

1 Metaphor in Scientific Thought and Writing

Nonscientists tend to think that science works by deduction, [. . .] but actually science works mainly by metaphor.

(Brian Arthur, quoted in Waldrop 1994:327)

[. . .] more metaphorical analyses should be conducted on actual scientific texts.

(Johnson-Sheehan 1998:177)

1.1 A Brief Introduction to Scientific Metaphor

It is by no means universally accepted that metaphor and science are inextricably linked. Many simply incorrectly believe that scientific discourse contains no metaphors—which in a sense is hardly surprising, given what we hear about the scientific method and science’s commitment to transparent objectivity. More significantly, perhaps, there are some voices, both past and present, that may have acknowledged the existence of metaphor in scientific discourse, but have nonetheless advocated a careful avoidance of all metaphorical modes of expression. These positions will be considered briefly before we go on to discuss less inimical views on the function of metaphor in communicating scientific ideas. Finally, and building on the striking claim of the first epigraph to this chapter that metaphor does not simply exist in scientific texts but is the main mechanism that enables science to work at all, this section will consider the strong likelihood that metaphor serves the vital function of channelling scientific thought in particular directions and thus exercises a definite influence on the ways in which progress occurs.

1.1.1 *Attempts to Dispense with Metaphor*

As Ortony observes, science is ‘supposed to be characterized by precision and the absence of ambiguity, and the language of science is assumed to be correspondingly precise and unambiguous—in short, literal’ (1993b:1). Scientific texts are thought by some to be characterised by the use of clear,

precise, unambiguous language suitable for reflecting the unembellished truth of science, with metaphors occurring rarely, if at all.

This notion at least partly takes its roots from the seventeenth century. The rise of science during this period coincided with a great interest on the part of many philosophers in the concept of an ‘ideal’ or ‘perfect’ language, which was conceived as a tool for representing concepts in an idealised manner without the interference of an intervening natural language. It was in 1678 that Leibniz produced a long fragment in which he proposed his *Lingua generalis*, one of a number of projects that emerged in the seventeenth century whose aim was the creation of an artificial linguistic apparatus, designed on purely logical terms, that would make this kind of direct representation of reality possible (Eco 1995:269–88).

While these experiments were abandoned as impracticable, the thought that they engendered, that a precise representation of the real world through the use of language but unobscured by ambiguity, fuzziness and figurative expression, has persisted in some quarters. The requirement for scientific texts to be characterised by the use of precise and unambiguous language was a distinctive quality of logical positivism, for example, which held that reality could only be exactly described through the medium of language ‘in a manner that was clear, unambiguous, and, in principle, testable’ (Ortony 1993b:1). The opposing view to this contends that the objective world ‘is not directly accessible but is constructed on the basis of the constraining influences of human knowledge and language’ (1993b:2). Ortony distinguishes two separate approaches to metaphor in line with these different ways of understanding how scientific language should function. The logical positivist view described earlier would be associated with an understanding of metaphor as something that is ‘deviant and parasitic upon normal usage’, and characteristic of rhetoric rather than science, while the contrary standpoint would be that metaphor was ‘an essential characteristic of the creativity of language’ (1993b:2; see also Leane 2007:83–4). In each case, my research aligns itself with the latter view—a position that is in line with modern research into language, cognition and the ability of human beings to process information.

1.2 Metaphor in Science Today

The last few hundred years have seen an abundance of scientific metaphors—including the medieval concept of the Book of Nature, Darwin’s natural selection and the curved space of Einsteinian physics—and this is a tendency that continues until this day, in spite of the efforts of the logical positivists and others. This section provides an overview of metaphorical use in scientific discourse, focusing in particular on the question of how metaphorical language can perhaps influence the direction taken by scientific researchers and on how metaphor lies behind much scientific terminology.

