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Genetics and genomics

The politics and ethics of metaphorical framing

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Introduction

This chapter focuses on the use of metaphors as common points of reference that establish relationships between the sciences, the mass media, and their publics. In particular, we discuss public debates about genetics and genomics from the 1990s to the 2000s in order to offer insights into the politics and ethics of metaphorical framing. Our argument is that metaphors, such as 'clones are copies', play an important role in the public communication of science and technology, just as they do in science itself. As Dupré pointed out, 'it has long been argued that all science depends on metaphors. Understanding grows by the projection of a framework through which we understand one kind of thing onto some less familiar realm of phenomena' (Dupré 2007). Metaphors in science have constitutive, explanatory and communicative functions. In this chapter we focus on the communicative function of metaphors in public debates about science and technology.

For more than half a century, public debates on developments in biotechnology in particular, and life sciences in general, have been dominated by two narrative frames. On the one hand, advances in genetics and genomics have been covered in terms of sensational *breakthroughs* in the progress of a science the aim of which is often said to be to *reveal the secrets of the book of life* and to provide a *key* to curing common diseases. On the other hand, specific applications of biotechnology, such as cloning and stem cell research, have been framed as scientists *playing God*, opening *Pandora's Box*, and creating *Frankenstein's monsters*. Both narratives are grounded in a view of scientific and technological progress as a linear movement in space, a *journey* either to *map* unknown territory, or to enter the darker regions of the manipulation of life, the consequences of which may become monstrous. These seemingly opposite narratives on science's progress both frame scientific and technological progress in terms of a journey (Hellsten 2002: 1–3; 133–5; Ceccarelli 2004). Such entrenched metaphorical framings are not easy to shift and can blind our imagination to other possible ways of grasping developments in science and technology.

The rhetoric of great promises of biotechnological research reached a climax in June 2000, in the public announcement that the sequencing and mapping of the human genome were nearing completion (Hellsten 2001; Nerlich et al. 2002; Nerlich and Dingwall 2003; Calsamiglia and van Dijk 2004; Ceccarelli 2004; Nerlich and Hellsten 2004; Gogorosi 2005; Bostanci 2006; Henderson and Kitzinger 2007). In the mass media, this scientific 'achievement' was glorified as the *opening of the book of life*, the revelation of the *secret text of life* or the finding of the *key* to curing diseases. The human genome itself was discussed as *a wondrous map*, a completed *book of life* or the *blueprint* for a person. These metaphors bathed the Human Genome Project (HGP) in a positive light that was intended to reflect back on the status of genetics and genomics at large, a field that had also revealed what some might regard as the darker and more worrying secrets of cloning and embryonic stem cells at the end of the 1990s. However, this metaphor of science progressing or, indeed, racing through a series of breakthroughs seems to imply a view of science as standing apart from society at large, and to strengthen the idea of science communication as one-way transfer of news of such scientific achievements to a grateful public.

The aim of this chapter is to give an overview of research on the role of metaphors in the public communication of science and technology, using genetics and genomics as the point of reference, and to discuss the role of specific types of metaphor, 'discourse metaphors' (Zinken et al. 2003, 2008), in such communication. We ask in this chapter: what role do (discourse) metaphors play in the public communication of genetics and genomics? How are these metaphors connected to the framing of scientific advances as a series of breakthroughs? Whose images and purposes do such metaphors support? And what are the political and ethical implications of such metaphorical framings?

Metaphors and science communication

Metaphor research is carried out in a wide range of fields, from poetry (Hawkes 1972) to archaeology (Mithen 1998). In general, metaphors are defined as interaction between a source and a target domain, or a mapping between these two domains (Black 1962; Hesse 1988; Lakoff and Johnson 1980; Richards 1989). In the metaphor 'life is a journey', for example, life is the target domain and journey the source domain, and the mapping from life to journey consists of a selected set of structural elements that are expected to be familiar to the users. Which elements of the source domain are used in discussing the target domain depends on the purposes of the user as well as the wider context of use (Chiappe 1998; Hellsten 2000). One specific source domain, journey, for instance, can be mapped onto various target domains, such as life, love or, indeed, science. Journey as a source domain provides a perspective on science that reduces the complexity of the object (Burke 1966) and makes it amenable to understanding.

