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A Meta-Metaphor for Science: The True and the Fictional within the Book of Nature

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Abstract

Evelyn Fox Keller is unsurpassed in the perspicuity with which she has drawn attention to the power of metaphor within science, to the work it does in defining scientific discourse, and in developing methodologies to analyse the consequences of semantic ambiguity. In this paper I consider a great metaphor for science, rather than within science. The ‘Book of Nature’ in which we ‘read’ the structures that science reveals is at least as old as Augustine, and enjoyed strong advocacy in other ages from Hugh of St. Victor, Boyle and Galileo, to name a few. Yet it is not without its dangers. The significance of ‘books’ changes with their availability, the language they are written in, the communities who are educated to read them, and their hermeneutic context. I will suggest ways that science has been construed differently following these changes in the metaphor’s meaning, including a suggestion that part of the early modern shift is from pure ‘reading’ of the Book of Nature, to writing it.

Introduction: metaphors of codes, books, and nature

In her 2015 article, *Cognitive functions of metaphor in the natural sciences* (Fox-Keller 2014), Evelyn writes of metaphor, ‘Indeed, the essence of a live metaphor is precisely the juxtaposition of similarity and difference, the manifest untruth of equating source and target.’ Her sensitivity and alertness to the power of metaphors in science both to illuminate and confuse, has been a constant, perceptive and arguably prophetic aspect of her writing throughout, and one that has prompted me to think afresh, and more guardedly, about the metaphorical cloud that envelopes my own scientific fields. In that same article, she clarifies two senses, often confused, of the metaphor of *code* when applied to the genome. The low-level sense is the simple coding for proteins, the second is the larger sense of Schrödinger’s (1944) ‘code-script’ that implies an entire organism:

Every complete set of chromosomes contains the full code; so there are, as a rule, two copies of the latter in the fertilized egg cell, which forms the earliest stage of the future individual. In calling the structure of the chromosome fibres a code-script we mean that the all-penetrating mind, once conceived by Laplace, to which every causal connection lay immediately open, could tell from their structure whether the egg would develop, under suitable conditions, into a black cock or into a speckled hen, into a fly or a maize plant, a rhododendron, a beetle, a mouse or a woman.”

It is this larger, deterministic and casual agency for organisms that is Evelyn’s object of criticism in her celebrated *Century of the Gene* (Fox-Keller 2000). The continued tension over the interpretation, and the causal strength of the idea of a biological code made me think about the wider and larger metaphor of *reading* within nature, and as a guiding interpretation of the function of science as a whole. I don’t know to what extent the ‘genetic code’ inherits its strength and longevity from this longer narrative, but here I would like to ask that question. For the ‘Book of Nature’ has been with us for many centuries of not millennia. Indeed, as we shall see, the notion that nature is not only a book (whose author is sometimes explicit but often only implied), but written *in code*, is certainly as old as the Middle Ages. Furthermore, over the

period in which the ‘Book of Nature’ metaphor has been active, the social framing and even the technological instantiation of the idea of a ‘book’ has changed beyond recognition. The metaphor is, at best, a very slippery and changeable one.

The Story of the Book of Nature

A metaphorical story of reading has dominated natural philosophy (and its earlier, theological, framing), since antiquity. The first signs of the Book of Nature narrative are implied by parallelisms between nature and scripture. Early examples in the Church Fathers are Origen (CE 185–253), who wrote in his commentary on the *Song of Songs*, that “all the things in the visible category can be related to the invisible, the corporeal to incorporeal, and the manifest to those that are hidden” and Athanasius (ca. 296–373), who spoke of the way in which the creation, “as though in written characters” declares through its order and harmony the Lord and Creator (both quoted in Harrison 2015 p.58).

The high Medieval period sees a development of a dual narrative of the Two Books: that of a twin revelation through the Book of Scripture and the Book of Nature. The 12th century scholar Hugh of St Victor in his *De Tribus Diebus*, wrote (Poirel 2002, 9-10):

For the whole sensible world is like a kind of book written by the finger of God – that is, created by divine power – and each particular creature is somewhat like a figure, not invented by human decision, but instituted by the divine will to manifest the invisible things of God’s wisdom.

