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"NANOTECHNOLOGIES: WHERE SHOULD THEY TAKE US?" The popularization of nanosciences on the web: A discourse analytical approach

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Abstract - The study investigates a set of web texts dedicated to nanotechnologies with the aim to assess the strategies deployed for the transfer of specialized notions to lay audiences and to evaluate how the controversy potential of the issue on hand is managed by different stakeholders. The texts under scrutiny – EU web pages and web reports issued by the environmental organization Friends of the Earth - show a primary concern, at the lexical level, with the *use* of nanotechnologies: *the use of* is in fact, among the most frequent three-word clusters around the lemma *nano*. In environmentalist texts the topic is often associated with highly emotional topics, i.e. *babies* and *food*, while EU web pages underline a more informational and even beneficial view of nanotechnologies, as in the case of those used *in medicine*, *in the workplace*, or already present *in nature*. This is confirmed also by the analysis of the interactional resources of metadiscourse (Hyland, Tse 2004), in particular hedges, boosters, and attitude markers are often called upon to support the writers' credibility and affective appeals. Coming to the strategies adopted for the purpose of popularizing discourse "to manage its means so as to enable understanding and learning" (Calsamiglia, Van Dijk 2004, p. 17), the corpus of environmentalist reports shows that technical words very frequently used, such as *titanium dioxyde*, *hydroxapatite*, *triclosan*, or *in vivo*, are never defined, suggesting that a previous knowledge of the reader in the field of chemistry and biology is taken for granted. By contrast, texts in the EU section are characterized by plain language, while technical words are very few and, when present, thoroughly explained.

Keywords: nanotechnologies; discourse analysis; popularization; metadiscourse.

1. Introduction

Nanoscience and nanotechnologies deal with materials science and its applications at the nanoscale. The formal definition of nanotechnologies provided by the National Nanotechnology Initiative (NNI) describes them as: "the understanding and control of matter at dimensions between approximately 1 and 100 nanometers, where unique phenomena enable novel applications"

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(NNI 2010, p. 1). Since nanotechnologies can have applications in several sectors, ranging from medicine, engineering and electronics to food, cosmetics, and renewable resources, they are bound to have strong repercussions on humans' daily life. However, they still have a "relatively low level of public visibility" (Dudo *et al*. 2011 p. 57), as confirmed by surveys conducted in the US among the general public. In fact, four out of five Americans (80%) think that they are "not well-informed" about nanotechnologies, with a fifth of all respondents (20%) thinking of themselves as "not informed at all" (Dudo *et al*. 2011).

Obviously, socio-cultural factors play a significant role in orienting attitudes and public perceptions. In this regard Corley and Scheufele (2010) have shown that individuals with at least a college degree displayed an increase in nanotechnology knowledge levels between 2004 and 2007, while those with education levels of less than a high school diploma had a significant decrease in knowledge levels.

Even if nanotechnologies have been described as a "potentially controversial science" (Fisk *et al.* 2014, p. 156), so far they have escaped the destiny of GMOs, when a wide-reaching backlash against genetically modified food was generated by the incapacity of adequately controlling the media exposure of scientists and experts and, above all, by the limited consideration for public perception mechanisms and social impacts of research (Lorenzet 2012, p. 2). This is confirmed, for instance, by a series of surveys conducted between 2000 and 2010 both in Europe and the United States, which showed that public opinion considered nanotechnologies generally useful, good, and positive, with their benefits outweighing possible risks (Lorenzet 2012).

As with GMOs, also when it comes to nanotechnologies there is a divide between public and expert opinion (Ho *et al*. 2011). However, while GMOs are widely considered safe by scientists and mistrust in the public has mostly been fostered by the media, interestingly enough in the case of nanotechnologies, it is the scientists who are significantly more worried about some long-term potential negative impacts on health and the environment of nanotechnology than the greater public (Scheufele *et al.* 2007). Unsurprisingly, it was molecular nanotechnology pioneer Eric Drexler who first suggested that nanotechnologies could lead to a new industrial revolution of unbearable proportions (Drexler 1986). On the haze of the visionary hype that was accompanying the development of this new science, Drexler unintentionally contributed to the generation of the so-called 'grey goo' scenario, prefigurating a hypothetical end-of-the-world situation, with self-replicating nanomachines eating out the planet:

> tough, 'omnivorous' bacteria could out-compete real bacteria: they could spread like blowing pollen, replicate swiftly, and reduce the biosphere to dust in a matter of days. Among the cognoscenti of nanotechnology, this threat has become known as the grey goo problem. (Drexler 1986, p. 172)

The 'grey goo' narrative, which actually takes up only two pages of Drexler's book *Engines of Creation* (1986), was used as an example of the possible dangers associated with nanotechnologies, even if Drexler himself felt the need to back away from his famous claim afterwards, realizing that it could lead to conflicts between science and society.

