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Discursive Representations of Controversial Issues in Medicine and Health

La rappresentazione discorsiva di questioni controverse in ambito medico e sanitario

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"Designer Babies" and "Playing God": Metaphor, Genome Editing, and Bioethics in Popular Science Texts*

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Abstract

This study is a corpus-based analysis of metaphor in popular science texts about genetic engineering. It explores two sub-corpora of web articles drawn from *Nature.com* and *TheGuardian.com* in order to identify the metaphorical associations that authors of popularisation discourse trigger in the audience's mind and the ethical issues that these associations may raise. The focus is especially on the genetic modification of embryos, which is often described as 'text editing', as well as on modified offspring, often defined by authors as 'designer babies'. The former metaphor is connected to the traditional metaphor of the genome as a 'text' (Calsamiglia and van Dijk 2004), whereas the latter is rather connected to the commercialisation of modified babies, regarded as 'designer' or 'tailored' goods. The study shows how metaphor can be used both for popularising effects, mapping concepts from abstract to concrete domains, and for ethical reasons, persuading audiences of the dangerous consequences and high risks of genome editing. Only a small portion of metaphors in the corpus authorises and encourages genome editing as a 'step' towards progress and 'fight' against disease.

Keywords: bioethics; genetic engineering; metaphor; popularisation; scientific discourse.

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1. Introduction

> We are indeed playing God with our genes. But it is a good thing because God, nature or whatever we want to call the agencies that have made us, often get it wrong and it's up to us to correct those mistakes.
>
> *The Guardian*, February 02, 2016

Popular science journals and online newspapers are central for the communication of scientific knowledge to the public. In order to report on research findings and the achievements of scientists to an interested audience, popular science text writers need to transform scientific discourse into a form that is also comprehensible and interesting to non-specialist readers. In other words, they have to adapt their message to a wider audience, by recontextualising information and knowledge from one domain to another (Moirand 2003; Gotti 2014). In this recontextualisation process, the role played by metaphor is fundamental, as a linguistic strategy which can inform about developments in research and help laypersons understand the implications of recent discoveries and new techniques in science and biology.

This paper specifically investigates the role of metaphor in web-based popular science texts on the genetic modification of human embryos (also called 'genome / gene editing' or 'genetic engineering'). It analyses metaphor within the framework of Cognitive Linguistics Theory (Lakoff and Johnson 1980 and 1999), based on conceptual mappings between source and target domains. Although the popularisation of science cannot be regarded as a one-way process of simplification, or as translation for a public that is ignorant of scientific matters (Myers 2003), in popularisation discourse, metaphorical language can facilitate the transmission of scientific knowledge to non-experts, by associating highly specialised concepts to familiar and widely shared objects or facts.

Studies conducted thus far on popularisation discourse relating to the genome have shown that it is rich in metaphors, especially personifications of genes and DNA, or metaphors coming from the fields of communication (genome as a 'code', 'text', or 'book') or architecture (DNA as the genetic 'building blocks') (Hellsten 2002; Calsamiglia and van Dijk 2004; Pramling and Säljö 2007). However, when communicating about the modification (or manipulation) of the genome, authors of popularisation texts tend to focus not on the description of the process,

but on the negative consequences that this process may have, both from the medical viewpoint and from the perspective of its effects on society at large.

By examining a corpus of online articles drawn from *Nature.com* and *TheGuardian.com*, this study intends to investigate the role of metaphor as a linguistic strategy in popularisation discourse at large and, in particular, in the public debate about genome editing.

2. Theoretical framework

The perspective from which metaphorical language is examined in this study is that of Cognitive Linguistics. Specifically, the study adopts the Contemporary Theory of Metaphor first elaborated by Lakoff and Johnson (1980) and subsequently developed by Lakoff and colleagues (e.g. Lakoff and Turner 1989; Lakoff 1993; Lakoff and Johnson 1999), and critically discussed by Grady (1997) and Ruiz de Mendoza and Pérez Hernández (2011). Within this theoretical framework, Lakoff and Johnson (1980) describe metaphor as a conceptual mapping (a set of correspondences) from a source domain (called 'vehicle') to a target domain (the 'tenor'). The source is less abstract (i.e. more accessible to sense perception) than the target. Thus, for instance, in 'architectural metaphors', a human being is conceived of as *a building*, DNA is seen both as *a blueprint* for this building (Condit 1999), and as the material with which the building is constructed, i.e. *the genetic building blocks* (Pramling and Säljö 2007). These metaphors may help non-specialist receivers to understand the tenor (i.e. DNA) by associating it to the vehicle, which is a well-known object (e.g. a blueprint or a set of building blocks) [1].

In the literature, several scholars have observed that, in the coverage of genetics, the genome is frequently discussed in terms of familiar linguistic or semiotic metaphors, relating it to 'information', 'text', or 'code' metaphors (Rosner and Johnson 1995; van Dijck 1998; Boon 2002; Calsamiglia and van Dijk 2004; Pramling and Säljö 2007). As Stelmach and Nerlich (2015, 198) state:

> Popular genetics and genomics discourses were built around a small number of what one can call "grand" metaphors relating to master narratives about what makes us human (Lyotard 1979), such as the book of life, the blue-

[1] See Gibbs (1994) for the role of metaphor in inferential activity and understanding.