1.2.1 *Metaphor in Scientific Discourse*

Interestingly, nowadays, the important role of figurative language and thinking in science is for the most part even acknowledged by writers from whom a highly cautious attitude to such matters would be expected:

Metaphors and analogies are essential to science and theory. Complex and more abstract areas of science rely particularly on metaphor and analogy to add clarity to knowledge and to communicate that knowledge. This is perfectly legitimate and indeed, to some extent, unavoidable. In science, analogies and metaphors may emerge as useful ways to think about, describe, and explain objective facts and evidence. For example, psychologists have employed the metaphor of visual selective attention being like a 'spotlight' illuminating the relevant information out there in the world from the surrounding darkness of all that we ignore. In many respects this has proved a very fruitful metaphor guiding thinking in this area of study. The problem here is not the use of analogies or metaphor in scientific thinking, but the clear abuse of them.

The problem with pseudoscience is its use and over-reliance on metaphor as an argument in and of itself. Rather than employ metaphors and analogies as illustrations of scientific knowledge, pseudoscience employs analogies to deduce new conclusions and propose alternative truths. At this point it no longer becomes a mere illustration; it becomes an argument by analogy (or metaphor . . .).

(Braithwaite 2006)

It should be noted that Braithwaite argues that metaphor and analogy are sometimes needed in order to add clarity. Of interest here too is the distinction that he draws between science and pseudoscience in terms of their use of metaphor and analogy. The fact that this article was originally published by an organisation called UK-Skeptics means that the appraisal that it offers is likely to be a relatively sober one.

Mithen similarly identifies the use of metaphor and analogy as one of three critical properties of science (1996:245). However, it seems highly probable that the level of metaphoricity varies from one area of science to another. Dunbar, for example, argues that metaphors occur most frequently in texts about physics and evolutionary biology, with the reason being that the subject matter of these disciplines concerns phenomena 'that everyday experience does not equip us to talk about', unlike that of chemistry or anatomy, for example, for which the 'conventional mechanistic terminology' of everyday language is totally appropriate (1995:142). Dunbar also argues that such metaphors tend to use the social human world as their source domain (1995:142; see also Mithen 1996:308). Some brief comments will be made in Section 1.2.4 regarding how popular science texts differ from specialist ones in this respect.

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Finally, it should be pointed out that some metaphors become very central to our way of thinking and speaking about certain subjects, which means that, if the time ever arrives when these metaphors come to be considered obsolete, a certain realignment of concepts and means of expression will become necessary. This is the case with evolutionary biology, very central to which has always been a metaphor originally suggested by Darwin himself in *The Origin of Species*: ‘The affinities of all the beings of the same class have sometimes been represented by a great tree. I believe this simile largely speaks the truth’ (Darwin 1872:129). Darwin’s original vision was of the totality of life on earth represented by a tree, each branch of which was a single species, some of which reach an eventual dead end but others—today’s surviving species—extend until the very top. This image has supplied several generations of scientists with not only a fundamental ‘unifying principle for understanding the history of life on Earth’ (Lawton 2009:34) but also with an ultimate aim in the form of the eventual faithful reconstruction of the tree itself.

However, this view has been gradually dismantled as we have improved our ability to read genetic material and, ultimately, entire genomes. In 1999, Doolittle made the provocative claim that ‘the history of life cannot properly be represented as a tree’ (1999:2124). Clearly, the Tree of Life does not exist in nature, but it is rather imposed on nature as a framework for classification (see Lawton 2009:37). If species do not simply pass on traits but also regularly exchange genetic material or hybridise with other species (as it appears that they do), then what emerges is not a ‘neat branching pattern’ so much as an ‘impenetrable thicket of interrelatedness’ (2009:36). While the model that it represents has probably not yet outlived its usefulness when applied to animals and plants, in all likelihood it no longer provides an adequate description of the workings of evolution in general; like Newton’s mechanics, it has proved to be revolutionary and highly fruitful in its time but probably can no longer account for the highly complex data that is now being observed and discovered in the real world (see Lawton 2009:38–9).

