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The Price of Metaphor is Eternal Vigilance: Language Metaphors in Popular Genetics

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Abstract: Using literary critical tools, this paper will examine the role played by metaphor in contemporary popular science writing on genetics. Following Richard Whitley's assertion that popular science writing's 'expository practices are not epistemologically neutral' I argue that, given its central pedagogical role in popular science writing, an analysis of the use of metaphor is critical to our understanding of popular scientific discourse. In this paper, I engage in textual analysis focussing on the presence and effect of just one metaphor – that of language – in popular science writing on genetics. Specifically, I argue that language metaphors are deployed strategically to support the authors' positions on genetic determinism: metaphors of language, with a few notable exceptions, are seen to generally present a gene-centric approach to ontogeny.

Keywords: Popular Science, Metaphor, Genetics, Determinism

> *It is impossible to carry out scientific explanation without metaphors. Indeed we can hardly speak without them. The most we can demand is that we be conscious of the metaphorical content of our words and not be carried away […] No metaphors are truly benign and without dangers. As Norbert Weiner observed, 'The price of metaphor is eternal vigilance'.*
> Richard Lewontin, from the foreword to Susan Oyama's *The Ontogeny of Information*, 2nd Edition

Introduction

THE METAPHOR OF language in popular science explanations of genetics has become almost ubiquitous. Descriptions of DNA as 'the book of life', of the base pairs as letters, genes as sentences, or the genetic material as an 'encyclopaedia' or 'instruction manual' – these metaphors are commonplace. In this paper I will examine the role that this system of metaphors plays in popular science writing on genetics, focussing especially on the way in which this metaphor is deployed to support particular views on genetic determinism.

It is important to establish, before going any further, a working definition of 'popular science writing'. I will be using the term to denote book length works, either by scientists or non-scientists, whose express purpose is to explain for a non-specialist or lay audience a particular scientific theory, scientific discovery, or area of science. This categorisation excludes, therefore, science journalism, science in popular culture, and science fiction. It is also important to note that although my approach to popular science writing is a critical one, my critique is not aimed at the genre – I do not see popular science writing as a 'distortion' or 'simplification' of 'real' science. In this, I follow the lead of those such as Richard Whitley and Stephen Hilgartner who have been instrumental in undermining this 'dominant view' of popular science.[1] It has become almost compulsory in studies of popular science[2] such as this one to include just such a rejection of the traditional conception of popular science, drawing on Hilgartner, Whitley, and Clôitre and Shinn[3] – to the extent that one wonders whether the dominant view is not now one that supports this realignment. However, this thorough overturning of an inflexible and often derogatory view of popularization is to be appreciated, even if the phrase 'dominant view' may well now be outdated.

Briefly, the traditional model (I will use this phrase in place of 'dominant view') of popular science involves two communities – on the one hand scientists and scientific institutions; on the other, the public. Popular science is seen as a translation of the know-

[1] Stephen Hilgartner, 'The Dominant View of Popularization: Conceptual Problems, Political Uses', *Social Studies of Science* 20, (1990), 519-39; Richard Whitley, 'Knowledge Producers and Knowledge Acquirers: Popularisation as a Relation Between Scientific Fields and Their Publics', in *Expository Science: Forms and Functions of Popularisation*, ed. by Terry Shinn and Richard Whitley. Sociology of the Sciences Yearbook 9 (1985), 3-28.
[2] See, for example, Greg Myers, 'Discourse studies of scientific popularization: questioning the boundaries', 5, 2003, 265-279; or Elizabeth Leane, *Reading Popular Physics: Disciplinary Skirmishes and Textual Strategies* (Aldershot: Ashgate, 2007).
[3] Michel Clôitre and Terry Shinn, 'Expository Practice: Social, Cognitive and Epistemological Linkage' in Shinn and Whitley, 31-60.