> print of life, the glorious map [...] and, of course, the code and computer program of life.

For instance, in the metaphor THE GENOME IS A CODE, the sequence of the human genetic code is described as *the letters in the book of life* and genes are *words written with the genetic alphabet* (Pramling and Säljö 2007). Following the same mapping, the human genome can be conceptualised as *the language with which God created life*, and the set of genes stored in 23 chromosomes constitute *an autobiography of the human species* (Calsamiglia and van Dijk 2004). Similarly, in the metaphor DNA IS A LIBRARY OR A BOOK, genetic material *carries the hereditary information* (Rosner and Johnson 1995; Hedgecoe 1999), or, it is described as *a complete book containing a great many million pages* (Pramling and Säljö 2007).

Therefore, the role of metaphors in constructing certain images and understandings of science and genetics is crucial (Martins and Ogborn 1997; Hedgecoe 1999). Metaphors are used to popularise complex issues as they present novel and abstract ideas in terms of something familiar and concrete (Black 1962; Lakoff and Johnson 1980). By their familiarity, or at least their ability to evoke commonly shared meanings and feelings, metaphors function as common ground for interdiscursive exchange and communication both within and between various discourses of the public sphere. For instance, in the metaphor GENES ARE LETTERS OF THE BOOK OF LIFE some features of the source domain (alphabet) are transferred to the target (genes) in order to concretise and popularise the otherwise invisible genes. In this sense, metaphors function as mediators between different discourses and among different participants (Hellsten 2002).

However, metaphors are not only innocent tools of science popularisation (Väliverronen 1998). While emphasising certain aspects, metaphors hide some other aspects of a given issue. When genes are conceptualised as letters, only one perspective on the issue is given and other possible ways of defining genes are omitted from the public debate. In Burke's (1989, 247) terms, "[m]etaphor is a device for seeing something in terms of something else. It brings out the thisness of that, or the thatness of this". Of course, what is emphasised depends on the user of metaphor, be he or she a scientist, a journalist, or a layperson, as well as on the metaphor that he/she chooses (Hellsten 2000).

In more recent years, Lakoff and Johnson (1999) have developed a more complex version of the Contemporary Theory of Metaphor,

which also integrates Grady's (1997) theory of primary metaphor. In this theory, complex metaphors are made up of primary metaphors that develop through conflation (the experiential association of discrete conceptual domains). For instance, GENES ARE LETTERS OF THE BOOK OF LIFE develops from the primary metaphor THE GENOME IS A CODE, and GENETIC MODIFICATION IS TEXT EDITING is a complex form of the primary metaphor THE GENOME IS A TEXT. In particular, the latter metaphor involves the cognitive operation of domain highlighting (Ruiz de Mendoza and Pérez Hernández 2011): that is, it places emphasis on the fact that the genome can be defective or faulty and may need change.

This study focuses on the metaphorical language that is used to open or heat the debate on genetic modification, often referred to as 'genome / gene editing'. Indeed, genetic modification has significant consequences which are generally highlighted by writers, because it may have a serious impact on society. First, there may be religious implications connected with the idea that, when manipulating our genes, scientists are substituting God. Second, there may be moral reasons connected with parents' choice to modify some traits of their children, not only those traits that are linked to disease immunity, but also physical traits linked to standards of beauty, such as eye or hair colour, height, or to intelligence. Third, gene editing has also an impact on the economy, in that it starts up a profit-making business that only the wealthy can afford, thus widening the economic and social gap between the better-off and the poor. However, gene editing may also have positive outcomes, such as the prevention of some genetically related illnesses, and other advancements in medical, biological, and scientific fields. The latter pros sometimes counterbalance the cons in popular science texts.

Hence, on the one hand, this study aims to emphasise the communicative and informative function of metaphor, especially used to reduce the asymmetry between specialist scientists and non-specialist audiences. On the other hand, it aims to stress the persuasive function of metaphor in popular science texts, in which it is used to make the public aware of the bioethical implications of gene editing. As a more general goal, the study aims to show how gene editing has extended the genetic and genomic repertoire of metaphors, from central "grand" metaphors, such as the 'book', 'code/programme', 'map' and 'blueprint' metaphors (Nerlich and Hellsten 2004), to metaphors that are more connected with society's consumerism and pursuit of ideals of perfection, or even with the destructive effects that gene editing produces on humanity.

3. Corpus and methodology

The corpus used for the analysis of metaphor in popularisation discourse consists of two sub-corpora of online texts collected from the electronic versions of the scientific journal *Nature* and the newspaper *The Guardian*. The fifteen articles taken from *Nature* cover the time span 2007-2018 and the seventeen articles taken from *The Guardian* are dated 2004-2018, but, since the debate has become especially heated in recent times, most of the articles are dated 2018. The two sub-corpora (hereinafter, *Nature Corpus* and *Guardian Corpus*) respectively consist of 24,386 words and 23,306 words, totalling 47,692 running words. The choice of these two different sub-corpora and their association and integration to constitute a unique corpus are motivated by their online access, because web-based journals and newspapers represent resources open to a wide and not necessarily expert audience, and therefore considered two genres of scientific popularisation.