In addition, notwithstanding these assertions by writers such as Doolittle and Lawton, the concept of the Tree of Life is still very much alive in microbiology and molecular biology, although as a pictorial representation it is undergoing constant development and revision. Modern versions of the Tree of Life in fact no longer really resemble a tree, and the original terms ‘tree’ and ‘branch’ have now been joined by others such as ‘lineage’ (see Pace 2009; Hug et al. 2016).

Interestingly, metaphorical language can sometimes start to fall behind current scientific thought, eventually even lagging so dramatically that it can actually belie the scientific worldview, as we shall see in Interlude One. However, the next section will consider the implications of this relationship between science and metaphor in somewhat more general terms.

1.2.2 Metaphor and the Channelling of Scientific Thought

What Braithwaite does not appear to allow for is the possibility that metaphor's scientific scope of application is not limited to conceptualising, describing and explaining objective facts and evidence but that it can play a role in helping our understanding of the natural world to advance (selectively) in certain directions. In the technical literature, this is known as metaphor's theory-constitutive function, and it will form part of our discussion later on (see Section 5.1.1).

We have already considered the example of how Darwin's tree metaphor has acted as a convenient framework for conceptualising the workings of evolution and how it gradually appears to be giving way to alternative models—or at least transforming itself beyond recognition—as our understanding of the relevant processes has increased. As I have just suggested, while it is current, such a metaphor will suggest to researchers certain avenues of investigation that are congruent with it and at the same time may make it less likely that other directions will be pursued. As another possible instance of this phenomenon, we may cite the metaphorical use of the word *engineering* to refer to technical areas to which it did not previously apply—for example, energy engineering, nanoengineering, genetic engineering and language engineering. It seems that this *engineering* metaphor, once adopted, will influence the way scientists conceptualise their work and may very likely lead their research in new directions.

If such a channelling influence does indeed exist, we would expect scientists themselves to articulate their thoughts on it to some extent. Interestingly, the author of at least one of the articles included in the corpus does indeed reflect on this phenomenon. The following quotation, for example, comes from the article entitled 'Synthetic Life':

'Interchangeable components are something we take for granted in other kinds of engineering,' Endy notes, but genetic engineering is only beginning to draw on the power of the concept. One advantage it offers is abstraction. Just as electrical engineers need not know what is inside a capacitor before they use it in a circuit, biological engineers would like to be able to use a genetic toggle switch while remaining blissfully ignorant of the binding coefficients and biochemical makeup of the promoters, repressors, activators, inducers and other genetic elements that make the switch work.
(Gibbs 2004:77)

There are a number of further examples from Gibbs (2004) that also imply an acceptance of the legitimacy of this function of metaphor, including the following:

Biologists are crafting libraries of interchangeable DNA parts and assembling them inside microbes to create programmable, living machines.
(Gibbs 2004:75)

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‘We would like to be able to routinely assemble systems from pieces that are well described and well behaved,’ Endy remarks.

(Gibbs 2004:76)

That way, if in the future someone asks me to make an organism that, say, counts to 3,000 and then turns left, I can grab the parts I need off the shelf, hook them together and predict how they will perform.

(Gibbs 2004:76)

At a mechanical level, individual BioBricks (as the M.I.T. group calls the parts) can be fabricated and stored separately, then later stitched together to form larger bits of DNA.

(Gibbs 2004:77)

We can also find such an acceptance in other *Scientific American* articles, such as the following:

. . . once nature developed such an effective mechanism for silencing the subversive genes in viruses and mobile DNA sequences, it started borrowing tools from the RNAi tool chest and using them for different purposes.

(Lau & Bartel 2003:40)

Taken together, these examples represent strong evidence for the validity of the idea that the existence of a metaphor can in some way engender particular kinds of creative thinking in the practitioners of a specific scientific discipline. However, as conceded by Gibbs, such analogies can only be applied in certain respects (2004:78)—an observation that is of course in line with the concept of partial mapping that is introduced in Section 3.1.2.