Since that precedent and because of the lessons coming from previous negative experience on biotechnology, scholars have consistently suggested the importance of a close supervision on the social and ethical reflections surrounding nanotechnologies since the early stages of their development. Hence, despite the potentially deflagrating 'gray goo' incident, scientists and policy makers have managed to limit the spread of negative implications related to nanotechnologies by adopting meaningful communication and avoiding biased terminology (Lorenzet 2012). This is confirmed by the results obtained by means of the tool Google Trend, which measures the information demand by citizens on selected topics, by plotting the frequency of Google searches for related keywords. The results obtained in the present time of writing by feeding Google Trends three specific keywords, namely: nanotechnology, biotechnology and climate change, confirm the same results obtained by Lorenzet in 2012. They highlight a progressive decrease in public interest towards nanotechnology over the last fifteen years and show how the interest in nanotechnology is considerably less than that in other potentially controversial issues, such as 'biotechnology' and 'climate change' (see Figure 1).

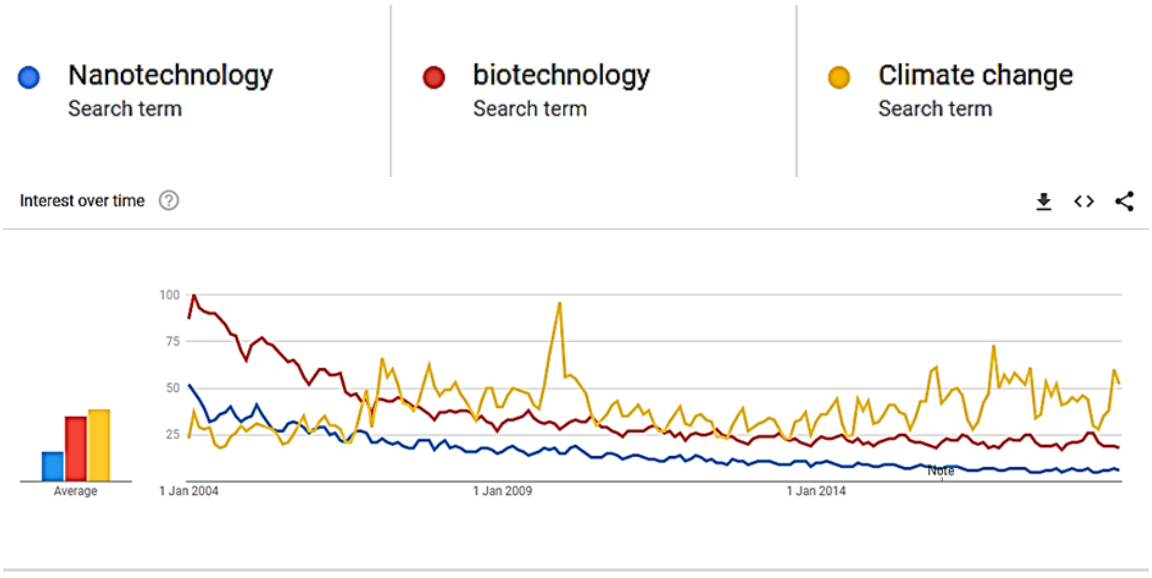

Figure 1
Global Information Demand on Google for nanotechnology, biotechnology, and climate change (source: Google Trends, normalized data; November 2018).

On the one hand these results can be explained by considering that public understanding of nanotechnology is still minimal (Cobb, Macoubrie 2004; Scheufele, Lewenstein 2005), even though media reporting has been increasing over the past decades (Stephens 2005) and many efforts have been made to elicit public participation through 'upstream engagement' practices (Wynne 2001).