Reading the two books became a dominant metaphor for the application of human sense, reflection, and insight into nature. As Peter Harrison (2015) points out, the analogy is by no means arbitrary – it accompanies the understanding that a reading of nature was a virtuous discipline analogous to the reading of scripture, a spiritual exercise rather than its early modern reorientation as an epistemology. The Two Books metaphor surfaces in the 13th century in reflections on the seven liberal arts of the English polymath Robert Grosseteste in the tersest of summaries, ‘grammar informs sight’ (cf. Gaspar et al. 2019), and in the Franciscan scholar Bonaventure, who hints at some of the hermeneutical difficulties such a book would present to an aspirant reader (quoted in Brague 2009, 80):

The whole world is a shadow, a way and a trace; a book with writing front and back. Indeed, in every creature there is a refulgence of the divine exemplar, but mixed with darkness ...

Such detailed development of the metaphor is delightful as well as instructive: a book written ‘front and back’ has ink on both the *recto* and *verso* of each parchment or vellum folio – each surface is covered with meaning, and there is the possibility of bleed-through of ink when the pages are thin, and consequent confusion of reading if care is not taken.

The notion of God’s second book is one of the (many, but suppressed in much literature on the history of science) continuities between the medieval and early modern periods, notably in Galileo, who refers not to its medieval usage but quotes Tertullian directly. But by the early 17th century his well-known account indicates that nature’s symbols have metamorphosed from Hugh’s creatures into the notation of mathematics (Burt 2003, 75).

Philosophy is written in the grand book of the universe, which stands continually open to our gaze. But the book cannot be understood until one first learns to comprehend the language and read the letters in which it is composed. It is written in the language of mathematics, and its characters are triangles, circles and other geometric figures, without which it is humanly impossible to understand a single word of it; without these one wanders about in a dark labyrinth.

The translation, though formally correct, is misleading in one sense, in that the ‘mathematics’ that Galileo has in mind for the metaphorical language of nature’s code is that of *geometry* (as is clear from his later explanation), not the algebraic, differential and field-theoretical formalisms of contemporary theoretical physics. Galileo was more of a medieval in this regard than his conventional hagiography allows for. He is also one of the last of the medieval readers of the Book of Nature in the *cultural* implications of that idea before literacy became a capability of more than a tiny minority. For already the twin revolutions of Reformation and Printing by moveable type had transformed the referent of book-reading, transforming the metaphor once more. For if a central tenet of the reformers was that the reading and interpretation of scripture, once the prerogative of the priesthood, becomes the personal task of every vernacular reader, then a similar democratisation of the reading of the second ‘book’ might also be expected on the grounds of cultural history alone. So it proves to be. Towards the end of the 17th century the narrative of God’s second book of Nature is central to the emerging hermeneutical stance of early modern science, in protestant jurisdictions at least. An important example is found in Boyle’s advocacy of the early form of citizen-science known as ‘Occasional Meditation.’ He writes (quoted in Hunter 1990, 284):

The World is a Great Book, not so much of Nature as of the God of Nature, ... crowded with instructive Lessons, if we had but the Skill, and would take the Pains, to extract and pick them out: the Creatures are the true Aegyptian Hieroglyphicks, that under the rude form of Birds, and Beasts etc. conceal the mysterious secrets of Knowledge and of Piety.

The context is key: Boyle is encouraging his lay readers to keep a notebook always to hand, to record their impressions of nature through everyday encounters, and to ponder their meaning. Both reading and interpretation of nature become the task of everyone, within the same daily rhythm as Bible reading and private meditation. The reading of scripture and the reading of nature have both undergone a reformation, although continuities of personal virtuous practice are perceptible here even as natural philosophy is pivoting towards epistemology and away from piety.