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ledge produced by the former community and absorbed by the latter, in a one-way passage of information. Furthermore, the process of popularization is seen as 'at best, "appropriate simplification" [...] At worst popularization is "pollution" '.[4] Finally, popular science is not seen as having any impact on the elite scientific community. Hilgartner sees the image of 'contaminated' popular science as a crucial corollary of the maintenance of the ideal of 'pure' scientific knowledge, shoring up 'an idealised view of genuine, objective, scientifically-certified knowledge' and also placing the judgement of which popularizations are '"appropriate" [...] and which are "distortions" ' in the hands of the scientific community.[5]

The primary criticism of the traditional model is the reductiveness of the process and of the formulation of the two communities: there is a far greater heterogeneity than is conceived in the traditional model. Firstly, the audience, the 'knowledge acquirers' in Richard Whitley's phrase, are traditionally seen as 'large, diffuse, undifferentiated and passive'; but Whitley shows that parts of the audience exert an influence back upon scientific research and that (even excluding 'the important set of audiences constituted by other scientists') they vary in levels of scientific knowledge.[6] In short 'there are a number of readily identifiable audiences for scientific knowledge which pursue a variety of goals and which are important for scientific research in a number of ways'.[7] Similarly, the scientific community is not a single monolithic entity, but a diverse conglomeration of groups, each with varying epistemological assumptions and experimental practices. The traditional idea of popular science translating between the scientists and the public has been eroded partly by the fact that 'the expansion and specialisation of scientific research in the past 200 or so years has resulted in many scientists popularising their work to other groups of scientists as well as to non-scientists': specialisation has 'increasingly necessitated intrascientific popularisation'.[8] There is, to use Clôitre and Shinn's phrase, 'a sort of expository continuum' of science writing, ranging through 'specialist, inter-specialist, pedagogical and popular articles'.[9]

Moreover, popular science covers not merely recognised scientific 'facts' but a full spectrum of knowledge from rarely disputed, long held assumptions, through widely believed, but unproved, theories, to wild speculation and conjecture. Popular science often represents an expository space for ideas which are precisely *not* established; popular science's role as a forum for speculative theorisation, in a way impossible in a professional journal, can, and perhaps should, be seen as a vital one – especially for the cross-fertilisation of ideas within the scientific community. A. Truman Schwarz has asserted that 'Popularization is [...] a way of going public with controversial opinions' and W. Daniel Hillis notes that popular science books often involve ideas 'that have absolutely no way of getting published within the scientific community'.[10] Richard Dawkins recognises the importance of the genre when he reveals that his own books contain both 'popularizations of material already familiar to scientists and original contributions to the field that have changed the way scientists think, albeit they haven't appeared in scientific journals'.[11]

Just as I do not see popular science writing as an inferior copy or a distortion of academic science papers, so I will not be arguing that the use of particular metaphors, or the manner of their use, are 'mistakes' or misjudgements on the part of the author. Metaphorical language is an important tool in every writer's toolkit – science writers as much as novelists. My argument, rather, is that we as readers must be aware – as Lewontin notes in my epigraph – of the metaphoric status of some of the descriptions in popular science writing, and that popular science writers must be aware of the potential of metaphoric language, more even than literal language, to allow multiple interpretations. Both readers and writers must maintain, in the words of Norbert Weiner, the vigilance that is the price we pay for the use of metaphor.

Gene-Centrism, Enviro-centrism, Interactionism

'Everybody,' Matt Ridley asserts in *Nature via Nurture*, 'with an ounce of common sense knows that human beings are a product of a transaction between the two [nature and nurture]'.[12] Susan Oyama notes that the 'ease with which extreme nature and nurture positions are parodied ensures that no one will stand behind either straw man'.[13] The debate