As for the method, the articles making up the corpus were initially found by using the advanced search tool of both websites, and looking for the key words *gene*, *genetic*, *genetics*, and *genome*. A close reading of the articles was then necessary to manually select texts about genome editing. In the *Nature* website, three articles on genetic engineering were part of the subsection *Nature Biotechnology*, two were from *Genetics in Medicine*, and an article retrievable from the same website was from the *European Journal of Human Genetics*. All the other articles came from the *News* subsection. Not all articles were freely accessible. Those that were not were excluded from the analysis, in that papers with a restricted access are more likely to be addressed to a specialist audience. In the electronic version of *The Guardian*, instead, all articles were freely accessible and those on genome editing especially appeared in the *Science* Section.

Through close reading of the relevant articles, I found out that genome editing was often discussed by scientists and journalists in connection with the issue of 'designer babies'. Indeed, two collocations which were frequently used in the sub-corpora analysed were *gene editing* (72 occurrences/44.7% in the *Nature Corpus*[2]; 69/26.2% in the *Guardian Corpus*) and *designer babies* (11 occurrences/6.8% in the *Nature*

[2] Percentages indicate the number of collocations out of the overall number of metaphorical expressions found in the related sub-corpus.

Corpus; 43/16.3% in the *Guardian Corpus*; cf. *designer children* appearing only once).

Close reading was also crucial for identifying non-literal (esp. metaphorical) language, in that keyword or collocation searching needed to be refined in order to retrieve all instances of metaphor. *Table 1* shows the number of metaphorical expressions (and the percentage per word) manually identified in the two sub-corpora investigated.

Table 1. – Quantitative data on metaphors in the Nature Corpus and Guardian Corpus.

	Nature Corpus	Guardian Corpus	Overall
Running words	24,386 words	23,306	47,692
Metaphors	161	263	424
Percentage per word	0.66%	1.12%	0.88%

Even though the two sub-corpora are comparable with respect to size, the *Guardian Corpus* appears to be richer in metaphors than the *Nature Corpus*. Nature metaphors are about three-fifths of the Guardian ones. This figure was expectable, given the familiarity associated with metaphorical language and the ordinary informality of online newspapers vis-à-vis online scientific journals (Mattiello 2015).

What follows is a predominantly qualitative analysis of the most common metaphors in the overall corpus, with an initial quantitative overview of the associations identified in each sub-corpus (*Table 2*). Examples for sections 4.1-4.8 are taken from both sub-corpora.

4. Analysis, results, and discussion

In this section, I analyse the metaphors identified in my corpus from both quantitative and qualitative viewpoints. Not all instances of metaphorical language identified will be taken into account in the analysis, only those that are strictly linked to gene editing and that can contribute to the public debate on this topic.

The analysis focuses on the associations between common source domains, such as embryos or genetic modification, and target domains, such as machines or text editing, which contribute to simplify scientific concepts for non-expert publics, or else to persuade readers of the bioethical issues revolving around genetic manipulation.

Table 2 shows quantitative results of the metaphorical associations in the two sub-corpora. In the table, metaphors have been arranged by overall frequency, although there is often no balance between the two sub-corpora. For instance, the 'playing God' metaphor is much more used in *The Guardian* sub-corpus than in *Nature*, whereas the 'patent' metaphor prevails in the journal, but not in the newspaper.

Table 2. – Quantitative data on the metaphorical associations in the Nature Corpus and Guardian Corpus.

Metaphorical associations	Nature Corpus	Guardian Corpus	Overall
Genetic modification is text editing	39	43	112
Modified babies are designer goods	11	44	55
Phenotypic traits are shopping lists	8	15	23
Embryos are machines	7	13	20
Ethics places boundaries/barriers	8	9	17
Parents are consumers/customers	3	11	14
Genetic modification is playing God	1	11	12
Genetic modification is a race/game	7	4	11
Embryos are patents	8	1	9
Disease is enemy to fight	–	8	8
Modified babies are tailored clothes	1	6	7
Progress is moving forward	3	3	6
Embryos are buildings	1	5	6
Gene editing is a weapon	-	6	6
Ethical debates are struggles/battles	3	3	6
Permission is green light	2	3	5
Phenotypic traits are selected from a menu	1	4	5
Modified babies are superhuman beings	1	3	4
Permission is open doors	2	2	4
Eugenics is a spectre/nightmare	2	1	3
Gene editing opens Pandora's box	1	1	2
Genetic modification is science fiction	2	–	2

