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REPRESENTATION OF GENE-EDITING IN BRITISH AND ITALIAN NEWSPAPERS
A cross-linguistic corpus-assisted discourse study

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Abstract – This study provides a cross-linguistic overview of the most recurrent representation strategies of gene-editing in British and Italian newspapers over a period between 2015 and 2018. The aim of the study is to a) identify the archetypal representations in English and in Italian, also considering translation-related issues, and b) to assess whether these representations are positively or negatively framed across the corpora. The research is carried out in a quantiqualitative vein, using the method of corpus-assisted discourse analysis. Corpus linguistics tools are used for text search and data processing and rely on the triangulation of normalized frequency, dispersion and range parameters. Methods of (critical) discourse analysis are applied to the qualitative part of the research. Literature on science popularization and metaphorical framing of genetic concepts is also part of the analytical toolkit. The findings identify a relative lack of terminological stability concerning the denomination choices, especially evident in the Italian corpus. The archetypal representation strategy revolves around the idea of technology and (physical) change. The analysis highlights the use of some ideologically charged denominations across the corpora, with a prevalently positive framing of the technology as applied to agriculture in the Italian corpus and a more balanced framing of gene-editing in the UK corpus. The findings uncovered a paradigm shift in the metaphorical representation of genome: from a mysterious code of life to a domesticated and operationalized idea of a tool.

Keywords: gene editing; representation; cross-linguistic corpus-assisted discourse analysis.

1. Introduction[1]

The developments of biology and medicine raise fundamental questions which should be subjected to appropriate public discussion as they concern

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core issues in people's lives, given that new technologies in the biomedical field have paved the way to new and hitherto unknown possibilities. One of such possibilities is the so-called gene-editing, also known as genome editing, a technique through which living organisms – plants, animals and even humans – could be modified by introducing changes at the gene level, *in vitro* and *in vivo*. Scientific and lay communities are preoccupied with drawing lines between the possible 'ethical' uses of this technology – ranging from improving agricultural yield by plant gene-editing (Piatek *et al*. 2018) and curing rare genetic diseases by gene therapy on human patients *in vivo* (Nami *et al*. 2018) – and potential 'unethical' applications aimed at human enhancement, which could produce superhumans and designer babies. Yet, the borderline between these two poles is not as solid as most people would like to think; in fact, it becomes increasingly porous (Benjamin 2015, p. 50). The novelty of this technology has left modern regulators unprepared, as it is difficult to regulate a tool, which can be used for a variety of applications. Most probably, the regulators' approach will tie into consolidated public attitudes towards what is considered appropriate and ethical and what is a taboo. Consequently, it is of utmost importance that the public at large learns about these scientific novelties in order to take an informed decision on this highly controversial issue.

It has been posited that popularisation "is the only possible solution" (Garzone 2006, p. 81) to inform the public at large about modern advances in science and technology. Gene-editing, as an advancement that touches upon the cornerstone of human existence, has to undergo thorough public scrutiny, yet this scrutiny often relies on various media "as a source of health information (and misinformation)" (King, Watson 2005, p. 1). In fact, any public inquiry into controversial issues will inevitably rely on the information received through conventional or new mass media rather than the actual underlying science, which, along with reaching vast audiences, are actively involved in setting the agenda of the popularisation process. They leave an impact on the construction of the public's understanding of scientific phenomena by producing news and providing opinions (Garzone 2006, p. 84; Gotti 2014, p. 26). As a result, media discourse can promote positions of power and ideologies (Fairclough 1995), in light of the tendency of mass media to provide an interpretation of the news covered.

This study aims to uncover the most recurrent and archetypal representations of gene-editing in popularised texts (Section 2), with an indirect goal of raising awareness about gene-editing, and to investigate whether these representations could be considered neutral or biased across the corpora, adopting the methodological framework of Corpus-Assisted Discourse Analysis (Section 3). The analysis focuses on the most distinctive representation strategies of gene-editing across two corpora of British and

Italian newspapers. The findings are organised in six subsections, integrating quantitative data under the form of tables and numbers with a discourse analytical approach applied to the qualitative interpretation of representative examples. Finally, Section 6 presents concluding remarks and ideas for future research.

2. Theoretical framework

There is a wealth of research on science popularisation through newspapers (e.g. Garzone 2014; Gotti 2014; Hyland 2010), carried out through a variety of perspectives, on account of the importance of such knowledge dissemination and the easy availability of popularising science newspapers and "general" newspapers with science news sections. As Hyland (2010, p. 3) notes in 2010, "most daily newspapers now have specialized science sections and the number of science articles in the press has been increasing", and little has changed ever since. Linguistic studies on popularisation of genetics range from a comprehensive analysis of genome sequencing overviewed in the Spanish press (Calsamiglia, van Dijk 2004), an analysis of media framing of biotechnology (Marks *et al*. 2007) to a vast number of studies on genetic metaphors (see, e.g. Nelkin 2001; Nerlich, Hellsten 2004; Pramling, Säljö 2007) that are used to communicate the concepts of genome organization to the general public, and thus pursue clear popularisation goals. Starting from 2000s, representations of the genome have consolidated around the image of a written document, a book, a text or a code (Nelkin 2001; Pramling, Säljö 2007) to be discovered, demystified and decoded. By contrast, gene-editing, discovered only in 2012, has only just started to generate terminology and imagery suited to convey such a novel concept (O'Keefe *et al*. 2015, p. 3; see also Mattiello 2019; Nikitina 2020), making research on linguistic and discursive representations of this new technology a relevant field of study with a potential to uncover valuable inputs for the scientific community, also from a cross-linguistic standpoint.