[4] Hilgartner, p.519.
[5] Hilgartner, p.520.
[6] Whitley, pp.4-5.
[7] Whitley, p.5.
[8] Whitley, p.4, p.10.
[9] Clôitre and Shinn, p.31, p.32.
[10] Quoted in Leane, p.20; quoted in John Brockman, *The Third Culture* (New York: Simon & Schuster, 1995), p.26.
[11] Quoted in Brockman, p.23.
[12] Matt Ridley, *Nature via Nurture: Genes, Experience and What Makes Us Human* (London: Harper Collins, 2003), p.3.
[13] Susan Oyama, *The Ontogeny of Information : Developmental Systems and Evolution*, 2nd edn (Durham, NC: Duke University Press, 2000), p.2.

between genetic-determinists and anti-genetic-determinists (or nurturists) is, then, a question of degree, and for this reason I will use the terms 'gene-centric' to refer to those writers who argue for the relative importance of genes in ontogeny, and 'enviro-centric' for those who assert the importance of environment in the development of an organism.

Both gene- and enviro-centric positions allow that ontogeny inevitably involves the interaction of both genes and environment, and indeed 'interactionism' may seem to present a compromise between the opposing groups. But although 'a generally interactionist *vocabulary* is rapidly becoming universal',[14] it is, according to Susan Oyama, a falling between two stools:

> How does it [interactionism] manage to be virtually universally adopted and thus to lend itself to such radically different approaches? The suspicion is that it has become conceptually vacuous while acquiring the symbolic value of a membership badge, to be flashed upon entry into serious discussion: yes, I belong to the company of reasonable people; now let's talk about the real stuff.[15]

Oyama's argument in *The Ontogeny of Information* is that we need to deconstruct the dichotomy of nature and nurture – that *all* of the variants of interactionism, as they are customarily used, merely combine 'encoded nature with varying doses of contingent nurture', a solution which 'is no solution at all'.[16] Development, she argues,

> can no longer be explained as a combination of translated information from the genes (to make innate features) and information acquired from the environment (to modify, supplement, or complete those features). Nor can phenotypic features be divided into those that are programmed or biological and those that are not, or ranged on a continuum of relative degrees of programming.[17]

There is not space for a thorough appraisal of Oyama's position here, but I agree with her persuasive and subtle arguments concerning development, and her criticisms of this form of 'conceptually vacuous' interactionism. A key element in Oyama's ensuing critique is her categorisation and analysis of metaphors, in particular what she terms the 'cognitive-causal' gene, or what Stephen M. Downes, in his review of the second edition, calls simply the 'information gene'.[18] In a chapter entitled 'Variations on a Theme: Cognitive Metaphors and the Homunculoid Gene', Oyama briefly examines metaphors of blueprints, plans, rules, instructions, programs, and information in different guises. These metaphors constitute 'a cluster of pervasive metaphors rather than being a legitimate component of an explanatory theory'. 'The information gene concept,' Oyama believes, 'is a metaphor that has seriously misled us'.[19]

In this paper I too will concentrate on metaphor. I propose that metaphors in popular science writing often play an important role in the presentation of the author's argument, and are used strategically to support a particular position. Specifically, I will show that metaphors of language are most frequently employed in popular science writing on genetics to support a view that prioritises the importance of the genes in the creation of an organism, and plays down the role of environmental factors.

The Language Metaphor

The history of the language metaphor has been examined in greater depth by other scholars, and this paper will not rehearse these studies in detail.[20] However, a brief background is in order. The origin of language as an explicatory metaphor in genetics can be traced to a slightly different metaphor, a conjecture made by Erwin Schrödinger, in his influential little book *What is Life?* in 1944, that genes were a 'code-script': 'Every complete set of chromosomes contain the full code' and this embodies 'the entire pattern of the individual's future development and of its functioning in mature state'.[21] As Susanne Knudsen has pointed out, the significance of the metaphor is that it is not simply descriptive of the chemical *properties* of DNA (Schrödinger actually thought the genetic code was held in 'chromatine', not DNA alone), but also of *process*: 'the figurative representation [of a code-script] suggests what the chromosomes *do*: they encode the individual's future