A quantitative analysis suggests that, although many metaphorical associations are shared by the two sub-corpora, there are differences in terms frequency of use. While the 'text editing' metaphor is frequently used in both the *Guardian Corpus* and the *Nature Corpus*, some of the meta-

phorical associations found in the newspaper are rare in the scientific journal (e.g. 'playing God', 'tailored clothes', 'buildings' metaphors), or even absent (e.g. 'disease is enemy to fight' or 'gene editing is a weapon' metaphors). Moreover, authors of newspaper articles insist more on the commercial implications behind gene editing (*designer babies*, *shopping lists*, *consumers/customers*, *tailored clothes*, *phenotypic traits selected from a menu*) than authors of scientific articles. The same is true for the religious (*playing God*) and moral (*machines*) implications of gene editing: the former metaphorical association occurs only once in *Nature* (vs. 11 times in *The Guardian*), while the latter 'embryos are machines' metaphor occurs 7 times in the journal and 13 in the newspaper. By contrast, the 'embryos are patents' and 'genetic modification is a race' metaphors occur more frequently in *Nature* than in the *Guardian Corpus*, thus showing the efforts of scientists to succeed in genetic modification and to make this become a legal practice.

On the other hand, the positive idea of progress involved in gene editing (*moving forward*) seems to be shared by the two sub-corpora, thus counterbalancing the risk taken by scientists (*Pandora's box*) and the fears involved therein (*spectre/nightmare*).

Let us check now if a qualitative analysis of the metaphors in *Table 2* (§§ 4.1-4.8) can confirm these preliminary quantitative findings.

4.1. *Genetic modification is text editing*

The conceptualisation of genetic modification as 'text editing' is one of the commonest in the sub-corpora. As remarked by Calsamiglia and van Dijk (2004, 376), in genetics, scholars have themselves defined and explained genes and the genome in terms of a 'text' or 'language'. Correspondingly, in my data I find two sets of metaphors, namely those applying to the properties of the genome itself, described as a 'text to edit', on the one hand, and those applying to the scientific acts or procedures, such as that of 'correcting errors' or 'rewriting', on the other hand. *Table 3* shows a sample of these sets of metaphors.

In the *Nature Corpus*, 39 metaphors can be placed in the category Genetic modification is text editing. In particular, the genome (or DNA) is described as a text to be edited (*edit your children's genes*), and the process of genetic modification is viewed as correction (*had corrected the gene*). Similar metaphors are found in the *Guardian Corpus*, 43 belonging to the above category, in which writers suggest editing

DNA (*edit DNA*), correcting the mistakes before the last version is finalised (*correct the mistakes before the child's development goes to its final draft*), or even rewriting the text to obtain an improved version (*rewrites DNA*). The sharing of these types of metaphorical associations by the two different sub-corpora is clearly connected with the traditional conceptualisation of the genome as a 'text', whereby genetic modification has been described as a process of 'text editing' by both journalists and scientists.

Table 3. – 'Text editing' metaphors.

Category	Examples in Nature Corpus	Examples in Guardian Corpus
Genome/DNA is a text to edit	Should you **edit your children's genes**?	technologies that could **edit DNA** in the same way that we can edit text
Modification is correction	she wished that her parents **had corrected the gene** responsible for her blindness	to **correct the mistakes** before the child's development goes to its **final draft**
		Genome editing is different in that it precisely targets the **existing faulty gene for** knock-out or **correction**
Modification is rewriting	—	Instead of fixing words, gene editing **rewrites DNA**

4.2. *Genetic modification is a race/science fiction/playing God*

Additional metaphors identified in the two sub-corpora categorise genetic modification as a 'race', 'science fiction', or even as 'playing God'. Quantitative data in *Table 2* show that the first two sets of metaphor are more frequently used in the *Nature Corpus*, while the 'playing God' metaphor is typically used in the *Guardian Corpus*, but not in the journal. *Table 4* shows examples which fall into these categories.

The first set of metaphors places emphasis on the attitude of scientists, who are taking part in a competition or race (*gene editing was already racing*) in which all the competitors try to be the fastest ones and to finish first (*this race for the first GM baby*). The second

set, instead, places emphasis on the science fiction landscape where scientists are working (*science-fiction scenarios*), and even plays with the word 'science', as opposing to 'science fiction' (*gene editing: science or science fiction?*). The latter question even sounds as an accusation of lack of seriousness, since gene editing is viewed as a fictive, absurd, or impossible task. The last set finally places emphasis on the concerns about the role of scientists, who are *"playing God" with our genes*, going against nature, and creating babies as if they had divine power (*has created babies*).

Table 4. – 'Race', 'science fiction', and 'playing God' metaphors.

Category	Examples in Nature Corpus	Examples in Guardian Corpus
Genetic modification is a race	Although **gene editing was already racing** through research laboratories	We must stop **this race for the first GM baby** **The race is on to get gene editing therapies** into the clinic
Genetic modification is science fiction	Designing babies through **gene editing: science or science fiction?** **science-fiction scenarios** of 'designer babies' remain just that	—
Genetic modification is playing God	In nations like the US, the Christian-leaning beliefs of many lead to a concern about **'playing God'**	we are **"playing God" with our genes** a scientist **has created babies** that way

4.3. *Modified babies are designer goods/tailored clothes/superhuman beings*

The embryos in genome editing are also the target of debate, in that they are viewed as 'first-class products', 'excellent goods', or even 'superhuman beings'. The metaphors in *Table 5* belong to these three categories.