The metaphor finds its final flourishing in the natural theology of Paley and the authors of the *Bridgewater Treatises* (Topham 1992). Their series subtitle is less frequently reproduced: it is on the *Power, Wisdom and Goodness of God as Manifested in the Creation*. To follow Paley in his deduction of a personal creative agent of interventionist design in the structure of a biological lensed eye is precisely to read and interpret the text of the Second Book in terms of its author. Yet as Topham (1992) points out, the Treatises themselves track a growing tendency to emphasise scientific content at the expense of the level of theological hermeneutic that Paley had included in his Natural Theology (Paley 1802). They progressively de-emphasised the import of their series subtitle. The book of nature was already distancing itself from the book of scripture as the 19th century’s disciplinary fragmentation and disassociation developed. In a final contextual twist to the transformation of the metaphor before the 20th century, the great mathematical physicist Maxwell noted the potential consequences that publication was no longer confined to the form of the codex and the book, as Matthew Stanley has pointed out (quoted in Stanley 2015, 41):

Perhaps the 'book', as it has been called, of nature is regularly paged; if so no doubt the introductory parts will explain those that follow, and the methods taught in the first chapters will be taken for granted and used as illustrations in the more advanced parts of the course; but if it is not a 'book' at all but a magazine, nothing is more foolish than to suppose that one part can throw light upon another.

The narrative of the Two Books has been a compelling one since antiquity for aesthetic, cultural and theological reasons. For those reasons, however, the metaphor is fluid, taking on the shape of the significance of books and their writing and reading in all three corresponding domains of practice. The parallel growth of literacy and science in Europe from the medieval period onwards, the emergence of printing, widespread education, and the new forms of writing and publication that accompany early modern science, also render the metaphor itself almost irresistible. As the cultural frame around the production, reading and significance of books changed, so does the interpretation of the idea of a second divine volume. But simplistic adherence to the metaphorical reading of the Book of Nature as a conceptual framing for science generates a set of irresolvable problems at its nexus with theology. It is well to heed the warnings with which Augustine characteristically hedged its use, writing in late antiquity (Augustine *Contra Faustum* XXXII, 20):

But had you begun with looking on the book of nature as the production of the Creator of all, and had you believed that your own finite understanding might be at fault wherever anything seemed to be amiss, instead of venturing to find fault with the works of God, you would not have been led into these impious follies and blasphemous fancies with which, in your ignorance of what evil really is, you heap all evils upon God.

Augustine thinks of the poor scribe, who fails to understand what is before him, but attributes that to a failure of the author (or perhaps to a previous transcriber), rather than to his own limitations. I have come across several instances of such scribal presumption in the case of medieval mathematical natural philosophy, especially when this is highly original. An example is in the *De Generatione Sonorum* (on the generation of sounds) of Robert Grosseteste, where the author advances a highly sophisticated theory of geometrical combinations of motion in the parametric definition of both the symbols by which vowel sounds are written in Latin and Greek, and (by hypothesis) the forms of the vocal tract when pronouncing them (Gaspar et al. 2019).

The relevance of the long-history of the Book of Nature metaphor to the notion of *coding* was therefore implicit from the beginning. Long before the hints of Hugh of St. Victor and Bonaventure, or the explicit reference to the hieroglyphic encoding of the Book by Boyle, the problems of decoding, and an anticipation of the consequences of flawed decoding, were anticipated by Augustine in his development of the metaphor. It is fascinating to speculate to what extent this grand metaphor (of nature as a whole constituting a code) might have affected the choice of coding as a language in which to express (in either weak - protein or strong - organism forms of coding) the work of the gene. However, in the task of critically appraising that much narrower field of application of writing and reading within nature, it is of interest to examine where the wider metaphor breaks down.

Problems with the Metaphor of the Second Book

Augustine anticipates the first flaw in the Two Books metaphor – that the understanding of nature, and its representation in current forms of natural philosophy, will be culturally constrained, and subject to the projection of ethical and other human values onto material form which cannot support them. Strong advocate of the universal accessibility of the natural world as reflecting God's creative power as he is, Augustine knows that overinterpretation of nature as a message in itself is a wrong turning. The long story of theodicy (Southgate 2003) raises questions that humans have always wanted to ask of the apparent disorder of nature but when they do, what they see in nature is more likely to pattern the phenomenon of a mirror than a book. Dawkin's attribution of 'selfishness' to an abstracted form within nature, from this perspective, joins a long tradition of misattribution, which includes 'cruelty', 'capriciousness' and 'intemperance'.