[14] Ibid.
[15] Oyama, p.6
[16] Oyama, p.5.
[17] Oyama, p.3.
[18] Stephen M Downes, review of Susan Oyama, *The Ontogeny of Information* in *Perspectives in Biology and Medicine*, 44, (Summer 2001), 464-469, (p.465).
[19] Ibid.
[20] Evelyn Fox Keller, *Refiguring Life: Metaphors of Twentieth Century Biology* (New York: Columbia University Press, 1995); Lily Kay, *Who Wrote the Book of Life?: A History of the Genetic Code* (Stanford: Stanford University Press, 2000); Richard Doyle, *On Beyond Living: Rhetorical Transformations of the Life Sciences* (Stanford: Stanford University Press, 1997).
[21] Erwin Schrödinger, *What Is Life? (*Cambridge: Cambridge University Press, 1992. First published 1944), p.22.

development'.[22] It is this fact that results not only in the metaphor's longevity, but also its central place in the subsequent theory-formation of genetics, and its adaptation and revision in subsequent decades.

It has long been observed that the history of genetics, in particular of the theorisation of the gene, has resulted in a dual understanding of what a gene is. In his concise history in *The Misunderstood Gene* Michel Morange describes how the gene began simply as a term for hereditary 'factors', and not a material object at all.[23] Indeed, due perhaps to a fear of returning to a preformationist understanding of genetics, there was a resistance to the idea of a physically located 'gene'. Nonetheless, through experimental research, culminating in Watson and Crick's publication in 1953, the location of genes was identified with the chromosomes and then finally with DNA. However, with its localization, the gene did not lose its former sense of the *process* through which transmission of factors took place. Judith Roof has coined the term 'DNA gene' to refer to the resulting composite concept: 'The two categories – the gene as an organized operation, DNA as a chemical material – have merged conceptually, producing something like a "DNA gene" '.[24] This combining of physical object and the process of transmission is also noted by Evelyn Fox Keller. Arguing that creating a discourse, forging a 'way of talking about genes', was of critical importance to the development of genetics, Keller sees the concept of the gene that was created as 'part physicist's atom and part Platonic soul – at one and the same time a fundamental building block and an animating force'.[25]

It is through a secondary metaphor of translation that Schrödinger's code metaphor finds itself increasingly elided with a metaphor of language. Knudsen identifies George Gamow as responsible for introducing the translation metaphor in his immediate response to Crick and Watson in 1955; but concerned as she is primarily with a diachronic study of the code metaphor, she does not mention that the combination of the, at least partly, historically contingent fact of the identification of base pairs by the four letters A, G, T, C, and the, albeit incorrect, translation metaphor inevitably results in the evocation of language. Language is present, where the code metaphor is not, in the passage she quotes from Gamow:

> the problem reduces to finding a procedure by which a long number written in a four-digital system (four bases forming the molecules of nucleic acid) can be *translated* in a unique way into a long word formed by about twenty letters (twenty amino acids which form protein molecules).[26]

It is interesting to notice the way in which in this passage the word 'translation' acts as a metaphoric hinge: the metaphor of a digital, number system shifts, via the concept of translation, to a metaphor of language – a protein 'word' formed of amino acid 'letters'.

The code metaphor, then, morphs into the language metaphor, especially in the immediate aftermath of Watson and Crick's discovery of DNA in 1953. This is partly because of the influence of linguistics: Lily Kay has noted the 'striking analogies between the two fields' of linguistics and genetics in the 1950s. But the importance of codes and cryptography during the Second World War also surely played a part. As wartime codes were primarily messages, so the cracking of codes became one of translating and reading them – codes became essentially linguistic. Likewise, the cracking of the genetic code became a process of 'reading', a shift encapsulated in the passage from Gamow above.