On the other hand, it should be borne in mind that these results may be an overgeneralization, as different countries – and different communities – respond differently to nanotechnology risks (Gaskell *et al*. 2005). In particular, a transatlantic divide exists in the public perception of nanotechnologies, since more favourable attitudes towards nanotechnologies were found in the United States than in the United Kingdom and Europe (Burri, Bellucci 2008; Einsiedel 2005; Fisk *et al,* 2014; Gaskell *et al.* 2004, 2005). More religious countries, including Italy, Austria and Ireland, also show more sceptical attitudes. According to a research carried out by Scheufele *et al.* (2009), nanotechnologies were perceived as 'morally acceptable' by only 33.5% of respondents in Ireland, while the proportion in Belgium was 82.4%. In addition, the proportion of respondents who disagreed that nanotechnologies were 'morally acceptable' was also relevant in the United States (24.9%).

Some research suggests, however, that the message about nanotechnology could be evolving over the time to highlight the relative risks which had previously been neglected or overseen (Weaver *et al.* 2009). This trend would appear coherent with patterns in the US media coverage of biotechnology – which was, in general, initially positive, but grew more critical over time (Ten Eyck, Williment 2004). Likewise, nanotechnology-related communication might be in its early, positive phase, and conflicts might be yet to come. As the risk of replicating the biotechnology scenario is not entirely averted, it is surely interesting to observe how different stakeholders communicate about nanotechnologies.

2. Materials and methods

The present study focuses on selected communication about nanotechnologies made available on the web: a set of EU webpages dedicated to nanotechnologies and reports on the same topic released by the environmental organization Friends of the Earth. In order to carry out the analysis, two small-scale corpora were compiled, which respectively include: 1) web reports on nanotechnologies issued by Friends of the Earth (from now on FOE) in 2011, 2014, and 2016; 2) EU webpages on nanotechnologies published in the period from 2013 to 2019.

Nano silver: policy failure puts public health at risk https://foe.org/resources/nano-silver-policy-failure-puts-public-health-at-risk/ (NS)	11,257 tokens
Tiny ingredients, big risks https://1bps6437gg8c169i0y1drtgz-wpengine.netdna-ssl.com/wp-content/uploads/2017/legacy/2014_Tiny_Ingredients_Big_Risks_Web.pdf (TI)	20,775 tokens
Nanoparticles in Baby Formula. Tiny new ingredients are a big concern https://foe.org/resources/nanoparticles-in-baby-formula-tiny-new-ingredients-are-a-big-concern/ (NP)	15,694 tokens
TOTAL	47,726 tokens

Table 2.1
FOE reports on nanotechnologies issued on www.foe.org.

Nanoscience and technologies http://ec.europa.eu/research/industrial_technologies/nanoscience-and-technologies_en.html	960 tokens
Outreach projects http://ec.europa.eu/research/industrial_technologies/outreach_en.html (OP)	292 tokens
About NanoDiode http://www.nanodiode.eu/about-nanodiode/ (ND)	2,228 tokens
About Nano http://nanopinion.archiv.zsi.at/en/about-nano.html (NO)	3,560 tokens
Nanoyou project https://nanoyou.eu/nanoyou-project/about.html (NY)	559 tokens
TOTAL	7,599 tokens

Table 2.2
EU webpages on nanotechnologies.

Friends of the Earth is a global organization rooted in the United States and founded by David Brower in 1969, which is present in 75 countries. Its members define it as "the world's largest federation of grassroots environmental groups".[2] Its aim is to "defend the environment" and "champion a more healthy and just world". The reports on nanotechnologies collected for

[2] From www.foe.org. Accessed on January 2019, 22.

the present study are the outcome of independent laboratory analyses commissioned by the association and made available online on the FOE website.

Nanodiode.eu, nanopionion.eu, gonano-project.eu and nanoyou.eu are web platforms launched by the EU in 2013 to establish an innovative, coordinated programme for outreach and dialogue throughout Europe, so as to support the effective governance of nanotechnologies. They were created with the aim of monitoring public opinion on nanotechnologies, with a special focus on hard-to-reach target groups, e.g. people who do not normally encounter and give their opinion on nanotechnologies at first hand. Nanoyou (Nano for Youth), in particular, aims to increase young people's basic understanding of nanotechnologies and to engage in the dialogue about its ethical, legal and social aspects. Specific pages devoted to research in nanosciences and nanotechnologies within the main European Commission website (ec.europa.eu), were also taken into consideration in the analysis.