In research concerned with science communication, metaphors have been investigated in two contexts. First, metaphors are used in communication within the sciences (Montuschi 1995; Hallyn 2000) as important for the creation of new ideas (Hesse 1966; Leatherdale 1974; Bono 1990; Schön 1993), for building novel scientific models

(Black 1962; Knorr 1981), and for transferring ideas and terms across scientific fields of research, for example, from clockworks to astronomy (Newton's understanding of the universe) and from astronomy to atomic physics (Bohr's model of the atom). Second, scientists use metaphors in communicating their work to wider audiences (Bucchi 1998; Van Dijck 1998). In the mass media, metaphors are used as part of journalistic routines for purposes of popularising, concretising and dramatising issues, that is, for making issues both newsworthy and interesting for the relevant audiences (Anton and McCourt 1995). As Bucchi (1998: 30) notes, metaphors are also used to address different audiences simultaneously. The ability of the mass media to produce and sell news, and therefore to address a diverse public, is dependent on such resonance: the news has to resonate with something familiar, with earlier, accessible ways of framing issues (Gamson and Modigliani 1989; Benford and Snow 2000) and across different topics. In this process, metaphors offer a way of understanding new issues and complex processes in terms of shared experiences. In addition, metaphors may be used to evoke powerful images and emotions, thus adding drama to the news (Väliverronen 1998).

Another research tradition has perceived any concept as a potential metaphor; thus 'metaphoricity' can be defined as function of a concept in its context of use (Bono 1990; Maasen and Weingart 2000). In their study of the role of metaphors in the dynamics of knowledge, Maasen and Weingart (2000) followed the terms 'paradigm', 'chaos' and 'struggle for existence' across various disciplines over time as opening up common ground for debates. Metaphors such as 'science is a journey' may serve as communicative tools, connecting various discourses and offering common ground for debate (Maasen and Weingart 2000). They act like boundary objects that are both flexible enough to adapt to novel situations, and robust enough to maintain identifiable structures (Star et al. 1989). Like social representations in general, they are ambiguous and therefore adaptable enough to allow several uses and interpretations (Moscovici 1984), both over time and across various topics in a society, without necessarily losing their original implications.

A more recent line of research has focused on discourse metaphors that are 'relatively stable metaphorical mappings that function as a key framing device within a particular discourse over a certain period of time' (Zinken et al. 2008). Discourse metaphors evolve over time in the discourses where they are used, and resonate over time, across topics, across actors, and between each other. This line of research focuses on the dynamics of metaphors, and argues that metaphors and their meanings tend to become conventional in use and in interaction with other related metaphors and sociocultural contexts. Discourse metaphors are emergent and flexible rather than being universal conceptual structures.

In this process, previous uses of a particular source domain, which might have been very useful in generating metaphorical mappings at certain periods, become entrenched and may limit users' ability to explore different source domains when creating new metaphors. The creation and understanding of metaphors in actual discourse is therefore constrained by existing conceptual mappings and discourse metaphors, the history of metaphor use, and social, political and cultural preferences.[1] The myths and metaphors around 'man' playing God, or the creation of 'monsters', for example, have their roots in a long cultural history (e.g. the Prometheus myth), which may give such metaphors a special appeal and stability. Further, metaphors form complex families of linked metaphors, relatively stable ecologies of metaphors (Nerlich and Dingwall 2003) that have different life cycles in different domains of use. Such metaphors can be 'chosen by speakers to achieve particular communication goals within particular contexts rather than being *predetermined* by bodily experience' (Charteris-Black 2004: 247). Whereas in the conceptual metaphor tradition the focus is on the 'embodiment' of metaphors, in the communicational metaphor tradition the focus is on sociocultural 'embeddedness'.