In general, the popularisation process is perceived as a form of knowledge transformation and recontextualization acting on the "specialized-lay" continuum (Calsamiglia, van Dijk 2004, p. 370) addressing the non-specialised audience (Gotti 2014, p. 16). At the same time, journalists, who may not be experts in gene-editing and may find the science behind it challenging (Petersen 2001, p. 1257), could be tempted to rely on trusted sources, without any further checks, recycling denominations, designations and metaphors used by other authors. Popularisation processes through newspapers are associated with a tendency to magnify public response by selecting and foregrounding the most newsworthy elements, irrespectively of their scientific relevance, just "to arouse as much interest as possible in

readers" (Garzone 2014, p. 91). Such selective knowledge transformation may result in (un)intentional interpretation suggestions, bias, slant and even lead to ideological manipulations (Fairclough 2014; Garzone 2018; van Dijk 1998), thus generating specific interpretations of reality (van Dijk 1998, pp. 135-140) through linguistic representations.

3. Aims, materials and methodology

The study sets out to examine the discursive and linguistic representation of gene-editing in the British and Italian press over a four-year period (2015-2018). These two languages and cultures were chosen based on the idea that representations of sensitive knowledge tend to reflect cultural assumptions and to coincide with the expectations of the audiences. The paper thus pursues a twofold goal: to analyse patterns of gene editing representation in newspapers in each of the languages considered and to assess any convergent and/or divergent tendencies from a cross-cultural perspective.

The analysis is carried out on two corpora of newspaper articles, in English and in Italian, created ad hoc using keywords *gene*, *genome* and *editing* (and their Italian equivalents). The first corpus ("GE_UK") consists of 200 newspaper articles that appeared in 36 UK newspapers, including their national, regional and Sunday editions. The second corpus is comprised of 149 articles written in Italian and published in Italian newspapers ("GE_IT"), including both national and regional editions. Both corpora were compiled using the research engine of LexisNexis, looking at the period between 2015 and 2018 (see Table 1) and including both tabloids and broadsheets.

	GE_UK	**GE_IT**
Texts	200	149
Texts per year (%)	2015 – 17% 2016 – 24% 2017 – 36% 2018 – 23%	2015 – 13% 2016 – 28% 2017 – 23% 2018 – 36%
Tokens	135,065	84,023
Types	7,990	11,776
Ave. text length (w)	680	600

Table 1
Corpus composition.

The basic methodological framework is that of Corpus-Assisted Discourse Analysis (Baker 2006; Baker *et al*. 2008; Partington *et al*. 2004), which exploits operational synergy between quantitative research using Corpus-Linguistic methodology and Critical Discourse Analysis (Fairclough 1995,

2014; van Dijk 1993).

The Corpus-Linguistic part started with normalisation of all raw frequencies. As the subcorpora had different number of tokens, all data had to be converted to relative, or normalised, frequencies ("NF"), in order to achieve comparable results.[2]

In addition to normalised frequencies, dispersion values ("D") were examined to measure the uniformity of distribution of search words.[3] The pure range ("R") – i.e. how many texts employed a given expression irrespective of occurrences within a single text – was also calculated, as it showed the pervasiveness of linguistic choices.[4] As a result, all quantitative assessments are based on the combination of three parameters: normalised frequency, dispersion and range.

Following Stubbs (1994, p. 212), who emphasises "the need to combine the analysis of large-scale patterns across long texts with the detailed study of concordance lines", patterns were examined in combination with concordance analysis carried out using WordSmith Tools 6.0 (Scott 2015). This operation provided helpful indications of the respective representations in English and in Italian.

Since media discourse is a privileged place to introduce dominant views on knowledge and ideologies in society (Van Dijk 2005), the qualitative part of the analysis assessed discursive and linguistic data as a social practice. The emphasis was placed on the ideological colouring

[2] The normalisation base was set at the mean value between the two corpora, i.e. (135,065 + 84,023) / 2 ≈ 110,000. Consequently, all absolute frequencies were normalised and rendered comparable in MS Excel following the formula (absolute frequency / tokens in the corpus) * 110,000. This study sets the significant frequency cut-off at 30 occurrences per 110,000 words, or ≈0.03%, which is a more stringent parameter than is typically adopted in quantitative studies. Significant frequency cut-off is a relatively subjective parameter, which is set at different thresholds by different authors (e.g. Biber (2006) uses the benchmark of 0.004%; Goźdź-Roszkowski (2011) adopts the 0.02% cut-off point and Breeze (2013) sets it at 0.005%), see Nikitina (2018, pp. 192-193) for other comparisons.

[3] WordSmith Tools 6.0 (Scott 2015) calculates the dispersion value adopting the algorithm of Juilland's D (Gries 2019, pp. 13-14). The theoretical range of Juilland's D is between 0 and 1, where values close to 0 indicate a skewed distribution and values close to 1 stand for homogeneous dispersion. Typically, values above 0.9 mean a very high level of dispersion, values between 0.8 and 0.9 a high level of dispersion and values between 0.7 and 0.8 translate into a medium high level (Biber *et al.* 2016, p. 441). These ranges were taken as indicative for this study. No *D* cut-off was set, as recent quantitative research has demonstrated that Juilland's *D* formula tends to inflate the values if it is applied to corpora with more than 100 corpus parts (Biber *et al*. 2016; Gries 2019). In fact, it emerged in this research that nodes occurring only five times per 110,000 words demonstrated *D* values above 0.5, which seemed counterintuitive. Moreover, Juilland's *D* calculates the dispersion across corpus parts that are assumed to have identical size (Gries 2008, pp. 410-411), which is not always true in this study.

[4] Again, all data was converted to percent in MS Excel (e.g. 50 texts out of 200 = 25%). The range cut-off point was set at 10%.

associated with different labels used to represent gene-editing in terms of referential strategies (how is the phenomenon of gene-editing named and referred to linguistically across the corpora?) and predication strategies (what traits, qualities and features are attributed to them across the corpora?) (Reisigl, Wodak 2001). As it is often troublesome to distinguish between referential and predication strategies, these were collectively referred to in this study as *representations*, reflecting Hall's view on this phenomenon as "the process by which members of a culture use language […] to produce meaning" (Hall 1997, p. 61). As some representations were built around metaphors, the impressive literature on metaphors in genetics was consulted (Calsamiglia, van Dijk 2004; Nelkin 2001; Nerlich, Hellsten 2004; Pramling, Säljö 2007).