1.2.3 *Metaphor and Terminology*

From at least the time when the eleventh-century monk Constantine the African, working on metaphorical principles, used the Latin word *cataracta* (‘large waterfall’) to describe a rather nasty condition of the eye (McVaugh 2001:326–8), metaphor has been used as a basis for scientific and medical terminology. It is in fact one of the main ways in which new terms are formed (besides morphological, syntactic, lexical and stylistic: see Divasson & León 2006:59, 61). As will be discussed later in this section, ancient languages such as Greek and Latin play an important role in terminology formation in many Western languages, which means that in any terms created in this manner, the metaphoricity will be hidden, although still implicitly present.

As argued by Arbib, ‘Almost any interesting descriptive term can be shown etymologically to be a dead metaphor’, the examples that he provides being *spirits* (for whisky), *leaves* (for pages in a book) and *fiery* (for a

person's temperament) (2012:277). A similar observation had in fact been made by Owen Barfield—a member of the famous Oxford-based Inklings literary group—more than 80 years earlier:

. . . one of the first things that a student of etymology . . . discovers for himself is that every modern language . . . is *apparently* nothing, from beginning to end, but an unconscionable tissue of dead, or petrified metaphors. . . . If we trace the meanings of a great many words . . . about as far back as etymology can take us, we are at once made to realize that an overwhelming proportion, if not all, of them referred in earlier days to one of these two solid things—a solid, sensible object, or some animal (probably human) activity.

(1973:63–4, first published 1928)

This observation quite clearly goes much further than merely commenting on the derivation of scientific metaphor. However, the extent to which a term's (or a word's) etymology—whether it is transparent or opaque—will affect a reader's interpretation of it (or his or her ability to identify it as essentially metaphorical) will be considered briefly at the end of this section. The prevalence of dead metaphor can create something of a dilemma for the translation researcher. How much of this should be included in the data: all, some or none of it? If every example is included then it is possible that other, more 'interesting' types of metaphors may be drowned out, and yet without it the picture will be incomplete. In my research, I have tried to resolve this issue by including a representative sample of examples, some of whose metaphorical import is contained in their Greek or Latin roots, but leaving dead metaphor largely to one side, working on the assumption that its translation is probably not of interest to translation studies, if only because in most cases it tends to be largely automatic.

Many Western European languages in fact contain considerable amounts of terminology derived from these ancient tongues. Indeed, according to Caselmann, such terms account for a staggering 98% of the English scientific vocabulary (1998:vii). The main reason for this is the millennia-long tradition that has existed in the West that has treated Latin—and to a lesser extent Greek—as the only proper media for transmitting knowledge and learning (1998), but it is also possibly due in part to the tendency to suppress metaphor that was referred to in Section 1.1: while not removing a metaphor entirely, this approach to terminology formation will at least conceal a term's metaphoricity within the Latin or Greek morphemes of which it is composed.

Finally in this section, we need to turn to the question of the relative transparency of scientific terms in different languages. The morpheme-by-morpheme meaning of terms can either be largely concealed, as is the case with Latin and Greek terms in English (assuming that the reader has no knowledge of these languages), or partially or completely apparent, as with many terms in German, Polish, Russian and Chinese.

In order to illustrate this, we will look at three brief examples. The first two, which are taken from Hofstadter (1997), focus exclusively on Chinese, while the third, which I have produced myself, is multilingual.

The first example concerns the Chinese words for different kinds of dinosaur. As is well known, in common with most or all other European languages, English derives its words for these ancient creatures from Greek roots—the precise meanings of which are probably not available to most speakers unless they take the trouble to find them out. In contrast, the meanings of the Chinese terms are often completely transparent to native speakers, as particular characters with the required ranges of meaning are simply collocated to produce a new word. In many but not all cases, the meanings are direct translations of the Greek terms used in Western languages (see Hofstadter 1997:297; the simplified Chinese form is given first, followed by the traditional):

brontosaurus ('thunder lizard'):	雷龙/雷龍 (<i>leilong</i> , 'thunder dragon')
tyrannosaurus ('tyrant lizard'):	霸王龙/霸王龍 (<i>bawanglong</i> , 'tyrant-king dragon')
pterodactyl ('wing finger'):	翼手龙/翼手龍 (<i>yishoulong</i> , 'wing-hand dragon')
stegosaurus ('roof lizard'):	剑龙/劍龍 (<i>jianlong</i> , 'sword dragon')
triceratops ('three-horned face'):	三角龙/三角龍 (<i>sanjiaolong</i> , 'three-horn dragon')