The aim of the analysis is to assess how specialized information about nanotechnologies is transferred to lay audiences, with a view to evaluating how the controversy potential of the issue on hand, i.e. nanotechnologies, is managed by different stakeholders. Indeed, even though knowledge dissemination is often referred to as a "recontextualization" (Calsamiglia, Van Dijk 2004) or a "translation" (Gotti 2014) of scientific information from experts to non-experts, it is nonetheless true that any communication does not simply mediate the scientific knowledge, but actively contributes to the production of new, common knowledge and opinions about science and scientists – including information and views that do not derive from scientific sources (Calsamiglia, Van Dijk 2004, p. 371). This is why popularizing texts can "inform, raise awareness and cause the reader to take action" (Gotti 2014, p. 29), depending on how the schematic structure of knowledge is organized.

The methodology used for the analysis relies on corpus linguistics and discourse analysis. In the first place all the texts contained in the two corpora were uploaded to the linguistic analysis software Wordsmith Tools (Scott 2016): after creating two sets of wordlists, the concordances of the most frequent lexical items were plotted, so as to obtain the main clusters in which they featured. Then the extended co-text of these clusters was analyzed, with a view to investigating the prevailing semantic prosody[3] associated with the

[3] Semantic prosody has been studied by corpus linguists for almost two decades. Still, Hunston (2007, p. 249) refers to it as a "contentious term". In fact, disagreement on what it refers to has led to debates on the topic (e.g. Hunston 2007; Stewart 2010). Points of disagreement include the questions of (a) whether the prosody resides in the lexical item or in the discourse, (b) whether semantic prosody is connotational in nature or not, and (c) whether, or how, semantic prosody is different from semantic preference. See Hunston (2007), Morley and Partington (2009), and Partington (2004) for a discussion of these issues. Highly critical views of semantic prosody have also been voiced (Whitsitt 2005, in particular).

examples, in order to shed light on the aura of meaning with which each of the selected word forms is imbued by its collocates" (Louw 1993, p. 157).

In order to fine-tune the results that emerged from the scrutiny of semantic prosody and gather more information on how the writers handle the reader's interpretative process, reference was made to Hyland and Tse's 2004 study. Accordingly, the two corpora were searched for instances of interactive markers,[4] which "are concerned with ways of organizing discourse […] and reflect the writer's assessment of what needs to be made explicit" (2004, p. 168) and interactional resources,[5] which are essentially evaluative and engaging, as they "involve readers in the argument by alerting them to the author's perspective towards both propositional information and readers themselves" (2004, p. 168).

Finally, it was decided to focus on the strategies of explanation adopted to mediate scientific knowledge, in the attempt to disclose how and to what extent each of the two corpora actively contributes to the production of new, common knowledge and opinions, which do not necessarily derive from scientific sources. Accordingly, following Calsamiglia and van Dijk's (2004) categorization of the various strategies of explanation deployed to introduce new knowledge, the corpora were scrutinized in search of those "semantic means that allow language users to relate new knowledge to old knowledge" (2004, p. 370). In particular, the analysis revealed the presence of descriptions, definitions and examples.

3.The Analysis

3.1. Comparing the corpora

Both typologies of texts under scrutiny show a primary concern, at the lexical level, with the *use* of nanotechnologies. *Use* is the second most frequent lemma in the corpus of EU webpages, after *nano*, and the third in the corpus of FOE reports, after *nano* and *food*, as shown in tables 3.1 and 3.2.

[4] Interactive resources include: *transitions*, mainly conjunctions; *frame markers*, which refer to text boundaries or elements of schematic text structure; *endophoric markers*, which refer to other parts of the text; *evidentials*, which indicate the source of textual information and *code-glosses*, which signal the restatement of ideational information in other ways (Hyland, Tse 2004, p. 168).

[5] Interactional resources include: *hedges*, which mark the writer's reluctance to present propositional information categorically; while *boosters* imply certainty and emphasize the force of propositions; *attitude markers*, which express the writer's appraisal of propositional information; *engagement markers*, which explicitly address readers; and *self-mentions*, which reflect the degree of author presence in terms of the incidence of first person pronouns and possessives (Hyland, Tse 2004, pp. 168-170).

	Lemma	occurrences	ptw normalized frequency[6]
1	*nano*	314	41.3
2	*use*	77	10.1
3	*research*	53	7.0
4	*produce*	50	6.6
5	*europe*	44	5.8
6	*risk*	40	5.3
7	*inform*	36	4.7
8	*safe*	27	3.6
9	*new*	25	3.3
10	*dialogue*	23	3.0

Table 3.1
EU top lexical lemmas.