Finally, representations were assessed in terms of their positive or negative components on two levels: *semantic prosody* (Louw 1993; Sinclair 1991), standing for the immediate collocational co-occurrence, and *discourse prosody* (Stubbs 2001), i.e. the tendency to co-occur with certain elements in a wider co-text, beyond the boundaries of a single clause or sentence.

4. Findings

As the topic of corpus texts was known, and the corpora were designed to trace the representations of gene-editing, the quantitative research started with the examination of statistically significant lexical patterns across the corpora involving the terms *gene, editing* and *genome* (and their Italian equivalents) to assess the denominations given to the technology (see 4.1) from a cross-linguistic perspective. Subsections 4.2-4.3 focus on other specific denominations found in the texts that are used as synonyms (genetic enhancement) or as contraries (genetic modification) of gene-editing. Subsections 4.4-4.5 deal with general terms of a superordinate nature used to represent and frame gene-editing, and subsection 4.6 provides synthesis and discussion of the findings, focusing on the positive vs. negative representations and tracing general cross-corpora patterns.

4.1. Denomination

First the level of *denomination* or *designation* was assessed. Although denominations are often explanatory in popularising press (Calsamiglia, van Dijk 2004, pp. 374-375), it was decided to look at the choices of specialised terms to denote a concept without providing an explanation, also called *terminological definition* (Gotti 2014, p. 18). Analysis of key terms *gene, editing, genome* has revealed instability concerning the designation of *gene-editing*. In the UK corpus this designation did not exhibit a clear (non-)

hyphenation standard, and sometimes was also referred to as *genome editing*. The UK corpus also used *DNA editing* and *genetic editing*; however, these versions were statistically insignificant as they had low frequency, low dispersion and low range. It has to be stated that at the corpus design stage "gene editing" only was set as a search parameter, thus the variation observed may be construed either as a sign of general terminological instability associated with this novel phenomenon or as the outcome of the popularisation process, notorious for unsystematic use of disciplinary terms (Gotti 2014, p. 17). This instability becomes particularly evident in the Italian corpus, as Table 2 illustrates.

GE UK	**NF**	**D**	**R**	**GE IT**	**NF**	**D**	**R**
gene editing	586	0.811	80%	gene editing	41	0.742	15%
gene-editing	338	0.770	67%	gene-editing	41	0.742	10%
genetic editing	9	0.613	5%	editing genetico	90	0.862	32%
genome editing	86	0.828	27%	genome editing	157	0.877	45%
				genoma editing	5	0.596	3%
				editing genomico	4	0.478	2%
				editing genico	3	0.3	0.67 %
DNA editing	10	0.429	4%	editing del DNA	3	0.3	1%
				editing del genoma	8	0.644	4%
Total	**1029**			**Total**	**351**		

Legend. NF = normalised frequency; D = dispersion; R = range.

Table 2
Denomination of gene-editing across the corpora.

The Italian texts introduced non-integrated English borrowings *gene-editing* (in both orthographical versions) and *genome editing*, which would go in line with the overwhelming "Anglicization" of Italian (Furiassi *et al*. 2012, p. 1) reflecting some recent labelling choices employing Anglicisms in Italian, ranging from *Jobs Act* to *stepchild adoption*. Along with non-adapted loanwords there are some mixed Anglo-Italian variants, or loanblends (Haugen 1950) that use the node *editing* while translating the modifiers in various combinations. However, most of these mixed variants are statistically insignificant. Without further research it remains unclear whether these borrowings were "necessary" to cover the lack of an Italian word for this notion, or "luxury", i.e. introduced on account of the prestige of the lending language (Santulli 1999, pp. 75-83). The total number of hits across the corpora suggests that the Italian corpus employed other, most probably, purely Italian versions of the term, which are discussed in further detail in the next paragraphs.

4.2. Gene editing as enhancement / improvement

Against the background of terminological variation and transposition of the main keywords into the Italian corpus highlighted in the previous section, it was interesting to observe the introduction of some purely Italian variants to denote the technology of gene-editing. The most widespread of the Italian variants was *miglioramento genetico* (lit. "genetic improvement", see Table 3), used by 15% of journalists. This term is often introduced through juxtaposition – "a process whereby the specialized term is followed by its periphrasis" (Gotti 2014, p. 18), with some kind of graphical division in-between, and sometimes co-exists along with the English term (see example (5)). A similar trope was found also in the UK corpus, where gene-editing was presented as genetic enhancement, yet it appeared only in 9% of texts in English as compared to 15% of texts in Italian. In general, the semantic field of improvement or enhancement is quite widespread across the corpora. It has to be noted that the Italian "migliora*" (NF: 149; D = 0.873; R = 38%) is more positively loaded than the English "enhance*" (NF = 109; D = 0.895; R = 22%); and semantically the latter is more comparable to "aument*" (NF = 55; D = 0.721; R = 19%). The trope of enhancement is less frequent, less dispersed and used by fewer authors in the Italian corpus. Comparison of "migliora*" (NF: 149; D = 0.873; R = 38%) with a semantically closer "improve*" (NF = 91; D = 0.856; R = 36%) revealed the dominance of this pattern in the Italian corpus as compared to the UK corpus.

Table 3 shows some recurrent lexis carrying the idea of enhancement / improvement across the corpora, with their semantic prosody indicated underneath.

GE UK	**NF**	**D**	**R**	**GE IT**	**NF**	**D**	**R**
genetic enhancement	29	0.820	9%	miglioramento genetico	35	0.831	15%
enhance*	109	0.895	22%	migliora*	149	0.873	38%
enhanc* intelligence / a trait - human / genetic enhancement - genetically enhanced - enhancement technology - enhanced children - potential types of enhancement				rese - cure - soluzioni - funzionalità - piante - genetico - condizione umana - riso - dei sintomi - dei processi produttivi			
improv*	91	0.856	36%	aument*	55	0.721	19%
crops / yield - life - health / welfare - looks/appearance - quality / aspects - safety - nature - policy - intellect / intelligence - efficiency - genome - understanding - treatment - productivity - success rates - trait(s) – performance				le capacità - massa muscolare - il livello - temperatura - quantità - resa			

Table 3
Gene editing as enhancement / improvement.