The metaphor conceptualising babies or embryos undergoing genetic modification as designer goods is one of the most frequent in the corpus. A majority of the expressions, however, occur in the *Guardian Corpus*, with 44 cases against the 11 cases of the *Nature Corpus*. This

4:1 proportion suggests the 'designer goods' to be one of the most popularising metaphors as far as genome editing is concerned. The collocation *designer baby/babies* is currently used among journalists, who tend to enclose it in inverted commas, as a quote (*'Designer babies': the ultimate privileged elite?*). The co-text of this collocation is always suggestive of the writer's sarcastic, even polemical tone. In *Nature*, designer babies are part of a redesigned planet, together with *engineered mosquitoes*. In *The Guardian*, they are described as *an ethical horror* or *the ultimate privileged elite*, cynically alluding to the economic issue behind genetic engineering and its costs to parents.

In the corpus, babies are also described as tailored pieces of clothing that are shaped to adapt to their parents' tastes (*tailor-made babies*, *bespoke babies*, *with tailored features*). Again, the idea of first-class, expensive, exclusive, elite goods emerges from these metaphorical expressions, but mostly in the newspaper sub-corpus.

Table 5. – 'Designer goods', 'tailored clothes', and 'superhuman beings' metaphors.

Category	Examples in Nature Corpus	Examples in Guardian Corpus
Modified babies are designer goods	From **designer babies** to engineered mosquitoes, advances in genome-editing technologies	**Designer babies**: an ethical horror waiting to happen?
		'Designer babies': the ultimate privileged elite?
Modified babies are tailored clothes	Gene editing: **Running with scissors**	**tailor-made babies** in their "numbered test tubes"
		so-called "designer babies", **with tailored features**
		opening the door to **bespoke babies**
Modified babies are superhuman beings/heroes	Life after **SuperBabe**	fears over a slide towards producing **superhuman babies**
		creating a kind **of demi-god race** that will be taller, healthier, probably better-looking
		I don't think we are going to see **superman**

Finally, the absurd idea of beings having extraordinary characteristics and superhuman power is stressed by the metaphors *superhuman babies*, *SuperBabe*, *superman*, and *demi-god race*.

4.4. *Parents are consumers, phenotypic traits are shopping lists/selected from a menu*

Genome editing is associated with several actions and operations that are regarded as a sort of commerce. Parents, for instance, are viewed as 'consumers' and the phenotypic traits of their future offspring as a 'list of goods' to be purchased, as long as they can afford them. However, the proportion of metaphorical expressions found in the two sub-corpora is again different: i.e., the *Guardian Corpus* displays a 2:1 ratio for the 'shopping lists' metaphor compared to the *Nature Corpus*, and nearly 4:1 for the 'consumers' metaphor. This difference in quantitative data between the two sub-corpora shows that the related expressions are especially used by journalists as popularising metaphors, less frequently so by scientists in their online articles. *Table 6* shows some of the rich amount of data related to these metaphors.

These expressions suggest what happens in consumer eugenics: when *the wealthy can purchase a perfect offspring*. In particular, parents can select their offspring's traits from a menu (*drop-down menus*), but other parents can also choose from a catalogue (*a design-your-own-baby catalogue*), or à la carte (*select different traits à la carte*), as if phenotypic traits were dishes or goods on a list (*parents' shopping list*). The trade of phenotypic traits is highly criticised by using metaphorical language, in that in the journalists' view more and more parents are treating their babies as objects to select or goods to purchase.

Table 6. – 'Consumer', 'shopping list', and 'menu/catalogue' metaphors.

Category	Examples in Nature Corpus	Examples in Guardian Corpus
Parents are consumers	"I prefer a child with ...": designer babies, another controversial patent in **the arena of direct-to-consumer genomics**	If it happens at all, the aim will be not to engineer societies but **to attract consumers** a future where **the wealthy can purchase a perfect offspring**

Category	Examples in Nature Corpus	Examples in Guardian Corpus
Phenotypic traits are shopping/wish lists	**The phenotypic characteristics that may be on the users' (e.g., parents') 'shopping list'** can include both disease-related and non-disease-related traits	**the list of traits people select** with the service
Phenotypic traits are dishes/products on a menu or catalogue	Also, inevitably, there will be companies eager **to "serve" them [traits]** 'designer' babies by **selecting embryos for height, eye color, or other nonmedical related features**	a future in which we start selecting a criterion of eye or hair colour from **a design-your-own-baby catalogue** a patent that includes **drop-down menus from which to choose a future child's traits** From there, it's not too hard to imagine something akin to the Subway sandwich line where you **select different traits à la carte**

4.5. *Embryos are machines/buildings/patents*

In popular science texts on genome editing, embryos are additionally described as 'machines' (especially 'computers'), 'buildings', or 'patents'. The metaphors in *Table 7* belong to these categories.