The following section discusses the public communication of genetics and genomics as a case to illustrate the communicative roles of discourse metaphors in the public debate about science and technology.

The Human Genome Project

On 26 June 2000, a group of scientists and politicians announced in a fanfare of publicity that the human genome was nearly mapped. Bill Clinton, then President of the USA, held a press briefing at the White House flanked by the leaders of the two competing US human genome projects, Dr Craig Venter of the private company Celera Genomics, and Dr Francis Collins of the publicly funded International Human Genome Project. They were joined via satellite link from London by Tony Blair, Prime Minister of the UK. In the press briefing, President Clinton declared:

> Nearly two centuries ago, in this room, on this floor, Thomas Jefferson and a trusted aide spread out a *magnificent map* – a map Jefferson had long prayed he would get to see in his lifetime. The aide was Meriwether Lewis and the map was the product of his courageous expedition across the American frontier, all the way to the Pacific. It was a map that defined the contours and forever expanded the frontiers of our continent and our imagination.
>
> [. . .] After all, when Galileo discovered he could use the tools of mathematics and mechanics to understand the motion of celestial bodies, he felt, in the words of one eminent researcher, 'that he had learned the language in which *God created the universe*'.
>
> Today, we are learning *the language in which God created life*. We are gaining ever more awe for the complexity, the beauty, the wonder of God's most divine and sacred gift. With this profound new knowledge, humankind is on the verge of gaining immense, new power to heal.
>
> (White House 2000 [italics added])

This declaration reverberated through mass media worldwide, and scattered the seeds of cognitively and culturally hardy metaphors that could flower in almost any language and culture (see Nerlich and Kidd 2005), such as the genome as a map and a language – not just any sort of map or language, but a map that would open up new frontiers, like the map used to conquer the Wild West; and a language that was spoken by God.

Eight months later, in February 2001, the two competing groups involved in the genome sequencing project published their results in *Nature* and *Science* (Lander et al.

2001; Venter et al. 2001). These articles confirmed one unexpected result of the genome project: the human genome may contain only about 35,000 genes[2] instead of the expected 100,000. The challenge this posed to the so-called central dogma of biology did not seem to attract much media attention. The central dogma had emerged after the discovery of the double helical structure of the DNA molecule. Francis Crick and James Watson, discoverers of the double helix (Watson and Crick 1953) and two of the most celebrated heroes of science, had explained the functioning of the genes as a linear transfer of information, where one gene codes for one protein via RNA. This idea led to what Keller (2000) has called 'the century of gene', and it had implications for claims about finding gene-specific cures to diseases once the human genome was fully mapped.

The Human Genome Project was finally declared completed on 14 April 2003, on a date that coincided with the 50th anniversary of the discovery of the double helix structure of DNA, a coincidence that reinforced images of scientific glory. However, in 2003 the HGP was no longer celebrated for revealing the language of life, but instead as laying the foundation or basis for further research. The HGP was no longer seen as achieving an ultimate goal, but rather as a stepping-stone on a much longer, but still glorious, journey of science:

> The successful completion this month of all the original goals of the HGP emboldens the launch of a new phase for genomics research, to explore the remarkable landscape of opportunity that now opens up before us.
>
> (Collins et al. 2003: 286)

How was this change in views of the HGP as the principal *key* to unlocking the secrets of life, to that of the HGP as a mere *basis* for further research, justified in public? The new vision of the future painted by Collins et al. used the old architectural metaphor of the *blueprint* (which had been in use in genetics for a long time), but gave it a new twist. The earlier metaphor of the blueprint implied that DNA, or the human genome, provided the right information to build 'a human', but now the blueprint metaphor was used to indicate that the achievements of the HGP were themselves just the blueprint for a more elaborate construction: the science of the post-genomic era. The existing metaphor of the blueprint could readily be extended to the new situation, carrying with it accumulated positive associations. The authors set out their vision of the future in terms of a three-storey house built on the foundations of the sequencing success. The three floors were labelled as genomics to biology (elucidating the structure and function of genomes), genomics to health (translating genome-based knowledge into health benefits), and genomics to society (promoting genomics to maximise benefits and minimise societal harms).