Two tendencies emerged from the analysis of the concordances: positive and negative representation of gene-editing as enhancement / improvement. Whenever enhancement referred to agriculture (e.g. semantic prosody featuring words *crops*, *yield* or *piante*, *riso*, etc.), it was represented in a positive way (see examples (1) – (6)), stressing such good results as increased productivity or resistance to disease. In fact, the English "improve*" was used predominantly in reference to agriculture. Remarkably, *miglioramento genetico* appeared in quotes by politically-relevant persons, suggesting political support of this technique in agriculture.

(1) Genome editing is one of the *new tools which will allow us to enhance productivity* on the farm.[5]

(2) Use of the powerful gene-editing tool CRISPR-Cas9 *could help to breed* cacao trees that exhibit *desirable traits such as enhanced resistance to diseases*.

(3) The scientists argued that *crops had been artificially improved for centuries* through conventional breeding techniques, which led to genetic changes.

(4) Britain *needs to consider introducing genetically edited* farm animals and crops, the Environment Secretary said yesterday. Michael Gove said the technology could produce *more valuable livestock and boost crop yields.*

(5) "Solo attraverso la *ricerca innovativa e le tecniche più avanzate di miglioramento genetico* (genome editing), potremo soddisfare la domanda crescente", spiega Pier Carlo Scaramagli, presidente di Confagricoltura Ferrara.
"Only through the innovative research and the most advanced techniques of genetic improvement (genome editing), can we meet the increasing demand", explains Pier Carlo Scaramagli, president of Confagricoltura Ferrara.[6]

(6) […] abbiamo voluto finanziare con la Legge di Stabilità un piano di ricerca pubblica con una *dotazione di 21 milioni di euro e un obiettivo chiaro*: un *impegno mirato di miglioramento genetico* delle principali colture che caratterizzano il modello agricolo italiano.
[…] we wanted to finance, with the Stability Act, a plan of public research with a subsidy of 21 million euro and with a clear objective: a specific commitment to the genetic improvement of the main crops that characterize the Italian agricultural model.

On the contrary, when enhancement referred to humans, it conveyed a negative (see (7) and (9)) or a mixed message (8), warning against possible misuses of this technology, employing the ideas of risks, concerns, fairness and discrimination.

[5] Emphasis is added in all examples. All examples in English are extracted from the UK corpus (GE UK).

[6] All examples in Italian are extracted from the Italian corpus (GE IT) and are provided with a literal translation into English.

(7) However, it also *raises the risk of creating errors* in the genetic code that would be inherited and *difficult to remove*, or creating enhancements to subgroups within the population that would *exacerbate social inequalities*, the statements says.

(8) Human genome editing *holds tremendous promise for understanding, treating or preventing many devastating genetic diseases*, and for *improving treatment* of many other illnesses. However, genome editing to enhance traits or abilities beyond ordinary health *raises concerns about whether the benefits can outweigh the risks, and about fairness* if available only to some people.

(9) Qui […] si pone un *problema di discriminazione* tra chi potrà avere accesso a cure e miglioramenti e *chi ne verrà escluso*. E c'è chi teme scenari futuri di *discriminazione genetica* alla "Gattaca" (uno dei film proiettati e discussi a Trieste).
Here […] a discrimination problem arises, between who can have access to cures and improvements and who will be excluded from there. And there are those who fear future scenarios of genetic discrimination "Gattaca"-style (one of the films projected and discussed in Trieste).

It is noteworthy that some articles in the UK corpus attempted to construct discursively a positive representation of gene-editing as enhancement by domesticating it and pushing the readership towards accepting it as something normal. Some instances of such normalisation attempts include the use of *attributions* (Sinclair 1986) or *projections* (Halliday 1994), which consist in bestowing additional weight to what is being said by quoting authoritative sources (see (10) and (11)). Such use of quotes and citations is an acknowledged journalistic device in popularised texts (see, e.g. Garzone 2014, pp. 95-98).

(10) *Professor Church also dismissed fears* that allowing germline gene therapy to treat inherited disorders will automatically lead down a "slippery slope" to genetic enhancement with "beneficial" traits, such as sporting prowess, intelligence or physical appearance.

(11) In a *major report* on the looming frontier of human gene-editing, *the Nuffield Council on Bioethics (NCB) said it did not believe* there was an ethical red line in tinkering with the genetic material that will be passed to future generations. It also did not draw a distinction between using these techniques to tackle genetic diseases and for enhancing desirable physical or intellectual traits, so-called "designer babies", so long as it meets strict ethical and regulatory tests.

Other normalisation attempts demonstrated straightforward reframing drawing analogies with accepted enhancement techniques. The mechanism behind the comparison between gene-editing and aging reversal, vaccination, prosthesis or implants resides in transferring the acceptability of the latter group to the former, as examples (12; 13) illustrate.

(12) Some people say, "Oh, you shouldn't do [genetic] enhancement", but the thing is *we do enhancement all the time - to some extent, all aging reversal is enhancement. Vaccines are enhancement*.
(13) Through the *application of prostheses, implants, and other bioelectronic devices*, we are not only healing the blind and the paralysed, but beginning to *reconfigure our bodies, enhance our memories*, and generate entirely new ways of interacting with machines. Through genetic interventions, we are neutralising certain diseases long thought incurable.

Surprisingly, gene-editing was never framed as enhancement of humans in the Italian corpus. Under the CDA perspective, which observes both present and absent elements in the data, the lack of this element in the Italian press is remarkable. It could be tentatively construed as a culturally specific omission.

4.3. Gene editing vs. genetic modification

Another frequent and dispersed representation technique is built around the contrast between gene-editing and genetic modification. Although Table 4 demonstrates some differences concerning the word-class (cf. *genetically modified* vs. *OGM*), the overall pattern of using another genetic engineering technique to depict gene-editing is clear.