We see precisely the same situation with these names for subatomic particles (1997:298):

electron ('amber' + suffix -on):	电子/電子 (<i>dianzi</i> , 'spark seed')
proton ('first' + suffix -on):	质子/質子 (<i>zhizi</i> , 'primal seed')
neutron ('neutral' + suffix -on):	中子/中子 (<i>zhongzi</i> , 'neutral seed')
neutrino ('neutral' + suffix -in + suffix -o):	中微子/中微子 (<i>zhongweizi</i> , 'neutral seedlet')
photon ('light' + suffix -on):	光子/光子 (<i>guangzi</i> , 'light seed')

In this way, in this instance at least, Chinese probably represents the extreme of transparency, while in a language such as English, we see something approaching a maximum level of opacity.

Finally, Table 1.1 presents a multilingual comparison of the names of gases, including not only English and Chinese but also some of the other languages focused on in my research. The meanings of the individual morphemes of the German and Russian terms parallel those of the English, with the important difference, of course, that they are quite transparent because they are based on native rather than classical etymologies. The Polish, interestingly, uses a variety of approaches: it creates new words for oxygen and hydrogen from its own word stock but borrows the word for nitrogen from French (which itself is

Table 1.1 Relative Transparency of Terms for Common Gases in Different Languages
(as before, the simplified Chinese form precedes the traditional form)

English	Polish	German	Russian	Chinese
oxygen (from Greek <i>sharp/acidic</i> + <i>brought forth</i>)	tlen (from <i>tlic</i> = to smoulder)	Sauerstoff (<i>sour</i> + <i>substance</i> ; partially calqued on the Greek)	кислород (<i>kislorod</i> ; <i>acidic</i> + <i>origin</i> ; calqued on the Greek)	氧气/氧氣 (<i>yangqi</i> : <i>yang</i> derived from a character meaning <i>nourish</i> ; <i>qi</i> = gas)
hydrogen (from Greek <i>water</i> + <i>brought forth</i>)	wodór (from <i>woda</i> = water)	Wasserstoff (<i>water</i> + <i>substance</i> ; partially calqued on the Greek)	водород (<i>vodorod</i> ; <i>water</i> + <i>origin</i> ; calqued on the Greek)	氢气/氫氣 (<i>qingqi</i> : <i>qing</i> derived from a character meaning <i>light</i> ; <i>qi</i> = gas)
nitrogen (from Greek <i>native soda</i> + <i>brought forth</i>)	azot (from Greek <i>without life</i>)	Stickstoff (from <i>smother</i> + <i>substance</i>)	азот (<i>azot</i> ; from Greek <i>without life</i>)	氮气/氮氣 (<i>dangqi</i> : <i>dan</i> derived from a character meaning <i>diluted</i> ; <i>qi</i> = gas)

based on Greek). In general, Germanic and Slavonic terms tend to be more transparent than those of the Romance languages (and, to a lesser extent, English) in that they do not rely on Latin and Greek so consistently. Interestingly, in these instances, the Chinese words are less transparent than the previous examples: while each contains the character 气/氣, meaning ‘gas’, the precise meaning of the first character in each case may need to be hunted down in etymological dictionaries.