This metaphor of reading, and the language metaphor more generally, persists in more recent popular science writing on genetics, and it is on this that I will now concentrate. The following is a fairly representative example of the use of the language metaphor:

> Up to fifteen cistrons are strung together to give a transcription unit (scripton). The scripton corresponds to a compound sentence. Many hundred scriptons make up a replication unit (replicon), which can be compared with a paragraph of text [...] Finally, the gene [...] corresponds to the complete text. The hierarchical organization of a living system on the phenotypic level is directly reflected in the hierarchically organized structure of genetic information.
>
> The analogy between human language and the molecular-genetic language is quite strict [...]
>
> There are admittedly limits to this analogy. For instance, the molecular-genetic language [...] does not contain question marks.[27]

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22 Susanne Knudsen, 'Scientific metaphors going public', *Journal of Pragmatics*, 35 (2003), 1247-1263, (p.1251).
23 Michel Morange, *The Misunderstood Gene*, trans. Matthew Cobb (Cambridge, MA: Harvard University Press, 2001) p. 14.
24 Judith Roof, *The Poetics of DNA* (Minneapolis: University of Minnesota Press, 2007), p.3
25 Keller, p.9, p.10.
26 George Gamow, 'On Information transfer from nucleic acids to proteins', *Det Kongelige Danske Videnskabernes Selskab: Biologiske Meddelelser,* 2, (1955), 1-7, (p.1).
27 Bernd-Olaf Küppers, *Information and the Origin of Life* (Cambridge, MA: MIT Press, 1990), p.23.

The 'hierarchical organization' of both the living system and of genetic information is noted; but their reflection in the hierarchical organization of language is left implicit. This nesting of units of language is significant because the logical progression – normally, as here, from smallest to largest – from letter to full text implies an analogous logic to the progression from base pair to organism. This linear progression is even more explicit in the following example:

> The chain links [in DNA] can be likened to letters in a sentence, and DNA to a text or code that tells our bodies what to do. The alphabet consists of four letters [...] Starting with this known alphabet, the task of the Human Genome Project is to learn the sequence of the letters and to read the text. The size of the text is enormous. The card catalogue for the DNA library requires enormous computing capacity.[28]

Here the DNA is a 'text [...] that tells our bodies what to do' – there is no implication of other environmental factors. Indeed, the idea that the text tells 'our bodies what to *do*' (emphasis added) carries with it the suggestion of not only physiognomic traits, but behavioural ones.

This reductive progression from gene to organism is a key element in the gene-centric argument; emphasising the role played by genes necessitates disambiguating the link between the gene and the organism. Those metaphors that prioritise the gene as the root cause of physical or behavioural traits tend therefore to work in similar ways, rhetorically: by comparing genetics to systems in which the causal lineage is simpler, without the complexities of chemical, environmental, educational and social interventions, they analogously suggest the direct lineage between genes and the trait, playing down the role of environment. On the other hand, in the opposing enviro-centric rhetoric, the unitary parts of the system used in the 'vehicle' of the metaphor[29] are imagined as sufficiently affected by environment to represent a holistic sum that is far enough removed as to deny causal priority to the gene.

In general the use of the language metaphor in popular science writing on genetics falls into the first of these two categories: it tends to reinforce this non-interactionist gene-centrism. Language is represented, as I will show, as a system in which the progression from letters and words to meaning is simple, and unaffected by elements outside the system. By analogy, the suggestion is, the same is true of the relationship between genotype and phenotype. In order to show this, it is important to identify three key features of the use of the language metaphor in representations of genetics.