	Lemma	occurrences	ptw normalized frequency
1	*nano*	1,616	33.9
2	*food*	550	11.5
3	*use*	363	7.6
4	*produce*	361	7.5
5	*health*	289	6.1
6	*environment*	261	5.5
7	*safe*	199	4.2
8	*risk*	198	4.1
9	*ingredient*	134	2.8
10	*baby*	124	2.6

Table 3.2
FOE top lexical lemmas.

3.1.1. EU webpages

The use of is the first most frequent three-word cluster around *nano* in the EU corpus (see table 3.3).

	3-word cluster	occurrences	ptw normalized frequency
1	*the use of*	10	1.3
2	*at the nanoscale*	7	0.9
3	*what are nanotechnologies*	5	0.6

[6] The two corpora under scrutiny are not homogenous in terms of tokens, so the occurrences were normalized per thousand words, in order to make them comparable.

4	*nanodiode is a*	5	0.6

Table 3.3
EU most frequent 3-word clusters containing *nano*.

Looking at the co-text of *the use of*, it is possible to notice the presence of positively connoted expressions like *innovations* (example no. 1), *target cancer tumours* (example no. 2) and *increase the amount of electricity generated by each windmill* (example no. 3).

(1) and the use of nanotechnological innovations throughout society (ND)
(2) the use of 120nm diameter nanoparticles coated with a gold shell to target cancer tumours (NO)
(3) Lower weight blades are made possible by the use of nanotube-filled epoxy. The resulting longer blades increase the amount of electricity generated by each windmill (NO)

Obviously, also potential risks are mentioned:

(4) Nanosilver has many beneficial uses, but its benefits must be balanced over the risk of dispersing silver nanoparticles in the environment (NO)

Indeed, the word 'risk' has a higher frequency in the EU texts than in the FOE corpus (see tables 3.1 and 3.2). However, nanotechnologies are never associated with an idea of immediate *danger* (no hits of this word in the corpus), even if, in order to promote the responsible development of nanotechnologies in Europe, it is necessary to properly address the potential risks or challenges, without raising unnecessary alarm:

(5) Some recent research has shown that some nanoparticles, like carbon nanoparticles, can be found in a variety of products that contain "food caramels", which means things like bread, corn flakes, and biscuits. *This shows that we have been already exposed to nanomaterials probably for a long time with no harm caused to humans.* Any emerging technology may be associated with unknown health risks when it first reaches consumers. Think for instance of mobile technology: the health risk of using mobile phones emerged after years of using them and even now this risk is not fully understood. Despite this, we use them routinely. (emphasis added) (NO)

All in all, given the rather positive semantic prosody which is detected in the examples, it is possible to state that EU webpages underline a rather beneficial view of nanotechnologies, which are used *in medicine, in manufacturing* and are also already present *in nature* (*natural nanomaterials*).

(6) Using nanoparticles in the manufacture of solar cells is beneficial. (NO)
(7) Silver nanoparticles in socks eliminate the bacteria which cause smelly feet (NO)
(8) However some argue that the use of nanomaterials in medicine is fairly new (NT)

(9) Nanosized drug carriers to target cancer cells (NO)
(10) Often nanomaterials seen in nature are used as an inspiration for engineering innovative ones! (NO)
(11) strong and flexible materials like cobwebs are all using natural nanotechnologies (NO)

3.1.2. Friends of Earth (FOE) reports

In the FOE reports *the use of* is the third most frequent three-word cluster around the lemma *nano* (see table 3.4).

	3-word cluster	occurrences	ptw normalized frequency
1	*of nano silver*	57	1.1
2	*in baby formula*	36	0.7
3	*the use of*	35	0.7
4	*nanoparticles in baby*	33	0.6

Table 3.4
FOE: most frequent 3-word clusters containing *nano*.