On the other hand, once a metaphor has a firm hold on its object, then the interpretative flow can even reverse. One of the consequences of the Reformation was a transformation in the significance, social relations and expectations around 'God's First Book'. The medieval Bible was rare, expensive, written in Latin by scribal copying, and read and interpreted by the educated (and priested) few. By the sixteenth century in Protestant Europe, it was printed, relatively cheap and accessible, written in the vernacular, and the means of quotidian piety. If transformation from access interpretation by the few to the many was the effect of the Reformation on the reading of the First Book, would we not expect a similar induced effect upon the Second, if the metaphorical coherence were sufficiently strong? Indeed, the emergence of a sort of 'lay science' is precisely what we observe emerging in the 'Occasional Meditation' of Boyle, Flavell and others, by the latter seventeenth century (Anselment 2009). Boyle's *Occasional Reflections upon Several Subjects*, urged lay readers to mirror (if not to supplant) the observation of nature by professional scientists, notebook in hand and day by day. Furthermore, Boyle was explicit in acknowledging his debt to a genre of lay guides to daily spiritual exercises, that mirrored (but did not supplant) the ministrations of priests. The hermeneutical stance of early modernism drew its energy from one Book, and injected it into the other.

A second structural flaw in the natural-theological reading of the second book became increasingly visible during the nineteenth century, and was exposed in the greatest clarity by the ascent of the theory of evolution by natural selection. The passivity of written text simply fails to follow faithfully the emergent explorative potential of the tree of life. A written word is written once, and implies an immediate and proximal author. Yet an evolved species, perfectly accommodated to its environmental niche, did not require a pen to inscribe it there. Once Hugh of St. Victor's 'figures' start taking on lives of their own, speciating and exploring new 'texts' within the code of life, the metaphor begins to add inadequacy to a tendency to mislead. Books are, in the modern period, increasingly commonly written as read. One might even venture to extend the metaphorical meshing of gears that connect the First Book and its reformational stimulation of works of personal hermeneutic and piety to a the new science of *writing Nature* that became a hallmark of early modern science. The Royal Society found it necessary to invent the scientific journal. Boyle, and others, developed a new kind of writing and reporting scientific observation (one that detached, as far as was possible, the observer from the observed). Human relationship with Book of Nature turned from one of reading to one of writing. From there it is a small step to imagine nature writing the evolution of its own future into itself.

A third implication of the metaphor of the second book derives from its production. Books possess authors, and in most cases readers of a book may deduce something of the character and purpose of its author through more or less sophisticated levels of reading. Nature becomes a veiled or coded message from, and concerning, its Author. So if the Sacred Page can say of itself (Ephesians 3: 4-5 [NIV])

In reading this, then, you will be able to understand my insight into the mystery of Christ, which was not made known to people in other generations as it has now been revealed by the Spirit to God's holy apostles and prophets

then nature also becomes a once-veiled but increasingly transparent mode of insight into the person and nature of God. In the developed form of reading nature that became the nineteenth century movement known as Natural Theology, we look through nature towards a vision of its Creator. Wary as Luther was of the findings of early modern science, he was no critic of the second book analogy (Bornkamm 1958, 179):

All creation is the most beautiful book or bible, for in it God has described and portrayed Himself.

Attractive though such neo-oracular, albeit Christianised, interpretation of how to read nature might be, it runs as rapidly as the projection of the first problem into the thicket of theodicy – what must we deduce, in this mode of reading, about the creator of catastrophes and carnivores? We hear echoes of Augustine's warning that readers will find evils as well as glories on the face of a reading of nature, and attribute both to the intentional fiat of its Writer. This reading also elicits Maxwell's astute observation that books are written in order, with sequential explanation and development. Attempting to read a work more organic and fluid as if it were written as a single book leads to irresolvable hermeneutical problems.