GE UK	NF	D	R	GE IT	NF	D	R
genetic modification	51	0.799	22%	modificazion* genetic*	9	0.640	4%
gen* modif*	138	0.738	46%	modif* gen*	48	0.789	15%
GM	72	0.834	19%	gen* modif*	46	0.804	17%
GMO*	28	0.908	7%	OGM	288	0.865	33%

Table 4
Genetic modification as a contrast to gene-editing.

The public perception of genetically modified foods is notoriously negative, and analogies or disanalogies – depending on the author's stance – between gene-editing and GM were frequently invoked in the corpora. The predominant use in both corpora was to construct a disanalogy with GM, thus distancing the two technologies, and at the same time to represent gene-editing as something natural by analogy with cross-breeding (14) and nature (15) in general.

(14) Gene editing, a form of genetic engineering, is a faster version of what happens when animals or plants are cross-bred. […] It is *contrasted with genetic modification, or GM*, which is more unpredictable and involves transplanting genes into a plant or animal from a completely different species.
(15) *Rispetto agli Ogm standard il gene-editing è più semplice, economico e veloce*. Se con i sistemi tradizionali le carte che abbiamo in mano sono quelle della

> natura, stavolta - osserva Lippman – è come avere un asso nascosto nella manica.
> *In comparison with the standard GM, gene-editing is simpler, cheaper and faster. If, with the traditional systems, we had only the nature's cards in our hands, this time – Lippman observes – it's like having an ace hidden up your sleeve.*

However, such disanalogical reasoning was activated prevalently with reference to animals or plants. At the same time, the analogy with genetic modification was also used – in a limited number of cases – with a human referent, sending some negative (16) or mixed (17) messages. In example (17), for instance, the proposition featuring "genetic modification" and "gene-editing" is positive, but it is counteracted by the final word "warn".

(16) If scientists create *GM babies*, it will be impossible to avoid the *'designer babies' dystopia*, because the line between therapy and enhancement has not been respected with any other medical technology.
(17) Britain may need to change its IVF laws to allow the *genetic modification of human embryos* so that scientists can use a gene-editing technique that could *eliminate certain inherited diseases*, leading biomedical organisations *warn.*
(18) Ed ecco un tweet di Dan MacArthur, professore di genetica ad Harvard: "Previsione: i miei nipoti verranno da *embrioni selezionati e edited (insomma modificati geneticamente*, ndr) e per l'umanità non cambierà nulla, sarà come vaccinarsi".
And here is a tweet of Dan MacArthur, genetics professor in Harvard: "Forecast: my grandchildren will come from selected and edited embryos (i.e. genetically modified, ed.n.) and nothing will change for the humanity, it will be like vaccination".

Interestingly, there were five cases in the Italian corpus where analogical reasoning was used to represent positively human gene-editing (see (18), note also an explication strategy in brackets), but it occurred only in direct quotes and seemed to be caused by translational reasons, i.e. the lack of an established neutral term to render the English "editing" or "edited".

4.4. Gene-editing as technology / technique

Having established the specific denominations in use across the corpora, the analysis proceeded with the identification of the principal taxonomic category, within which gene-editing was placed. The most pervasive representation strategy of gene-editing is through the *genus* of technology or technique that demonstrated high frequency, very high dispersion values and a very wide range (see Table 5). In contrast to the denominations discussed in the previous sections, it acts as a superordinate category, through which gene editing is represented. From a cross-linguistic standpoint, the preferences towards "technology" and "technique" are opposite across the corpora, with

the UK press favouring "technology" and the Italian press using predominantly "technic*" (lit. "technique*").

GE UK	**NF**	**D**	**R**	**GE IT**	**NF**	**D**	**R**
technolog*	433	0.937	78%	tecnologi*	190	0.909	46%
gene technology - powerful technology - revolutionary technology - CRISPR technology - technology work - extinction technologies - cutting-edge technology - kind of technology - gene-editing technology - genetic technology - crop technology - engineering technology - enhancement technologies - technology of genetic manipulation - information technology - use of technology - biomedical technologies				tecnologia di miglioramento - tecnologie digitali - tecnologia genetica - uso di tecnologie - tecnologia di miglioramento genetico - tecnologia CRISPR - nuova tecnologia - tecnologie di gene-editing			
technique*	385	0.801	74%	tecnic*	340	0.895	60%
genetic technique - powerful technique - engineering technique - revolutionary technique - gene-editing technique - breeding techniques - controversial technique - medical technique - similar technique				innovative tecniche - tecnica sperimentale - tecniche di ingegneria genetica - tecniche di miglioramento genetico - tecnica tradizionale - utilizzo di tecniche - tecniche di modificazione genetica - rivoluzionaria tecnica - tecnica CRISPR - tecnica di editing genetico - nuova tecnica - tecniche di modificazione - tecniche di gene-editing - tecniche di ricerca - tecnica di manipolazione genetica			

Table 5
Gene-editing as technology and technique.

Table 5 shows that at the level of semantic prosody the collocates of both "technology" and "technique" and their Italian equivalents tended to be neutral on account of their superordinate position of *genus proximum* rather than a new denomination: *gene technology*, *gene-editing technique, tecnologia genetica, uso di technologie, tecniche di modificazione genetica*. At the same time, the nodes were frequently accompanied by evaluative adjectives, such as *revolutionary, powerful, cutting-edge, controversial, innovative, sperimentale, rivoluzionaria*, which could already orient the reader towards a certain interpretation of the technique / technology.

Along with the discussion of *genetic enhancement / miglioramento genetico* (see 4.2), *genetic modification / modificazione genetica* (see 4.3), these nodes were used in the clusters *technology of genetic manipulation* (19) and *tecnica di manipolazione genetica* (20).

(19) Advances in the *technology of genetic manipulation*, specifically the development of a gene-editing technique called Crispr/Cas9, could allow scientists to *change the DNA of human IVF embryos before it has been shown to be safe, they warned*.

(20) Da quando, nell'aprile scorso, un team cinese ha pubblicato su "Protein & Cell" un articolo in cui si descrive la possibilità di modificare con *tecniche di manipolazione genetica* gli embrioni umani il *dibattito tra scienziati e bioeticisti non si è più sopito*.
Since last April, when a Chinese team published in "Protein & Cell" a paper which describes the possibility of modifying with techniques of genetic manipulation human embryos, the debate between scientists and bioethicists has never calmed down.