The same metaphors that had been used when the HGP was launched in the 1990s, and that were reinvigorated when the working draft of the human genome was announced in June 2000, were now extended successfully in order to justify further research in genomics, from the study of whole genomes instead of individual genes, to comparative genomics, to proteomics (Tyers and Mann 2003), the study of proteins instead of genes (as genes are in some respects 'recipes' for making proteins). In the future, these metaphors will perhaps be extended further to the study of the physiome, that is, to describe the human organism quantitatively, so that one can understand its physiology and pathophysiology (see the Physiome Project, www.physiome.org). This is the provisional end of a journey that started in the 1950s with the discovery of the double-helical structure of DNA, which became itself a positive icon for genetic research (Nelkin and Lindee 1995; Bucchi 2004).

The metaphor of genes as the *book of life* is rooted in a rather blatant metonymy, according to which the bases in DNA – adenine (A), thymine (T), cytosine (C) and guanine (G) – are labelled by their initial letters. By coincidence, this 'alphabetical' mapping, initiated by Watson and Crick (1953), occurred at a time when biology was influenced by certain advances in the science of language and in information theory. This meant that favour was given to metaphorical mappings between the study of genes and the study of language, codes and computer programmes (Jacob and Monod 1961). This influence has not diminished, but has grown with the advent of bioinformatics: DNA became a code (Condit 1999: 100–2; Kay 2000: 1–37).[3] As any randomly chosen popular primer for genetics will tell you:

> The alphabet is a code. . . . DNA is also a code . . . The DNA code uses groups of three 'letters' to make meaning. Most groups of three 'letters' code for an amino acid (some code for 'punctuation' – starts and stops). For instance, the DNA letters TGC code for an amino acid called cysteine, whereas the DNA letters TGG code for an amino acid called tryptophan. Each of these sequences of three DNA letters is called a DNA triplet, or codon. Since there are four different DNA letters (A, G, C and T), there are 4 × 4 × 4 = 64 different combinations that can be used to make a codon.
>
> (http://www.science-class.net/Lessons/Genetics/Your%20Genome.pdf)

Since the 1950s, the popular metaphors of genes as *codes*, a *blueprint* and a *map* have become central to the development of the sciences of genetics and genomics. They were not just there to communicate this science to the public in a pleasingly metaphorical way, but were indispensable to biologists in making sense of their work (Van Dijck 1998: 121). The metaphor of code was created in the 1950s, a time when the theory of information was in vogue, to understand the object of the new science of gene sequencing, and to communicate this view to the public. Condit (1999: 221) even argues that '[t]he new discoveries of molecular genetics were at first not communicable to the public. Science was mute in the public sphere until it formulated the coding metaphor'. Similarly, the metaphor of the blueprint became more popular in the public communication of genetics when the focus changed from genes to genomes as whole entities (ibid. 16). As Avise pointed out, 'many genomic metaphors have elements of truth, and each may have its time and place' (Avise 2001). More recently, the physiologist and systems biologist Denis Noble (2006: 21) has made similar claims. Different, even competing, metaphors can illuminate different aspects of the same situation, each of which may be correct even though the metaphors themselves may be incompatible. We benefit most when we recognise that. We should therefore treat the competition between metaphors differently from that between descriptions that differ empirically. Metaphors compete for insight, and for criteria such as simplicity, beauty and creativity, all of which we use over and above empirical correctness in judging scientific theories. But ultimately it is by the empirical tests that scientific theories live and die (ibid.).

By contrast, there are other metaphors, such as the *book of life*, which are less central to the science itself and more central to public communication of science. Such metaphors are useful when scientists or politicians want to 'sell' science to the public (Nelkin 1995). As Avise (2001) has pointed out, the *book of life* metaphor helped focus and sell the publicly funded HGP.