However, differently from what happens in the EU webpages, this cluster is associated with a semantic prosody evoking a sense of impending danger, as confirmed by the presence of expressions like: *inquire with their suppliers; warns about the different properties of nanomaterials* and *demand a moratorium on the use of nanotechnology.*

(12) We encourage companies to inquire with their suppliers about the use of nanomaterials (beyond just titanium dioxide) in all products they offer (TI)
(13) However, the agency's 2012 draft guidance on the use of nanomaterials in food warns about the different properties of nanomaterials compared to ingredients used in traditional manufactured food substances. (TI)
(14) Join Friends of the Earth to demand a moratorium on the use of nanotechnology in the food sector (NP)

Beyond the emphasis on the dangers connected with the use of nanotechnologies, FOE reports also show an association of nanotechnologies with highly emotional topics, i.e. *babies* and *food*.

(15) Preliminary studies suggest that nanomaterials may accumulate (and possibly even magnify) in organisms along the food chain. (TI)
(16) Nanoscale titanium and nanosilver are believed to be the most used nanomaterials in food and food contact materials. (TI)
(17) To our knowledge, these are the first laboratory studies focused on the detection of engineered nanomaterials in baby formulas that are marketed to the public. Friends

of the Earth tested a selection of six baby formula samples gathered from retailers in the San Francisco Bay Area. (NP)

Actually, language points to something more than a mere association. In fact, when referring to *babies* and *food*, it looks like Friends of the Earth are aiming at sensitizing public stakeholders towards the pervasiveness of nanotechnologies, which are to be found everywhere, including food and baby formulas, thus possibly contaminating our environment. In other words, the association between something new, about whose effects we still do not know much (nanotechnologies) and *babies* and *food*, namely two very sensitive issues which should normally be associated with a reassuring and positive context, seems to bring forth a negative semantic prosody, which is further amplified by the high frequency of the verb *found* (see table 3.5).

	verb	occurrences	Ptw frequency
1	*used*	126	2.6
2	*found*	87	1.8
3	*accessed*	80	1.6
4	*including*	62	1.2
5	*states*	51	1.0
6	*associates*	47	0.9
7	*manufactured*	42	0.8
8	*based*	37	0.7
9	*emerging*	37	0.7
10	*engineered*	31	0.6

Table 3.5
FOE: most frequent lexical verbs.

In fact, looking at the collocates of *found*, we can find words like: *concern, inhalation hazard*, etc, which evoke a negative scenario:

(18) We *found* nanosized structures and particles of potential *concern* in all six of the baby formulas tested, including: Nanohydroxyapatite (nano HA) in needlelike and non needlelike form, nano titanium dioxide (TiO2), and nano silicon dioxide (SiO2) (the nano TiO2 and SiO2 results were inconclusive) (emphasis added). (NP)

(19) Nanoparticles in Baby Formula *found* in the three powdered formulas we tested provide a probable *inhalation hazard* for babies, parents and other care givers, as well as workers involved in the manufacturing of these products (emphasis added). (NP)

On the contrary, the verb *found* does not figure prominently in the EU corpus:

	verb	occurrences	Ptw frequency
1	*used*	26	3.4
2	*using*	17	2.2
3	*make*	13	1.7
4	*funded*	12	1.5
5	*containing*	11	1.4
6	*needs*	11	1.4
8	*challenges*	8	1
9	*develop*	8	1
10	*need*	5	0.6

Table 3.6
EU: most frequent lexical verbs.

3.2. Metadiscourse markers

In order to fine-tune the results provided by the scrutiny of the word-lists, clusters and extended co-text, it was decided to search the two corpora for metadiscourse markers, in order to better establish how the writers handle the reader's interpretative process. The qualitative analysis carried out on the basis of the model of metadiscourse provided by Hyland and Tse (2004, p. 169) highlighted the presence of interactional markers, with a preference for *hedges*, *boosters* and *attitude markers*.

	EU	**FOE**
hedges	1.3	0.2
boosters	0.2	0.1
attitude markers	1.5	0.5

Table 3.7
Metadiscourse markers.

3.2.1. Metadiscourse markers in EU webpages[7]

Once again, by looking at the EU webpages, we come across a rather positive attitude towards nanotechnologies, combined nonetheless also with the awareness of potential risks or challenges.

[7] In all the examples that follow, the different metadiscourse markers have been highlighted by using italics.