Although these multiword terms did not satisfy the quantitative significance thresholds, analysis revealed peculiar information about denomination choices in the Italian corpus (cf. 4.1 and 4.2).

GE UK	**NF**	**D**	**R**	**GE IT**	**NF**	**D**	**R**
genetic manipulation	5	0.553	3%	manipolazione genetica	12	0.622	4%
manipulat*	21	0.806	11%	manipola*	29	0.728	9%

Table 6
Gene-editing and manipulations.

As Table 6 illustrates, the cluster *manipolazione genetica* (lit. "genetic manipulation") was used twice more frequently in the Italian corpus than *genetic manipulation* in the UK corpus, although the nodes "manipulat*" and "manipola*" with a wildcard were comparable by distribution and frequency. It emerged that *manipolazione genetica* was another possible Italian rendition of *gene-editing* (see (21) and (22)).

(21) Nella cassetta degli attrezzi ci sono *metodi nuovissimi* e ancora in via di elaborazione come il "*genome editing", la manipolazione genetica* che rischia di superare a destra gli Ogm.
In the toolbox there are newest methods, still under development, such as the "genome editing", the genetic manipulation that risks to outrun on the right the GMO.

(22) Abbiamo appena citato il caso del primo tentativo di applicare all'uomo *una rivoluzionaria ed efficacissima tecnica di manipolazione genetica* - identificata con la sigla Crispr - in corso proprio in questi giorni nel West China Hospital del Sichuan, in Cina.
We have cited the case of the first attempt to apply to a human a revolutionary and most efficient technique of genetic manipulation – identified with an abbreviation Crispr – going on in these days in the West China Hospital of Sichuan, in China.

Remarkably, the Italian corpus used *manipolazione genetica* with neutral or positively connoted lexis, as this multiword term is in fact listed in the *Treccani Online Dictionary*,[7] *Grande Dizionario Italiano by Hoepli*[8] and in the genetics section of the *Enciclopedia DeAgostini*[9] as a set of operations pertaining to the technique of genetic engineering effected to modify gene pool. The pole position of *miglioramento genetico* (NF = 35; D = 0.831; R = 15%) over *manipolazione genetica* (NF = 12; D = 0.622; R = 4%) assumes a possible ideological reading, as an intentional choice to foreground positive representation of the technique in the Italian readers, probably because *manipolazione* could evoke associations with subterfuge.

4.5. Gene-editing as a tool: between repair and correction

The representation of gene-editing as a technique or technology was further potentiated and extended through the use of *tool* metaphor both in Italian and in English. Not only was it frequent, it also pervaded the UK press, with extremely high dispersion values (0.924) and a significant range (52%), see Table 7.[10] By contrast, in the Italian corpus it was infrequent and skewed.

UK	**NF**	**D**	**R**	**ITA**	**NF**	**D**	**R**
tool*	180	0.924	52%	strument*	21	0.571	10%
powerful - similar - genetic - tool kit - gene-silencing - gene-editing - molecular - genome-editing				nuovo - di editing genetico			
-				attrezz*	7	0.550	2%
-				cassetta degli attrezzi - attrezzi molecolari			
scissors	38	0.829	19%	forbic*	16	0.731	7%
chemical – genetic – molecular – gene-editing				molecolari			

Table 7
Gene-editing as a tool.

In itself, the *tool* metaphor is not new. Generally, it is linked to the idea of repairing, fixing or modifying something, which makes it "easy to associate the use of such tools with enhancing the quality of our life and our

[7] "manipolazione, s." *Treccani Vocabolario Online*. http://www.treccani.it/vocabolario/manipolazione (12.12.2018).
[8] "manipolazione, s." *Grande Dizionario Italiano Hoepli*. http://www.grandidizionari.it/Dizionario_Italiano/parola/M/manipolazione.aspx?query=manipolazione (12.12.2018).
[9] "manipolazione (genetica), s". Enciclopedia DeAgostini, Online. http://www.sapere.it/enciclopedia/manipolazi%C3%B3ne+%28genetica%29.html (12.12.2018).
[10] Table 7 includes only instances of "tool" and its synonyms in concordance where "gen*" was found in the horizon of ten words to the right and to the left of the node.

surroundings" (Farquhar, Fitzsimons 2016, p. 102). Indeed, the concordance analysis showed that *gene-editing tool* collocated with verbs expressing such ideas (23; 24), creating a positive representation of this technique.

(23) It is the first time the powerful *gene-editing tool* Crispr-Cas9 has been used *to fix a mutation* responsible for a common inherited disease.
(24) A team […] used a *gene-editing tool*, Crispr/Cas9, to *repair the gene*.

The tool metaphor translates also into the metaphor of *scissors*, specifically genetic or molecular scissors. This image was also typical of the UK corpus, while its use in the Italian corpus was sporadic, reflecting the general avoidance of the tool metaphor.

(25) The process involves *cutting out DNA mutations with "molecular scissors" and replacing* them with healthy cells.
(26) […] si impieghino tecniche di editing genetico, ovvero attraverso l'*utilizzo di particolari "forbici" molecolari che spezzano la catena del Dna* nel punto voluto e ci "*incollano*" sopra la porzione voluta.
[…] are used techniques of genetic editing, i.e. through the use of particular molecular "scissors" that break the DNA chain in the desired point and "paste" over the desired portion.

The above examples (25; 26) pinpoint to another common representation strategy, based on the comparison of gene-editing and text-editing through the use of MS Word commands and their hybrid versions with the metaphor of cutting or slicing: *cut and paste, cut and edit, cut and slice, find and replace, cut and replace, copy and paste* and *taglia e incolla / taglia-incolla, taglia e cuci, taglia e modifica, copia e incolla, tagliare e sostituire*. Remarkably, the underlying metaphors of text editing commands are based on other metaphors, making it a double metaphor, where the text editing metaphor is embedded in the metaphor of physical operations (see (27)-(30)). This confirms the findings of previous research on metaphorical communication of genetic knowledge, applying this tendency also to the new technology of gene-editing.