By genome editing, scientists can 'programme', 're-programme', 'expand', 'engineer', 'upgrade' the embryos' genes. All these verbs come from the information technology field and sound inappropriate when they are used in the medical field. The contrast that they create in science texts underlines the inappropriateness of scientists' manipulation of human genome. In the same way, the description of manipulated embryos as 'patents', especially found in the *Nature Corpus*, contributes to feed bioethical debates about whether or not genetic engineering should be accepted and authorised, or rather refused and impeded.

Table 7. – 'Machines', 'buildings', and 'patents' metaphors.

Category	Examples in Nature Corpus	Examples in Guardian Corpus
Embryos are machines	**Programming favorable traits in embryos** may not be possible **Expanding and reprogramming the genetic code**	is it a good idea **to 'upgrade' our DNA**? genetic enhancement – **engineering babies with genes for desirable traits**
Embryos are buildings	The ability to genetically encode **an expanded set of building blocks**	The simplest and surest way to "design" a baby is not to **construct its genome** by pick'n'mix gene editing
Modified embryos are patented inventions	The so-called **'build a baby' patent**	**a patent** that includes drop-down menus from which to choose a future child's traits

4.6. *Ethical debates are struggles, ethics places boundaries*

Ethical debates relating to the issues in question are viewed as 'struggles', 'battles', even as 'storms' involving strong emotional reactions from the part of ethicists, patients, and researchers. Ethicists, on the one side, establish some 'barriers' that should not be overcome. Researchers, on the other side, try to cross the 'lines to edited embryos'. The metaphors in *Table 8* offer a sample of these categories.

The metaphors in *Table 8* are common in the first studies on metaphor. Lakoff and Johnson (1980), for instance, identified the mapping Argument is war, in which arguing is seen as engaging in battle, people arguing are enemies, arguments are weapons, etc. Analogously, in corpus writers use *a long-fought battle* or *the old struggle* to allude to the ethical dispute against genome editing. Related to this primary metaphor is also the secondary metaphor *The working group would also have to wrestle with where to draw the line*, in which the phrasal verb *wrestle with* accentuates the difficulties and efforts of this struggle. Ethicists continue to lay emphasis on what is morally wrong, raising barriers (*safety, technical and legal barriers still stand*) that scientists are trying to overcome.

Table 8. – 'Struggles' and 'barriers' metaphors.

Category	Examples in Nature Corpus	Examples in Guardian Corpus
Ethical debates are struggles/battles/storms	This has been **a long-fought battle** This harks back to **the old struggle** The working group would also have **to wrestle with where to draw the line** between ethically acceptable and unacceptable uses	genetic enhancement as just the latest step **in the struggle to improve human life** a new genome-editing technology that has been taking the scientific world by **storm**
Ethics places barriers/boundaries	Many safety, technical and legal **barriers still stand** in the way of editing DNA in human embryos some ethicists point out that human society has already **crossed some of these boundaries**	Gene editing is a long way from **overcoming this barrier** **the line to edited embryos** and intentional germline modifications **will be crossed soon**

4.7. *Gene editing is a weapon/opens Pandora's box, eugenics is spectre/nightmare*

In the public debate, the risks of gene editing are described as 'weapons' 'opening up Pandora's box', while eugenics is regarded as a 'spectre' or 'nightmare'. The metaphors in Table 9 illustrate these mappings.

The metaphors in *Table 9* all highlight the dangerous consequences of gene editing. By using metaphorical language, gene editing is described in the *Guardian Corpus* as a weapon (*one of the six potential weapons of mass destruction*), as a hammer (*a hammer in the hands of good and bad actors*), or, in both sub-corpora, as the process opening Pandora's box and releasing evils into the world (*gene editing opens Pandora's box*). Other metaphors stress the unforeseen problems and fears that may be connected with genetic manipulation, including the spectre of eugenics increasing social disparities (*the spectre of eugenics*, *opening up nightmares*).

Table 9. – 'Weapon', 'Pandora's box', and 'spectre' metaphors.

Category	Examples in Nature Corpus	Examples in Guardian Corpus
Gene editing is a weapon	—	he considers **gene editing one of the six potential weapons of mass destruction** [...] **a hammer in the hands of good and bad actors**
Gene editing opens Pandora's box	Scientists and bioethicists are concerned that **gene editing opens Pandora's box**	**The genetic Pandora's box is open**
Eugenics is a spectre/nightmare	leading to 'designer babies' and raising **the spectre of eugenics** Gene editing is now the stuff of do-it-yourself 'garage research', **opening up nightmares** for regulation and oversight	**The spectre of a harsh, impersonal and authoritarian dystopia** always looms in these discussions of reproductive control and selection

4.8. *Progress is moving forward, disease is enemy to fight, permission is green light/open doors*

To counterbalance the above tendency to describe progress as a dangerous weapon of mass destruction, the opposite standpoint views progress as a 'step forward', especially in the 'fight against disease' (cf. Semino, Demjén, and Demmen 2016 for 'fight' metaphors for cancer). From this perspective, gene editing can be accepted because it is morally right and authorised by regulation. However, quantitative data show that, like the metaphor 'gene editing is a weapon', the metaphor 'disease is enemy to fight' is only present in the *Guardian Corpus*, evidencing again the more subjective standpoint of journalists when referring to genome editing as compared to scientists' attitude. The metaphors in *Table 10* illustrate the pertinent mappings.