(20) Regarding those grand societal challenges and the need to respond to them by means of technological innovation too, *it is clear that* dialogue on between the European public, policymakers, researchers and producers needs to be fostered. (ND)
(21) In addition they (nanofilters) are more efficient, and they have *incredibly* large surface areas and can be more easily cleaned (NO)
(22) Meaningful communication is *especially* needed in the case of nanotechnology as the public seems to be more sceptical and less deferential about it. (NT)

Since it is important not to raise unnecessary alarm, hedges are often used to mitigate the force of statements referring to the possible negative impact of nanotechnologies:

(23) Some say we should avoid overuse of silver (in any form) in consumer products, as this *might* induce bacterial resistance in the environment.(NO)
(24) In these products the nanomaterials are embedded inside a composite, so there is no direct exposure risk to consumers. Workers producing this material *might* need some specific protection (filter masks, etc.). (NO)

3.2.2. Metadiscourse markers in FOE reports

Hedges seem to serve a different function in the FOE reports. In fact, because of the constant presence in their co-text of words charged with a negative semantic prosody, their use does not make the statements more tentative, but on the contrary, they add to their *ominous* force:

(25) *Perhaps* the most insidious environmental impact associated with the expansion of nanotechnology in agriculture is its entrenching our reliance on the dominant chemical intensive industrial agricultural model. (TI)
(26) It is difficult to know how widespread bacterial resistance to silver *might* already be in our hospitals and broader society. (NS)

Boosters and attitude markers serve the purpose of re-affirming the organization's negative outlook on nanotechnologies:

(27) This is why *we believe* it is important to assess the risk of even small amounts of particles in the human body (TI)
(28) *It appears* we are on the verge of repeating many of the mistakes associated with our enthusiastic adoption of conventional agrochemicals, whose long-term health and environmental costs are borne by farming communities and ecological systems worldwide. (NP)
(29) *Unfortunately*, many food items that Americans eat on a daily basis contain nanomaterial ingredients. (TI)

3.3. Strategies of explanation

The final stage of the analysis focuses on the strategies of explanation deployed to introduce new knowledge. Accordingly, following Calsamiglia and van

Dijk's (2004) categorization, the two corpora were scrutinized in search of definitions, descriptions, examples, metaphors and the like.

3.3.1. Descriptions, definitions[8] and exemplifications

EU texts are characterized by plain language, intentionally avoiding technicalities and obscure terminology; technical words are very few and, when present, generally explained by means of definitions or exemplifications.

(30) At the nanoscale materials that we are familiar with can show new properties. *For example*, a sheet of aluminium foil is a handy way to keep your sandwiches fresh until lunchtime. But if you take that same aluminium and grind it into smaller and smaller pieces, when they become very, very tiny (nanosize in fact) something odd happens – they become extremely reactive. Even explosive! This makes aluminium nanoparticles great for putting in rocket fuel, but probably not something you want near your lunch! (NO)

(31) Other innovative textiles have fibres specially engineered with nanomaterials that make the textile dirtrepellent: *if you spill a coffee onto these tshirts, they don't get stained!* (NO)

(32) *Imagine* popping a pain pill that is not only smaller, but up to nine times more effective. Using nanocrystals of drugs can make them more absorbable and better suited to reach their destination inside the body. (NO)

The FOE corpus only contextualizes and explains nano-related terms, while it provides very few definitions of other scientific terms applied in the nano discourse. For instance, technical words very frequently used – as *titanium dioxyde*, *hydroxapatite*, *hydrosol*, *triclosan*, or *in viv*o – are never defined in the corpus, suggesting that a previous knowledge of the reader in the field of chemistry and biology is taken for granted:

(33) Inability to assess the safety of a silver hydrosol added for nutritional purposes as a source of silver in food supplements (TI)

Conversely, an effort in describing the nano world is to be noticed:

(34) The term "nanotechnology" does not describe a singular technology, but rather encompasses a range of technologies that operate at the scale of the building blocks of biological and manufactured materials – the "nanoscale." There is still no internationally accepted set of definitions and measurement systems for nanotechnology, although work towards these has begun. However, the term "nanotechnology" is now generally understood to encompass both nanoscience and the broad range of technologies that operate at the nanoscale. (NP)

Explanations in the form of a glossary may also be provided:

[8] Calsamiglia and van Dijk (2004) point out that *definitions* are used to explain unknown words, while *descriptions* explain unknown things (p. 379).