(27) Gene editing, which effectively allows the precise *"cutting and pasting"* of DNA, *is already used in basic research and clinical studies* that involve non-heritable "somatic" cells.
(28) As regards *safety*, the Crispr-Cas9 method appears *remarkably accurate* in its ability to *"find and replace"* segments of DNA, with *an error rate of less than 1 in 300 trillion*.
(29) Potrebbe presto arrivare anche *sulle nostre tavole* il primo alimento modificato geneticamente grazie alla *rivoluzionaria tecnica di "taglia-incolla"*, detta Crispr.
The first genetically modified food could soon arrive at our tables thanks to the revolutionary technique of "cut-paste", known as Crispr.

(30) Siamo nel campo del genetic editing, del *taglia e cuci genomico*. Per Giuseppe Novelli, rettore dell'università Tor Vergata *"il nuovo correttore di bozze"* è *particolarmente abile nel vedere gli errori* del Dna e nel *cancellare l'errore* una volta individuata la mutazione responsabile della malattia.
We are in the field of genetic editing, of the genomic cut and sew. To Giuseppe Novelli, dean of the University Tor Vergata "the new draft editor" is particularly able in seeing the errors of the DNA and in erasing the error once the mutation responsible for the disease has been identified.

These functions are typically perceived as something non-threatening and already in use in our daily life, thus working towards domestication of gene-editing. In fact, the concordance analysis showed that they represented gene-editing always in a positive light (see (27)-(30)), stressing its precision, safety and ability to cancel errors.

UK	NF	D	R	ITA	NF	D	R
cut* and past* /find* and replace	56	0.751	23%	taglia* e cuci/incolla/modifica	60	0.522	21%
correct*	57	0.887	21%	correzione / correggere / corretto	107	0.894	40%

Table 8
Gene-editing as text-editing.[11]

Along with text-editing functions, the Italian texts widely employed *correzione*, as *editing* could be translated into Italian with this term (see (31)-(32)). However, if we compare *correction* with *editing*, the former was underused in the UK corpus as a noun (1 out of 70 raw hits), most probably because it had an additional meaning of disciplinary punishment in English,[12] and *editing* already carried the *errata corrige* meaning. However, *correct* as a verb is found in the UK corpus, too (see (33)-(34)).

(31) il team ha ora "in programma di utilizzare la stessa tecnica anche per *correggere direttamente la mutazione*, non solo per spegnerne gli effetti".
The team has now "in programme to use the same technique also to correct directly the mutation, not only to turn off the effects".

(32) Si tratta di *correggere un difetto genetico come si correggono le bozze di un libro*, facile sulla carta, molto difficile in pratica correggere proprio e solo quel difetto senza fare danni.
It deals with correcting a genetic defect like editing a book draft, easy on paper, very difficult in practice to correct exactly and only that defect without any damage.

[11] Table 8 includes only instances of "correct*" and its Italian equivalents where "gen*" was found in the horizon of ten words to the right and to the left of the node.

[12] "correction, n.". *OED Online*. http://www.oed.com.pros.lib.unimi.it/view/Entry/41910?redirectedFrom=correction (12.12. 2018).

(33) Gene editing to *correct faulty DNA* in human embryos has taken a step closer to becoming a reality, with scientists showing it is possible to *correct genetic problems* in mice before they are born.
(34) The international summit in Washington was organised by the national academies of the US, UK and China to take stock of *powerful new tools* that can make *precision changes to the code of life*, by *correcting*, removing and adding DNA to an organism's genome.

The metaphors of text editor go in line with the already conventionalised representation of genome in terms of a book, a text or a code (32) (Calsamiglia, van Dijk 2004; Nelkin 2001; Nerlich, Hellsten 2004; Pramling, Säljö 2007). Yet, in contrast to the popularisation of genome sequencing, where the "code of life" is represented in terms of decoding operations, news articles on gene-editing do not treat genome as a mystery code. Even though the node "code" appears in texts (UK: NF = 62, D = 0.843, R = 23%; IT: NF = 27, D = 0.683, R = 8%), it is framed in terms of a computerised text-"code" in need of a change, marking thus an important paradigm shift: from demystifying the secrets of life to operationalising something that is possible to change by means of human intervention.

4.6. Synthesis and discussion

Representations of gene-editing in British and Italian press may be grouped into two large semantic fields: change and technology (see Figure 1). These two fields are evenly distributed in the Italian corpus, whereas in the UK corpus the technology trope prevails. It must be acknowledged that the line between the two macrocategories is blurred as most texts intertwined both concepts within a single clause.

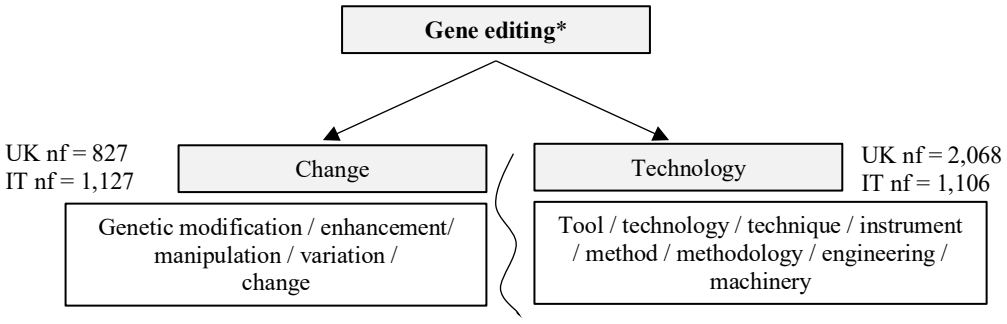

Figure 1
Representation of gene-editing and its variants across the corpora.

Gene-editing as change and technology was represented in both positive and negative ways, as the analysis of semantic and discursive prosody of the node

words examined in previous sections showed. Table 9[13] gathers most frequent and dispersed items that were used to frame gene-editing as a positive or a negative change / technology.