The popular metaphors used by scientists and the media to communicate about genetics and genomics illuminate diachronically and synchronically different aspects, but they all live and thrive in the same semantic and conceptual field of 'coded information' and mutually reinforce each other in science discourse and science communication discourse. This increases their allure and opens them up for ideologically based misuse, for example to argue for genetic determinism or to denigrate scientists engaged in genomics by accusing them of genetic determinism.

The BBC announced the near-completion of the human genome on its internet news page (30 May 2000):

> The blueprint of humanity, the book of life, the software for existence – whatever you call it, decoding the entire three billion letters of human DNA is a monumental achievement.

The announcement was accompanied by an image in two parts (http://news.bbc.co.uk/1/hi/in_depth/sci_tech/2000/human_genome/760893.stm): a banner entitled 'The human code crackers' projected against a band of DNA 'bar codes' and further illustrated by a stylised double helix and Leonardo da Vinci's famous image of Vetruvian man with outstretched arms in the right hand corner. Underneath was another image of the double helix imprinted on a jigsaw puzzle. Here the code metaphor takes on connotations that go well beyond the rather neutral denotation of the term 'code' in genetic textbooks. It also inserts the metaphor of the code into a whole cultural, semantic and visual field of related metaphors which, on the whole, continue to highlight various deterministic and glorifying aspects of the human genome (blueprint, book of life, software of existence, puzzle-solving, code-breaking, Leonardo da Vinci, the double helix).

However, not all metaphors are created equal. Some are more suitable than others for several interpretations and uses, and some gain more prominence than others in public debates on science. Their strength is derived, as illustrated above, from the cultural associations they evoke or exploit, and from the semantic field in which they mutually support each other. The ability of some metaphors to suggest shared images may be crucial in political and public arenas in building up links between scientific knowledge and political action (Mio and Katz 1996) on the one hand, and scientific knowledge and popular knowledge on the other (Van Dijck 1998; Nerlich et al. 2000, 2001). These are, as pointed out in the introduction to this chapter, discourse metaphors. The metaphors of the *map*, *code*, *book* and *blueprint*, which pervade genomic discourse, are all discourse metaphors that are particularly apt for science communication. Discourse metaphors have a social and cultural history, and influence social and cultural futures. They can be analysed only in a broader context, not just by pondering the possible meanings of certain terms. For instance, the way in which genes as *alphabet* functions as a metaphor depends largely on how it is interpreted as a symbol of genetics or as a particular way of dealing with it. New topics introduce new ways of speaking and arguing (new discourses), but there is also discursive continuity between different topics, both synchronically and diachronically, and this continuity manifests itself in discourse metaphors and, we would say, is essentially maintained through such metaphors.

The HGP, in particular, has exploited this metaphorical stability and continuity. The reason for this might lie in what some semanticists have called 'linguistic conservatism' and what we would like to call metaphorical conservatism. Semantic studies (Ullmann 1962: 198) have shown that language tends, in general, to be more conservative than science or culture. This means that words or, in our case, metaphors that are deeply embedded in our thinking and talking might perpetuate ideas, values and attitudes which, from the point of view of science, are outdated. 'Common sense tells us that imagination is always ahead of technology, and that our technological tools keep lagging behind. However, in the context of genomics, the opposite might be more accurate: our imaginative tools can hardly keep up with our technological innovations' (Van Dijck 1998: 198). Here we could add that these metaphors seem to carry with them an idea of science communication as a linear transfer. Metaphors have cognitive and emotive staying power, and do not shift easily in parallel with scientific and technological development once they have proven their value in science communication. A process of positive feedback or amplification between science and science communication seems to be involved here that strengthens salient metaphors.