The first, the most common form that the language metaphor assumes, is what we could call the 'physical manifestation of language'. In other words, language is normally represented in physical-tangible form – as a book, as a page, as a library. Language, in the language metaphor for genetics, rarely means language as an abstract system, or speech or dialogue; rather, it almost always means written words on a page. As a metaphor for the gene, therefore, this emphasises the gene's physicality, its locatability, its isolation and its unitariness: the gene becomes reified. As José Van Dijck has put it, the terms *gene* and *genome* 'become crystallized into things, rather than being fleshed out as complex processes. Reified into entities, they start to function in society as signs with fixed meanings, only to become signifiers in other contexts'.[30] These attributes, in particular locatability, are an important part of the gene-centric rhetoric, especially within the Human Genome Project (HGP) context, because they support the idea and the possibility of identifying and locating individual genes that 'code for' a trait. Amidst a public perception of the HGP as primarily medical-science research, the social benefit of the HGP and a form of gene-centrism are mutually supporting claims: in order to 'treat' or 'fix' genes 'for' diseases, they must be identifiable and locatable; the resulting implication is that genes as locatable entities are 'for' a trait – a distinctly gene-centric perspective.

Having noted that the manifestation of the language metaphor is almost exclusively textual, the second salient feature of the language metaphor is the kind of texts that are invoked as part of the metaphor. Dictionaries, encyclopaedias, instructions, blueprints, recipes are the paradigmatic texts; there is no instance, to my knowledge, of DNA being described as, say, 'the epic poem of life'.

> The [DNA] dictionary maps 64 code words onto 21 meanings [...] Human languages are numerous and changing [...] the 64-word DNA dictionary is universal and unchanging.[31]

> DNA can be regarded as a set of instructions for how to make a body, written in the *A, T, C, G* alphabet of the nucleotides [...] a book case

[28] Ted Peters, *Playing God?: Genetic Determinism and Human Freedom*, 2nd edn (New York: Routledge, 2002), p.3.
[29] This is I. A Richard's terminology: the 'tenor' of a metaphor is the subject to be described, the 'vehicle' is that to which the subject is compared. E.g. 'The setting sun [tenor] was a red ball [vehicle] in the sky'. See I.A. Richards, *The Philosophy of Rhetoric*, ed. by John Constable (London: Routledge, 2001. First published 1936), p.64.
[30] José Van Dijck, *Imagenation: Popular Images of Genetics* (New York: New York University Press, 1998), p.162.
[31] Richard Dawkins, *The Ancestor's Tale: A Pilgrimage to the Dawn of Evolution* (New York: Houghton Mifflin, 2004), p.22.

> containing the entire architect's plans for the entire building.[32]

> The genome – the sum total of an organism's DNA – was understood to be its book of life, life's little instruction book.[33]

These sorts of texts are chosen because the language is assumed to be unambiguous. The implication is that an unproblematic relationship between language and meaning is analogous to an unproblematic relationship between genotype and phenotype. The uncritical association of language with 'meaning' or 'coding for' is clear in the choice of texts that are used in these textual metaphors. The emphasis on communicative information, and the fixity of meaning in these texts, implies the unambiguous nature of 'translating' DNA into proteins, and thus into physical traits.

But language *is* ambiguous, and this leads onto the third feature of the language metaphor. The language metaphors in these books ignore the polysemy of meaning in language by taking a linguistic approach to language, rather than a literary one, and by using texts where the stated purpose is instructive or informative. But the result is that these metaphors of language in popular science books on genetics suggest the direct relationship between genotype and phenotype – in other words, gene-centrism. Discussing the similar metaphors of blueprints and programs, Thomas Fogle has observed that

> the comparison of DNA with blueprints and programs engenders the interpretation of genetics as a matching process between a single gene and a trait. This imposes a sense of biological determinism onto what is basically a contingent relationship between biochemical pathways, cellular structures and physiological processes.[34]

The same, I argue, is true also of the language metaphor.