(35) Nanoscience: The study of phenomena and materials at the atomic, molecular and macromolecular scales, where properties differ significantly from those at the larger scale. Nanotechnology: design, characterization, production and application of structures, devices and systems by controlling shape and size at the nanoscale. Nanomaterials: particles, nanotubes, nanowires, quantum dots, fullerenes (buckyballs), etc. (NP)

Finally, exemplifications can also be expressed by means of comparisons or similes:

(36) One nanometre is to an apple what an apple is to the Earth. (NO)
(37) One nanometer is one billionth of a meter. One way to understand how incredibly tiny these particles are is to consider a tennis ball in comparison with planet Earth. On scale, a tennis ball is the same size in relation to Earth as a nanoparticle is to a tennis ball. (TI)

However, once again, despite the apparent similarity between the two examples, it is possible to notice that while the former has a purely didactic and exemplificatory aim, the latter seems to stress the fact that since nano-particles are so tiny, they are everywhere, as it is very difficult to be able to spot and, especially, to dispose of them.

4. Conclusions

Popularization is a matter of interaction as well as information: it involves persons and identities alongside messages. Since it is not written on a blank slate of public ignorance, but enters into an "interdiscursive memory bank" (Myers 2003, p. 267), it is necessary to investigate it within a framework which takes into account the actors involved, their language choices and strategies and their communicative goals. In particular, since any communication does not simply mediate scientific knowledge, but actively contributes to the production of new information and views that do not derive from scientific sources (Calsamiglia, Van Dijk 2004, p. 371), the present study aimed to establish how the controversy potential of the issue on hand, i.e. nanotechnologies, is managed by different stakeholders. Relying on some of the tools of corpus linguistics, i.e. frequency-ranked wordlists, concordance lines, clusters and collocations, the first phase of the analysis established that differently from what happens in the EU webpages, where a rather beneficial view of nanotechnologies is underlined, FOE reports rely on a semantic prosody evoking a sense of impending danger. These two contrasting attitudes are confirmed by the analysis of interactive markers, which show a rather positive attitude towards nanotechnologies in the EU webpages. Potential risks

or challenges are not ignored, but in order not to raise unnecessary alarm, the statements referring to the possible negative impact of nanotechnologies generally feature hedges.

However, when the same interactional markers, i.e. hedges, are employed in the FOE reports, they serve a different function. In fact, since they often co-occur with words charged with a negative semantic prosody, their use adds to the ominous force of the statements, which is further reinforced by boosters and attitude markers.

Finally, when the two corpora were investigated in search of strategies of explanation deployed to relate new knowledge to old knowledge, they revealed the presence of descriptions, definitions and examples. EU texts are characterized by plain language with few technical words, which are thoroughly explained by means of definitions or exemplifications. By contrast, the FOE corpus does not provide many definitions of other scientific terms applied in the nano discourse. As a consequence, very frequently used technical words are never defined in the corpus, suggesting that a previous knowledge on the part of the reader in the field of chemistry and biology is taken for granted. Also when both corpora make use of a similar strategy of exemplification, by means of comparisons or similes, they do so to achieve different purposes. In fact, while the EU texts rely on a purely didactic and exemplificatory aim, the FOE reports seem to stress the negative implications of the reduced size of nano-particles.

In order to limit controversy about nanotechnologies and refrain from repeating the errors made in the case of GMOs, Lorenzet (2012) suggested downgrading the discourse on the risks connected with their use. Since so far the public is apparently not worried and generally supportive, it looks like the spread of negative implications related to nanotechnology can be avoided by adopting meaningful communication participation and by opening the discussion to other concepts and topics that can stimulate involvement, such as the impact on daily life, work activities, technological innovation, among others. This in indeed what we can find in the EU webpages, whose ultimate aim is to ensure a responsible development of nanotechnologies, so that this technology can progress while at the same time making sure workers and consumers are not exposed to risk. By contrast, the FOE reports constantly evoke a sense of impending danger in connection with nanotechnologies, and in order to make the information provided more authoritative, background information is taken for granted, as if to imply that the information is provided by extremely reliable and knowledgeable sources addressing well informed and well-read audiences.

The results of the analysis prove that the texts in each corpus do not simply limit themselves to conveying scientific knowledge, but also convey information and views that are clearly at odds, even though they refer to the same issue.

However, due to the limitations of the analysis, especially in consideration of the small size of the corpora, the discursive, social and mental processes concerning the management of knowledge about nanotechnologies have been only superficially disclosed. More multidisciplinary research will be needed to find out whether communication about nanotechnologies is actually evolving or not, towards highlighting the potential risks which had previously been neglected or overseen.

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