What does this mean for a science that is itself evolving? In an article entitled 'The sociable gene', Jon Turney (2005) has reflected on the growing mismatch between the scientific understanding of the gene and its popular metaphorical representations, and on the consequences of this mismatch for science communication. He writes:

> The old metaphors for genes and genomes, whether they originate in scientific discourse or in popularization or the rhetoric of research promotion, are familiar. Readers learn about the map, the code, the Book of Life, the blueprint, the recipe, the master molecule. And they often get the message that DNA is destiny.
>
> [. . .] there does appear to be an emerging mismatch between the image of the gene in the public realm and recent scientific understanding. If it is desirable to have informed public debate about genetics and its applications, it would be helpful to align these images better.
>
> (Turney 2005: 808)

Some scientists who are also science communicators, such as Craig Venter, have tried to challenge the supremacy of old genomic metaphors, especially after the 2001 publication of the full sequence of the human genome that challenged the linear idea of genes determining proteins. This is an extract of a public debate between Collins and Venter about the discourse metaphor, 'the genome is the book of life':

> What they discovered, Collins said, is that what has become known as the 'book of life' is really three books: a history book, filled with pages of the fossil

> record written in our DNA code; a parts manual pointing to the genes and proteins that create a human being; and a medical text that points to risk and disease, albeit, Collins conceded, in a 'language that we don't entirely know how to read yet.
>
> Venter took issue with Collins' characterisation of the genome. 'I don't view this as the book of life,' he said. 'And this is not the blueprint for humanity. This is a basic set of information that codes for our proteins.' You won't find the instructions for building the heart or building the brain, Venter explained, because this information comes in several different layers.
>
> (Gross 2001)

Others not only have contested old metaphors, but have tried to invent metaphors that emphasise the complex interaction between genes and their environment, such as the human genome as an orchestra, a genome salad (Butler 2001), or, as Avise surmised in one of the rare articles exploring new metaphors, a social collective or a miniature, cellular ecosystem – thus connecting to other common sets of metaphors in public debates, networks and webs (Avise 2001: 87). Noble (2006) has made the most concerted effort yet to shake up old metaphors of genomics and to bring a new metaphor – that of the *music of life* – to the attention of other scientists and the wider public through a popular science book. Again, this was prompted in part by the discovery of the relatively low number of genes in the human genome in 2001:

> Should we be surprised that there are so few? Should we not rather be amazed at the immense range of functional possibilities that such a genome can support?
>
> A musical analogy may be helpful here. The genome is like an immense organ with 30,000 pipes. [. . .] But the music is not itself created by the organ. The organ is not a program that writes, for example, the Bach fugues. Bach did that. And it requires an accomplished organist to make the organ perform. [. . .] If there is an organ, and some music, who is the player, and who was the composer? And is there a conductor?
>
> (Noble 2006: 33–4)

We will have to wait and see whether the new metaphor of the *music of life*, proposed by Noble, can compete with older ones – that is, whether it can resonate with public perceptions of the human genome and the HGP which, for a long time, have been dominated by the older metaphors.

The public communication, and perhaps perception, of molecular biology and DNA research has been shaped by geographical (journey) metaphors from the 1950s onwards (Van Dijck 1998; Condit 1999), but they all have their roots in longer histories of use that predate genetics and genomics. This historical ancestry provides discursive stability. The currency of the metaphor of the *book of life* dates back to antiquity and has a long history within the Judaeo-Christian tradition, where it refers to natural, eternal and universal texts (Kay 2000: 31). This universality is God-created and thus eternal. It gained its wider and more emotive currency by being rooted in Biblical imagery surrounding the book of life as evoked in Revelation:

> And I saw the dead, great and small, standing before the throne, and books were opened. Another book was opened, which is the *book of life*. The dead were judged according to what they had done as recorded in the books.
>
> The sea gave up the dead that were in it, and death and Hades gave up the dead that were in them, and each person was judged according to what he had done.
>
> (Revelation 20: 12–13, New International Version, www.biblegateway.com [italics added])

In parallel to the *book of life*, and reinforcing it, runs the metaphor of the *book of nature* common in the history of natural sciences, where science was perceived as an effort to *read and write the book of nature*. For Galileo, to whom Clinton referred in 2000, the book of nature was written in the language of mathematics (Cohen 1994).