The metaphors in *Table 10* all highlight the advancement involved in gene editing. Here research leads to progress, and genetics appears to have made a *breakthrough* by using the gene-editing method called Crispr-Cas9. CRISPR is metaphorically described as *a bullet train that*

has left the station, thus, like a bullet train, it is fast-moving and has no stops on its journey. Therefore, if gene editing is leading to a better world, where disease can be fought (*Gene editing unlocks access to an entirely novel way to fight disease*), it can be consented even by authorities (*green light to genetically modify human embryos*), *bespoke babies* being the risk to run.

Table 10. – 'Moving forward', 'enemy to fight', and 'green light' metaphors.

Category	Examples in Nature Corpus	Examples in Guardian Corpus
Progress is moving forward	Ethics **keeps moving**. What was once seen as dangerous **goes on** to be seen as within the confines of acceptable risk	**scientific breakthrough**
		There have to be very good reasons for **such an unprecedented step**
	CRISPR is a bullet train that has left the station – there's no stopping it	It has none of the ethical burdens **these steps towards germ-line modification** would be shouldering
Disease is enemy to fight	-	Gene editing unlocks access to **an entirely novel way to fight disease**
		Having edited the cells to make them **cancer-killers**
Permission is green light/open doors	What usually emerges from such discussions is a **green light** for properly regulated research	British researchers **get green light to genetically modify human embryos**
	gene-editing technologies that **could open the door** to germline gene therapy	there is no need for mass panic that about **opening the door to bespoke babies**

5. Gene editing and conceptual metaphors

In the previous section, I have focused on metaphorical expressions, such as *playing God*, *designing babies*, *running with scissors*, *upgrading DNA*, and so on. If we inspect these metaphorical expressions more closely, we can realise that they cluster together around a smaller number of overarching groups or "conceptual metaphors" (Lakoff and Johnson 1980). In addition, we can see how mappings between source domains and target domains are performed in order to make these metaphors work.

In particular, five major conceptual metaphors seem to structure the media discourse about gene editing that I have observed. The five overarching conceptual metaphors based on source-target mapping are the following:

- Gene editing is a mechanical agent (programmes, reprogrammes, updates, expands).
- Gene editing is a human agent (edits, corrects, rewrites, selects, picks, chooses, designs, redesigns, engineers, races, etc.).
- Gene editing is a human agent using a mechanical agent (produces, constructs, cuts, tailors).
- Gene editing is a divine agent (creates, plays God, opens Pandora's box).
- Gene editing is a dangerous object (hammer, weapon of mass destruction, atomic bomb).

These five conceptual metaphors appear to extend the genetic repertoire of metaphors. In the case of genomics, the target domain is commonly 'the gene' or 'the genome' and the source domains are familiar everyday (harmless) objects, such as texts, books, maps, blueprints, etc., which make the unfamiliar seem more familiar and comprehensible. In the case of gene editing, instead, we have various source domains (such as machines, mechanical devices, human agents, and even divine agents or dangerous objects), which activate different mapping processes.

Genetic engineering is firstly mapped onto machines, in that it may act like computers programming and updating data. In addition, it is mapped onto human agents, who can edit/rewrite the genome, choose ideal traits, design, or engineer perfect babies. It is also mapped onto human agents who use tools (machinery, scissors) to manufacture products, or to cut/tailor first-class goods. Moreover, gene editing is viewed as a divine agent, in that, like God, it is able to create or generate newborn babies, or, like Pandora's myth, it opens a jar containing all the possible evils that can affect humanity negatively. Finally, it is associated

with dangerous objects, such as hammers, weapons, or as the atomic bomb, for its dangerous, even destructive (explosive) effects. The latter mappings are especially connected with social debates on the moral and ethical implications of gene editing.

The mappings that these less conventional conceptual metaphors trigger, on the one hand, make the task of readers more difficult, in that less familiar or less common source domains, such as divine agents or dangerous objects, are used to explain scientific matters. On the other hand, they make readers aware of the responsibilities that scientists carry, and of the risks that they run, when they manipulate the human genome.

6. The functions of metaphor in science popularisation

The complex interplay of metaphors identified in the corpus is motivated by the huge amount of issues that are connected with genetic engineering and that are debated in popular science. *Figure 1* summarises the two main functions of metaphor in my corpus. On the one hand, metaphor has an explanatory/informative function, in that it describes genetic (medical) issues by using concrete domains, which are easier to access for a lay audience. On the other hand, metaphor has an expressive function, i.e. it mainly conveys critical remarks against the scientific community who are manipulating babies for their experimental purposes, or otherwise admits the advancement involved in biogenetics.

