

said Helene Hegemann,[28] poignantly paraphrasing W. H. Auden's observations about writing: 'Some writers confuse authenticity, which they ought always to aim at, with originality, which they should never bother about'.[29]

'Science sucks!' is a metaphor, a useful one. Perhaps, a frustrated sigh, from a young hero struggling to memorise a biochemical pathway for an exam, or a paraphrase for science's all-consuming nature, as individual talents painstakingly join forces to acquire knowledge. *Metapherein* is a Greek composite word derived from *meta* (over, across) and *pherō* (to bear, carry). Following Aristotle's definition of metaphor as 'the application of a strange term either transferred from the genus and applied to the species or from the species and applied to the genus, or from one species to another or else by analogy' (*Poetics*, 21, 1457b), it becomes clear why telomeres, protecting chromosome ends from degradation, have been likened to aglets, the plastic tips of shoelaces that protect them from unravelling. Not only can an apt metaphor be subtle as a synecdoche or boldly paralogical, it can exquisitely erase much verbosity. Metaphors allow human thought to express its capacity to weave associations, connections, and substitutions; they tell us about the way we think and show us ways to represent thought. To be able to understand them, their strengths and weaknesses, is key to being safe in science. When confronted with a supreme task, an exasperated hero might exclaim 'Suck science!', an assertion much more vehement than 'Science sucks!', pronounced with a wry smile. Word order and attention to detail are as essential to narrative as to science. Expletives are usually expressed in emotionally intense moments, jogging our minds with a 'bookmark' to immediately help memorize harsh events for future caution.

In this story, written in protagonist-narrator style with only one voice, the contributions and responses to disagreements by other members of the scientific team are not explicitly described. The several narratives which remain untold draw attention to an extraordinarily persistent myth about heroic science and scientists. It is often the case that in telling the story of a quest to reveal the secrets of Nature, scientists, like heroes, are prone to forget past benefits and focus praise on new discoveries, as was meant by 'One touch of nature makes the whole world kin'.[30] The potential for a heroic narrative style to be criticised as self-praising remains to be assessed by the reader.

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28 Nicholas Kulish, 'Author, 17, Says It's 'Mixing', Not Plagiarism', *The New York Times*, 11 February 2010, <http://www.nytimes.com/2010/02/12/world/europe/12germany.html> [accessed 20 June 2011].

29 Wystan H. Auden, 'Writing', in Id., *The Dyer's Hand, and Other Essays* (New York: Random House, 1962), republished in *Narrative Magazine*, <http://www.narrativemagazine.com/issues/fall-2008/writing> [accessed 20 June 2011].

30 William Shakespeare, *Troilus and Cressida*, ed., with a Commentary, by R. A. Foakes, Introduced by Colin Burrow (London: Penguin, 2006), Act III, Scene iii.

Where has our hero's journey taken us? What about the original questions aroused by the poster on the Wellcome Trust building? What is the boon to benefit the world? At the beginning unexpected results needed deciphering. Detailed study confirmed the original observations and a chance encounter provided additional data to secure publication. Being of general interest, the observations were narrated in a popular science magazine. Narration was more dramatically shaped by the press, to the point where some of the statements made were inaccurate, ironically in the medium that is closest to the general public. So the broadest opinion influencing critical political decisions can be tainted by inaccuracy, unless narrative remains true to science.

What drives the agenda, the science or the narrative? Was narrative true to science in our hero's story? Just a year ago, in a highly laudable manner, the senior author of the Spanish group heroically contributed a short manuscript revealing a mistake.[31] They had been unable to repeat their observations regarding the spontaneous transformation of long-term cultured human mesenchymal stem cells. Prevalent characteristic genomic alterations raised suspicion that the most plausible explanation for their hMSC spontaneous transformation phenomenon was an artefact. There was an unnoticed minimal cross-contamination of some of the original samples with HT1080 cells, a cancer cell line derived from a human fibrosarcoma with high culturability and tumorigenic potential. The Spanish group demonstrated that this cross-contamination was not easily noticed because the MSC modulated the growth of the HT1080 cells, which only showed their much faster duplication rates once the hMSC had succumbed to senescence. Their original manuscript in *Cancer Research* has been retracted.[32] The second surprise came from analysis of the chromosomes by a technique used in hospital diagnostic laboratories. Chemically painting chromosomes different colours failed to show karyotypic abnormalities in our tumorigenic cells.[33] This did not mean there were no genetic changes, rather that they were below the threshold limits of detection by clinically diagnostic methods. Certainly it would be useful to use a simple chromosome analysis as a tell-tale indicator that the cells might have changed in culture and should not be used for therapy. However, the corollary that the cells might be presumed safe if

31 Silvia Garcia, María C. Martín, Ricardo de la Fuente, Juan C. Cigudosa, Javier Garcia-Castro, and Antonio Bernad, 'Pitfalls in Spontaneous in vitro Transformation of Human Mesenchymal Stem Cells', *Experimental Cell Research*, 316 (2010), 1648 – 1650.

32 Ricardo de la Fuente, Antonio Bernad, Javier Garcia-Castro, María C. Martín, and Juan C. Cigudosa, 'Retraction: Spontaneous Human Adult Stem Cell Transformation', *Cancer Research*, 70 (2010), 6682.

33 Jorge S. Burns, Basem M. Abdallah, Henrik D. Schrøder, and Moustapha Kassem, 'The Histopathology of a Human Mesenchymal Stem Cell Experimental Tumor Model: Support for an hMSC Origin for Ewing's Sarcoma?', *Histology and Histopathology*, 23 (2008), 1229 – 1240.

the simple chromosome analysis revealed no change was not necessarily true. More stringent quality control tests will need to be developed. Finally, perhaps most surprising of all, the original idea that the telomerized cells were merely an experimental tool, never to be used in the clinic, has also been usurped. Using a revolutionary new method likened to implanting a 'teabag', telomerized hMSC were used as delivery vehicles to provide acute stroke patients with a cell-synthesized molecule known to limit neuronal damage.[34] The teabag is key to preventing the engineered hMSC cells from directly contacting the patient tissue and after a short treatment period to reduce acute neuronal damage, the implant can be removed. Clinical trials are at an early stage and it is too early to say to what extent the method works, but early indications are encouraging and the whole approach serves to highlight additional facets for how stem cells might be applied therapeutically. Indeed, stem cell heroes are likely to have more than a thousand faces and if communicating science in this narrative style has encouraged one more face to pick up this challenge, then the ultimate boon to benefit the world might be you.

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34 Anna M. B. Heile, Christine Wallrapp, Petra M. Klinge, Amir Samii, Moustapha Kassem, Gerald Silverberg, and Thomas Brinker, 'Cerebral Transplantation of Encapsulated Mesenchymal Stem Cells Improves Cellular Pathology after Experimental Traumatic Brain Injury', *Neuroscience Letters*, 463 (2009), 176 – 181; Murray Wardrop, 'Miracle "Teabag" Helps Stroke Victim to Speak Again', *The Telegraph*, 3 December 2008, <http://www.telegraph.co.uk/health/healthnews/3543937/Miracle-teabag-helps-stroke-victim-to-speak-again.html> [accessed 20 June 2011].

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