A fourth issue, delayed until it appears on the beach of the late-modern period as the tide of near-universal theism retreated, is a problematizing of scientific method itself. If the effective practice of science is unaffected by any personal stance of belief, and if both its methods and conclusions align with a material metaphysics, namely the set of practices and assumptions termed 'methodological naturalism' (Okello 2015), what value theistic belief and practice? To summarise the issue: the daily practice of scientific research is pursued *etsi deus non daretur* – the existence of, or belief in, a creating deity does not affect the laboratory or theoretical practice of science, or the likelihood of its success. Transcendence is not a scientific category, and science is pursued within an ontology of the material only. It is important to note the weakness of the claim: the extent of 'naturalism' is restricted to the methodological, not by extension to an entire worldview. Methodological naturalism does not imply metaphysical naturalism. Yet the adoption of methodological naturalism has sat uncomfortably with some believers, and some theologians (e.g. Plantinga 1997), because its deployment of a method that ostensibly ignores the divine seems to imply the irrelevance of a position of faith. However, attempts to reintroduce particular differences in scientific methodology with an ostensibly theistic methodology of science run into insuperable problems at the experiential and epistemological levels. A recent, and thorough, debate on the theological admissibility or otherwise of methodological naturalism has recently played out in the journal *Zygon* (Torrance 2017, Ritchie and Perry 2018). There is not the space here to revisit the arguments of that debate, but I wish instead briefly to develop the discussion of how the problematizing of the grand Second Book metaphor might speak to the smaller but similar metaphor of self-written codes within nature.

Problems with the Metaphor of Coding

At first blush, it is not a surprise that the vast overreach of the great Second Book metaphor for the whole of nature itself creates the four pitfalls (and others besides) on which it stumbles. It does not necessarily follow that the more carefully restricted script-metaphor of genetic coding will suffer from the same drawbacks. However I believe that there is something to be learned from their parallelism of seeking to illuminate nature in terms of writing and reading.

The writing and reading of 'code' has, like the notion of a book, its own cultural history. Indeed the two are technologically entangled as the second century technological marvel of the 'codex' testifies. Codes are open, or deliberately covert, aimed at a highly selected readership. They have carried the same twists of hierarchical power as the deployment of books, and the Book, itself. As we have seen, the imputation of moral values to the genetic code is itself an anticipated category error anticipated by Augustine.

The second 'flaw' of the original metaphor, that it opens up the possible confusion of writing as well as reading, in the case of the gene works rather differently. For this is the locus above all other in which the human ability to 'write' upon nature promises both the greatest rewards and the greatest dangers to the tree of life of which we are a part. Writing is precisely the technology we are now grappling with, yet finding ourselves short of guiding principles – the human genetic engineer is in new territory. Surprisingly, the theological tradition that worked so long with the metaphor of the Books is not so aridly conservative in this regard as one might at first suppose. This was my own surprise in a first attempt to explore a 'theology of science', but starting with the rarely-visited Wisdom tradition (McLeish 2014). This starting point elides to the third issue of the first book, but now the object of 'natural theology' becomes ourselves. What do we learn about the human authors of life's futures by the choices we make when writing ourselves and our progeny?

And once nature carries the deliberate script of human coders, we are led to wonder what might change in scientific methodology? The assumptions of 'methodological naturalism' would not be adequate to future explorers from another world, attempting to make sense of the tangled banks they find on third millennium planet Earth. For the coding of their organisms would not all have evolved through the process of natural selection. Without the assumption of other genetic agency, there would be no account possible of the modifications and extensions of genotype and phenotype that, for good or ill, the alien scientists encounter.

Metaphors are powerful. Especially metaphors of writing and reading. They take us on journeys of their own, suggesting stories by which we might not only interpret, but also rewrite, our world. I will be always so immensely grateful to Evelyn Fox-Keller for teaching me how this is no less true for the work of science, as for the works of imagination, and by that just how essential is the creative imagination for science itself.

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