GE UK	NF	D	R	GE IT	NF	D	R
Positive representations							
breakthough	71	0.541	29%	avanz*	42	0.827	14%
progress	25	0.737	14%	progress*	34	0.833	13%
advanc*	89	0.847	40%	svolta	24	0.622	11%
discover*	74	0.796	29%	scoperta	81	0.673	21%
innovat*	17	0.667	6%	innova*	107	0.796	33%
opportunit*	15	0.706	7%	opportunità	22	0.673	9%
develop*	255	0.920	66%	svilupp*	219	0.900	61%
Total	**546**	**Av = 0.745**	**Av = 27%**	**Total**	**529**	**Av = 0.761**	**Av = 23%**
Negative representations							
risk*	125	0.939	41%	risch*	115	0.899	34%
uncertain*	6	0.723	3%	incert*	8	0.478	4%
consequen*	29	0.800	13%	conseguenz*	22	0.759	7%
danger*	47	0.827	18%	pericol*	26	0.886	11%
fear*	49	0.828	22%	paur*	21	0.753	8%
worr*	24	0.732	14%	timor*	18	0.588	8%
warn*	73	0.709	31%	preoccupa*	18	0.700	7%
cauti*	21	0.824	10%				
Total	**375**	**Av = 0.798**	**Av = 19%**	**Total**	**229**	**Av = 0.723**	**Av = 11%**

Table 9
Positive and negative representations of gene-editing.

Both corpora exhibited a tendency towards a positive representation of gene-editing, which could be perceived both from the frequency of positively coloured lexis (GE UK total = 546; GE IT total = 529) and its dispersion (GE UK has an average *D* of 0.745 and an average range of 27%; the same values in the GE IT are respectively 0.761 and 23%). From a cross-linguistic standpoint, the corpora demonstrate both convergent choices (*development* and *discovery*) and slightly divergent solutions (*breakthrough* and *advancement* in the GE UK vs. *innovazioni* and *scoperta* in the GE IT). On a methodological note, it is remarkable how *breakthrough* demonstrated Juilland's D of 0.541 (insignificant) with normalised frequency at 71 occurrences, whereas *discovery* had Juilland's D of 0.796 (significant), with normalised frequency at 74 occurrences, and both were used by 29% of journalists, thus showing the importance of triangulation of different parameters.

[13] No cut-off points were applied in order to show a general picture.

The negative representations were on average less prominent across the corpora (19% in British texts and 11% in Italian texts). The main negative trope was that of *risk* (GE UK: NF = 125, D = 0.939, R = 41%; GE IT: NF = 115, D = 0.899, R = 34%). Interestingly, other negative items found in the prosody of the main nodes in the Italian corpus did not satisfy the frequency (NF =30) or range (10%) thresholds set in this study, i.e. their use was insignificant. On the contrary, the UK corpus deployed a wider array of negative depictions which on average satisfy the thresholds set, apart from *uncertain**. Such a tendency could be construed as a more balanced representation attempt of gene-editing in the British press, showing both positive and negative aspects.

5. Conclusions

Quantitative and qualitative analysis of the linguistic representations of gene-editing shed light on a number of convergent and divergent strategies across the corpora. First, some variation emerged in both corpora concerning the denomination choices, caused probably by the novelty of the concept. The texts under analysis confirmed previous research indicating the sporadic use of specialised terms in popularising newspapers, since gene-editing was represented using variegated imagery across the corpora. While in English these images accompanied a more clearly defined core term (*gene-editing*, with some variants), the Italian texts, in addition to popularisation efforts, had to deal with issues of translation. It is remarkable how the lack of a clearly established Italian term to render *gene-editing* resulted in ideologically charged translations, already attributing positive traits at the naming stage (e.g. *miglioramento genetico* (lit. "genetic improvement") was preferred over *manipolazione genetica* (lit. "genetic manipulation")), which showed a slanted position of the Italian media, most probably rooted in the political decisions to sponsor gene-editing in the Italian agriculture. A relative lack of topicalisation of the human applications of this technology in the Italian corpus deserves further attention. It would be interesting to look at terminological choices adopted by scientific papers in Italian overviewing this technique.

Despite some differences in the naming choices, both corpora demonstrated convergent patterns concerning the archetypal representations of gene-editing as a change (*genetic enhancement, correzione*) introduced using technology (*technology, tool, scissors, tecnica, tecnologia, metodo*). In general, both corpora relied on the *editing* (*correzione*) metaphor, in-built in the very name of this technique, drawing on the conventionalised metaphor of DNA as a text. The texts expanded the metaphor by using lexis associated with editing operations, creating thus a complex, double-layered metaphorical

representation. At the same time, in line with the popularising nature of newspaper discourse, gene-editing was represented through analogies and disanalogies with other, more widely known – accepted or contested – concepts, such as genetic modification, vaccination and natural selection or cross-breeding.

The research identified a paradigm shift in approaching discourse on genome in the popularised press. In contrast to media representations of DNA sequencing, gene-editing was not framed as a mystery to be decoded, but as a useful tool or technique that could change our lives for the better or that potentially puts at risk our very existence, if placed in the wrong hands. Thus, a shift was observed: from a popularisation discourse on demystification of the genome to a domestication and operationalisation of this previously mysterious matter.

In general, gene-editing appeared positively represented in both corpora, with the UK corpus providing a more balanced idea of advantages and disadvantages of this technique, as applied to both human subjects and agriculture. In light of the foreseeable need for the informed public decision-taking concerning the regulation of this technology, it would seem that the British press has performed a fuller popularisation task in comparison with the Italian press.

An important result of this study is also the successful application of the methodology of corpus-assisted discourse analysis. Quantitative thresholds allowed me to trace archetypal representation strategies without including those denomination strategies which were not representative in terms of their frequency, dispersion and range. At the same time, the critical approach to discourse provided an interpretation of certain representation choices and peculiarities that stretched beyond a mere quantitative mapping. The study did not pursue the goal of carrying out an in-depth critical discourse analysis, which somewhat limited the qualitative findings; however, this part is left for further research with downsampling. This project will continue in further research on gene-editing representation across different genres and stakeholders.

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