The expressive function is much more complex and connected with a multiplicity of issues, from bioethics to religion and economy. The debate revolves around the dangerous consequences of genetic modification, viewed as a religious offence ('playing God'), or as an outrage towards babies, who are viewed as 'superhuman beings' or similar. Moreover, there are economic and commercial sides, according to which genetic modification can be regarded as a profit-making business between 'producers' (scientists) and 'consumers' (parents). The former manufacture and trade ideal 'designer goods' whose characteristics are chosen by the latter from a 'catalogue'. From the medical viewpoint, genome editing represents either an explosion, an atomic bomb ('weapon') or the progress ('moving forward') to fight genetic disease ('enemy to fight'). British scientists, on the one hand, are given permission ('green light') to go forward with their research. Laypersons such as parents, on the other hand, may be persuaded by the latter positive associations and be encouraged to accept and even approve gene editing.

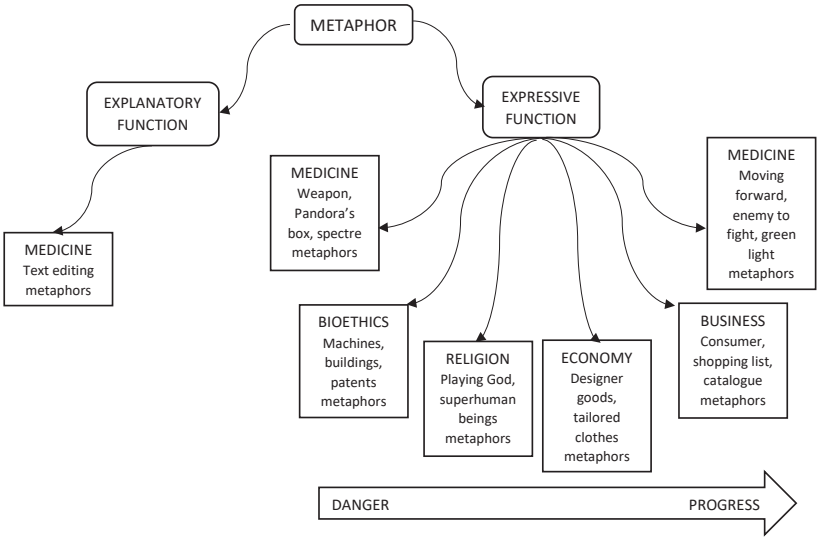

Figure 1. – Functions of the metaphors in the Nature Corpus and Guardian Corpus.

7. Conclusions

This study has contributed to the literature on science popularisation by showing the use of different types of metaphorical expressions and conceptual metaphors in a small corpus of online articles on genome editing. The metaphors identified in the corpus have demonstrated that genome editing can be viewed either as a dangerous menace to our society or as a sign of advancement and improvement.

In particular, the study has shown that, from the standpoint of science popularisation, 'gene editing' metaphors can be used to explain, clarify, and simplify scientific concepts that would be otherwise inaccessible to laypersons. For instance, metaphors such as *edit DNA*, *rewrite DNA*, or *correct the mistakes* make the concept of genetic modification more accessible and understandable also to non-specialist audiences, thus contributing to science dissemination. This study has also shown that metaphors can be used to make the audience aware of a variety of bioethical and moral implications of 'gene editing'. For instance, modifying genes can mean *playing God*'s role, producing *designer* or *tailor-made babies*, or creating a world where *the wealthy can purchase a perfect*

offspring. Still another set of metaphors are used to stress the progress that 'gene editing' involves. Researchers, indeed, firmly describe it as *an unprecedented step* or as *a powerful new resource in the fight against disease*. However, from a comparison between the two different sub-corpora explored, it emerges that journalists tend to stress more the commercial, religious and (im)moral aspects of gene editing, while, in the scientific journal, experts highlight more their efforts to succeed in genetic modification and to make this become a legal practice. From this viewpoint, the *Guardian Corpus* can be seen as more popularising than the *Nature Corpus*, as well as more orientated towards the consequences of gene editing, either negative (*weapon of mass destruction*) or positive ones (*fight against disease*).

Finally, the five conceptual metaphors identified in this study suggest that the expressive/persuasive function of metaphors prevails over the explanatory/informative one, and this is especially evident in the *Guardian Corpus*, where the metaphorical expressions identified are more numerous, varied, and innovative. Indeed, while grand metaphors in genomics were based on relatively transparent mappings between source domains (texts, books, and maps) and target domains (genes and genomes), such seemingly transparent mappings are less common in genome editing. There are various source domains that are being exploited, such as machines or mechanical devices, on the one hand, and human, divine agents, or even dangerous objects on the other. These less transparent mappings suggest that, in media discourse, authors mainly use metaphorical language to influence and persuade the audience that genetic engineering can implicate not only future innovation, but also massive destruction. From this perspective, popular science texts on the web, in particular online newspaper articles, can be viewed as both effective tools of knowledge dissemination to non-specialists as well as means of conveying messages on bioethics and ontology.

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