French and Italian were not included in the table as, etymologically speaking, in each case, the terms coincide with ones that have been included (French: *oxygène*, *hydrogène* and *azote*; Italian: *ossigeno*, *idrogeno* and *azoto*). The relative transparency of a term clearly has possible implications for the way in which the object or substance it represents is understood or interpreted, although one should be cautious about reaching hasty conclusions about such subtle, nuanced matters. However, it becomes a significant factor when it comes to identifying expressions as metaphorical, as the metaphoricality of the word *brontosaurus*, for example, seems to be of a different order from that of its Chinese equivalent 雷龙/雷龍.

1.2.4 Scientific Writing

Olohan (2016) presents a very thorough discussion of a large number of different kinds of scientific and technical translation, and her book includes chapters on both scientific research writing and popular science. One of the strengths of her treatment is the attention given to discursive aspects of these genres. This is of relevance here of course, although it has to be

said that this is more the case for some topics (e.g. mappings and, funnily enough, terminology) than for others.

Olohan highlights three particular features of scientific research writing. The first of these is the *move*. Moves are specific communicative functions (such as establishing or occupying a research niche), which can generally be correlated with identifiable text segments (2016:149–55). The second feature is *metadiscourse*, or, in other words, the devices that permit writers to organise text, engage their readers and indicate attitude (2016:155–7). Finally, *grammatical metaphor* refers to the mechanism whereby processes are frequently expressed as nominal phrases (2016:157–9). The first of these may have an application to metaphor in translation, but it is not explicitly investigated here, while the second is broadly reflected in the research contained in this book, principally in terms of the purpose parameter that forms the content of Section 5.1. Finally, grammatical metaphor is not touched on, as it is totally distinct from what is normally understood by the term *metaphor*.

While much of the aforementioned is probably reflected more or less equally in both research and popular scientific discourse, it is quite clear that there are significant differences between these two types of scientific communication, some of which are likely to have a bearing on the present discussion. Olohan summarises some of the main textual features of popular science reporting, while of the 15 items that she lists, the following find clear reflection in the texts that make up my data: emphasis on the novelty and importance of the content; tailoring of information to readers' existing knowledge and beliefs, avoidance of specialist terminology and explanation of terms that are included, direct quotation of scientists' words to enhance authority, presence of attitude markers to signal the writer's response or that which is expected of the reader, use of visuals to attract readers' attention and employment of similes to make the unfamiliar more familiar (2016:187–8).

Quite clearly, given the nature of my research, it is the last item that is of greatest potential interest, even though it focuses on simile rather than metaphor, as it provides independent confirmation of the use of figurative language in this genre of writing. In terms of the relative significance of this mode of expression in popular science and scientific research writing, Knudsen compares the numbers of metaphorical expressions in *Scientific American* and the more specialist journal *Science* and concludes that 3% of the words in the former are used in a metaphorical sense as opposed to only 1% in the latter (2003:1257).

Finally, Olohan considers how science news stories are localised or 'reframed' in translation in order to take the 'knowledge, interests and opinions' (2016:194) of the new audience into account. This process is reflected in the following issues: cultural specificity in terms of place names, institutions and other proper nouns, and measurements and currency; use of similes and comparisons with familiar concepts (although here I would want to include metaphor too); relevance of information for target readers; interaction with

other public discourses, often of a topical nature (2016:194–9). The question of the *Scientific American* articles' further reading sections, which I briefly discuss in Section 2.3, comes under this heading; had it been a major goal of my research, this might have been extended into other areas such as front covers, images, and article titles and subheadings, as well as the relative acceptability to the different international readerships of cultural references, puns, simple analogies, inverted commas, question and exclamation marks, long (or short) sentences, technical (or general) vocabulary and innovative language.

1.3 Conclusion

In spite of some dissenting voices, metaphor is an inseparable part of scientific discourse and has been for many centuries. A small number of powerful metaphors are closely associated with particular areas of science, although as scientists' understanding develops, these can be either abandoned or adapted to enable them to continue to reflect the most up-to-date scientific thought. Metaphor plays a number of roles in science, some of the main ones being the channelling of scientific thought and the creation of new terminology. Olohan's analysis of scientific discourse is wide-ranging and nuanced, and includes many features that are of relevance to my study.