In summary, the change from genetics to genomics has not yet led to a rush of new metaphors; instead, the existing metaphors were extended to cover new situations (Nerlich and Hellsten 2004). These stable metaphors helped 20th century scientists and the public to cope with the various genomic revolutions – they became symbolic coping mechanisms (Wagner and Hayes 2005), rooted in well established symbolic or interpretative repertoires. They also provided continuity within discontinuity.

Although the old genomic metaphors mainly evoke hopes and background fears, their use poses an inherent danger. While metaphors may help us capture novel events in terms of familiar events, '[t]here is a concomitant risk, of course: the metaphorical constructs also limit our ability to assimilate new information and, in conventional discourse, where certain literalness prevails, they can quickly lose their suppleness and become mere props for unreflective traditionalism' (Leiss 1985: 148–9).

In the following section we focus on the ethical aspects of public communication of genetics and genomics, and the use of metaphors in this activity.

The ethics of genetics and genomics

Developments in genetics and genomics are commonly supposed to be transforming not just how scientists are likely to investigate, and doctors to treat, our future illnesses, but the very way in which society operates and the way in which we view ourselves (Brown and Webster 2004). Our idea of humanity itself is in a process of creative refiguration: this is happening both literally on the level of the 'New Science' heralded and symbolised by the HGP, but also meta-linguistically and metaphorically as concepts from the new science filter into the public domain, and as concepts from the public domain filter into the representation of the science (Nerlich and Kidd 2005). In this sense, the story of the HGP is not merely that of scientific progress discussed above, but also of the nature of the public perceptions, fears and hopes involved.

In modern, technologically advanced societies, research of whatever quality can now have a direct and swift impact on public opinion and public policy. Social scientists and discourse analysts therefore have a duty to investigate how this impact is achieved, what technological, linguistic and cultural resources are used to achieve it, and to what purpose they are used. This is especially important in the fields of genetics and genomics, as we are dealing here with the 'meaning of life' itself, and promises of treatment and cure.

Moral and ethical questions that may result from increasing competition within the sciences, between research teams and between science communicators themselves, including scientists' increased need to seek public recognition via the mass media and the internet were highlighted when claims by Woo-Suk Hwang, a Korean stem cell researcher, to have achieved major breakthroughs in cloning embryos for therapeutic purposes turned out to be false. The scandal surrounding his research highlighted not only the ethical dimension of sourcing 'material' for research, but also issues of coercion, exploitation, informed consent, peer review and the pressure from politicians and funders on scientists to keep 'breakthroughs' coming (Bogner and Menz 2006; Gottweis and Triendl 2006; Franzen et al. 2007). It also exposed some aspects of media staging and science communication, which are becoming more common in a climate of increased competition for funding where 'the public' has become an important factor in the competition and in the 'knowledge transfer' activities that are now part of any science project. Metaphors around the central image or metaphor scenario of science as a journey or race, such as *breakthrough*, *milestone*, *overcoming hurdles*, *moving a step closer*, *breaking new ground*, *reaching a new frontier*, were plentiful in the media coverage. These metaphors shored up the hopes of patients waiting for a cure, hopes that were sadly dashed when some aspects of Hwang's research were exposed not only as unethical, but also as fraudulent (Cyranoski 2006). Soon the metaphors of race and journey went into reverse, and the media bemoaned the scientific and ethical *setbacks*, *stumbling blocks* and *obstacles* that this scandal had caused and exposed. Whereas the media hype surrounding the HGP based on the age-old metaphors of the *book*, *map*, *code* and *blueprint* has, on the whole, been successful in promoting genomics, the scandal surrounding Hwang's research involving human embryonic stem cells (already a rather contentious issue) has highlighted science communication as an activity in which scientists themselves engage in various, sometimes unethical, ways to promote their research. The scandal has perhaps also dented the appeal of the science as *journey/race* metaphor, and prompted a reflection on the ethics of metaphor use in science promotion and science communication (Wolvaardt 2007). Social scientists therefore should reflect not only on the risks posed by scientific advances, but also on the risks of science communication itself, which might be heightened by various aspects of 'modernity' that impinge on the research and publication process.