The exceptions in this case prove the rule. Just as the passages I have highlighted establish the centrality of the role of genes over environment through a language metaphor that limits or ignores the polysemy of language, other writers use the language metaphor to present a more interactionist position. Richard Pollack accomplishes this by shifting the ground of this metaphor from a linguistic, syntactic appreciation of the DNA 'text', to a more literary one; thus, just as literary critics propose multiple readings of texts, so 'the cells of our bodies do extract a multiplicity of meaning from the DNA text inside them'.[35] Pollack's purpose in importing the concepts of literary criticism is to show that 'the leap from DNA to protein is as arbitrary as the relation between signifier and signified'.[36] Pollack is using the same metaphor as other popular science writers, but for exactly the inverse purpose: elsewhere it is precisely the assumption of the unproblematic relationship between signifier and signified that represents the direct chain of causality from DNA to protein, and thence to physical and behavioural traits in the organism.

Lenny Moss has provided a similarly nuanced use of the language metaphor. He is even more explicit in citing linguistic and biological context as comparable. Just as in dialogue 'context [...] determines the significance of the word, not vice versa', so the same might be argued of genes within context:

> Contexts, in a biological vein, would be found at the many levels of structured, dynamic systems that are always in some relationship to other structured, dynamic systems, and/or a complex environmental ambience.[37]

For Moss, it is not the language metaphor that is at fault for gene-centric representations of genetics, it is the fact that it is misused. On the contrary, he sees the great 'explanatory potential of depicting genes as words whose significance is context-dependent'.[38] The introduction of context into the metaphor 'serves precisely to undermine vectoral unidirectionism (all causality emanating outward from the genes as the "deep text which underlies all else")'.[39] What both Pollack and Moss show is that although the language metaphor can be deployed in support of a gene-centric position, it can also be used – indeed, is perhaps better suited – to support an interactionist position with a greater emphasis on environmental influence.

Conclusion

Metaphors play a crucial pedagogical role in popular science writing. Indeed, as Lewontin observes, it is almost impossible to escape them – nor should this

[32] Richard Dawkins, *The Selfish Gene*, 2nd edn (Oxford: Oxford University Press, 1989), p.22-23.
[33] Nina V. Fedoroff, Nancy Marie Brown, *Mendel in the Kitchen: A Scientist's View of Genetically Modified Foods* (Washington, DC: Joseph Henry Press, 2004), p.81.
[34] Quoted in Van Dijck, pp.149-150.
[35] Richard Pollack, *Signs of Life: The Language and Meanings of DNA* (New York: Houghton Mifflin, 1994), p.5.
[36] Van Dijck, p.155.
[37] Lenny Moss, *What Genes Can't Do* (Cambridge, MA: MIT Press, 2003), p.72.
[38] Ibid.
[39] Ibid.

be our aim. However, it is important to remember Richard Whitley's warning that 'expository practices are not epistemologically neutral'.[40] We must subject metaphors to critique, and acknowledge that not only do they carry with them the same epistemological assumptions as the rest of a text, but they are also – it is inherent in their very structure – prone to ambiguity. Metaphors are a vital part of popular science writing's explanatory power, and as such, play a large part in creating public perceptions and discourses on science. These discourses in turn have tremendous impact, as Evelyn Fox Keller has noted:

> What then do I mean when I say that the discourse of gene action – now augmented with metaphors of information and instruction – exerted a critical force on the course of biological research? Can words have force in and of themselves? Of course not. They acquire force through their influence on human actors. Through their influence on scientists, administrators, and funding agencies, they provide powerful rationales and incentives for mobilizing resources, for identifying particular research agendas, for focusing our scientific energies and attention in particular ways.[41]

Given the significance of popular science texts in producing and moulding the public discourses surrounding science, and given the potential outcomes of the dominance of the discourse of gene-centrism, it is important that these texts receive the critical attention of literary scholars in the future.

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[40] Whitley, p.11.
[41] Keller, p.21.

About the Author

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Bradon Smith is a PhD candidate in the Faculty of English at the University of Cambridge, from which he also received his BA and MPhil. His doctoral research focuses on the role and effect of literary techniques in contemporary popular science writing and the parallel impact of scientific metaphor and representations of science in contemporary fiction. He also has research interests in the aesthetics and rhetoric of climate change, on which he co-convenes an interdisciplinary research group.

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