Concluding remarks

Metaphors play an important role in the public communication of science and technology, contributing to public understanding and misunderstanding of sciences. In our case, the main metaphors used for communicating about genetics have been readily extended to communicating about genomics, thus building a bridge between the 'new genetics', the HGP, the new genomics and post-genomics projects. The confirmation in 2001 of the relatively low number of genes that make up the human genome rendered problematic the metaphors of genes as *codes*, *blueprints*, *maps* and *books of life*, but did not lead to these metaphors being abandoned in the public communication of genetics and genomics. In this sense, the most popular metaphors have fallen behind the developments in science as well as the theorising about science communication (Turney 2005). The gap between developments in science and public representations of science may even be widening. However, a clean break in metaphors, which might be desirable from a scientific point of view, might not work in science communication and might lead to confusion and disorientation. Indeed, scientists may need ever more breakthrough or even catastrophe metaphors in situations where they have to compete with other research groups and where they have to justify their work in public (Weingart 2002). Weingart (1998) has studied the ever-closer intermingling of science and the media, which is demonstrated in the pre-publication of scientific results and the relationship between media prominence and scientific reputation. Scientists are keen to publish their results before other, competing research teams because this means they will be better placed to apply for patents and to gain public recognition in the form of prizes and awards.

The perils of such a race between scientific competitors framed by the science as *journey* metaphor were highlighted through the Korean stem cell scandal, where Korean researchers were in a race, mainly with British researchers, to achieve advances or breakthroughs in therapeutic cloning. This has led to calls for the discourse of scientific hubris based on breakthrough metaphors to be abandoned and replaced with a discourse of humility based on highlighting the progress of science as one of incremental steps, as trial-and-error and as a process rather than a series of spectacular products (see Rick Borchelt, reported by Wolvaardt 2007). The scandal also demonstrated, yet again, how scientific reputation is increasingly related to scientists' public appearances (Dunwoody 1999). This, of course, may turn into a vice in the case of the race for pre-publication.

The public debate about techno-scientific projects such as genetics and modern biotechnology is based on a complex intertwining of different discourses of science, research and development, markets, politics and economics. Here, metaphors are apt tools for communication. Some metaphors based on the scenarios of science as a *journey/race* are more precarious than others for framing scientific advances. Some discourse metaphors, such as the *book of life*, are more apt than others for framing scientific innovation, as they carry positive and well entrenched cultural associations from one context to another, and will not easily be replaced by any alternative metaphor. At the same time, certain discourse metaphors may have accelerated what Väliverronen (1993) calls a 'change from "publish or perish" to "appear in public or perish" science', a situation where scientists need to sell their research and themselves in public (Nelkin 1995). And, here – as formulated by Aristotle in his *Poetics* – 'the greatest thing by far is to be a master of metaphor'. But beware of its pitfalls.

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Notes

1 The metaphor that frames genetically modified food as 'Frankenfood', for example (Hellsten 2003) could only be created and understood in a society in which Mary Shelley's famous novel of 1831 was a 'cultural commonplace' (Black 1962), and only after that specific novel had been written. However, once established, this type of metaphor could spread to various other target domains (in this case, related hyponymically to the original one), such as Frankencrops, Frankenplants, Frankenrice, Frankenfish and Frankensalmon. Information scientists have developed ways to trace this automatically (Thelwall and Price 2006).

2 Later, this number was reduced even further to between 20,000 and 25,000 genes – about the same amount as a fruit fly has (*How Many Genes Are in the Human Genome?*, www.ornl.gov/sci/techresources/Human_Genome/faq/genenumber.shtml).

3 '[Erwin] Schrödinger compared the genetic material to an aperyodic crystal where information could be coded in a linear array. Years later Francois Jacob discussed with Roman Jakobson the similarities of language and heredity as systems built on elements without meaning. Later on, Neils Jerne in his Nobel Prize lecture talked about the "generative grammar" of the immune system' (Berwick et al. 1998).

Suggested further reading

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