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METAPHORICAL LANGUAGE IN SPECIALIZED AND POPULAR SCIENTIFIC TEXTS**

Abstract: *This study positions itself within the domain of analysing metaphor in naturally-occurring data. The use of metaphor often varies depending on many factors such as the context in which it is used, topic, audience, mode of communication and so on. This study specifically aims at investigating the differences and similarities in the use of metaphorical expressions between specialized and popular scientific texts. The research is based on the analysis of eight articles coming from four scientific disciplines: exact, life, social sciences, and humanities. A pair of texts comes from each discipline, one being a popular science article written by journalists for the general public, and the other being a research article written by scientists for their peers. All metaphorical language in the articles was identified using MIPVU, a systematic and transparent procedure for identifying linguistic metaphor. The findings indicate a pronounced difference in linguistic metaphor use between the two related text-types. These differences concern the frequencies, types, and functions of metaphorical language use. The variations in the use of metaphor proved to be largely explainable in terms of the differences in the components of genre and register.*

Keywords: *metaphor analysis, science, popular science, MIPVU, genre, register.*

1. Introduction

Recent research into metaphorical language has, in very general terms, followed two main strands – cognitive and linguistic. The former is the Conceptual Metaphor Theory (CMT) which was first developed and proposed in the revolutionary work *Metaphors We Live By* by Lakoff and Johnson (1980). This theory has been a response to the traditional view that metaphor is primarily a matter of words in the realm of poetic language that is mutually exclusive with the realm of ordinary everyday language. According to Lakoff and Johnson, metaphor is not just a rhetorical and fanciful device used by poets, as it was seen for many centuries. They argue that metaphor is pervasive in everyday life, not just in language, but in thought and action, claiming that our conceptual system, in terms of which we both think and act, is metaphorical in

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nature. They claim that "the essence of metaphor is understanding and experiencing one kind of thing in terms of another" (1980: 5). In order to demonstrate their point, they provide an example of a conceptual metaphor: ARGUMENT IS WAR. The concept ARGUMENT is understood in terms of the concept WAR, ARGUMENT being a target domain, and WAR being a source domain. This metaphor exists in our everyday language in a wide variety of expressions:

(1) Your claims are *indefensible.*
He *attacked* every weak point in my argument. His criticisms were right on *target.*
I *demolished* his argument.
You disagree? Okay, *shoot*!
If you use that *strategy*, he'll *wipe* you *out*. He *shot down* all of my arguments.
(1980: 4; italics in original)

All the italicized expressions in (1) are linguistic realizations of the given conceptual metaphor and describe a verbal argument in terms of war. CMT holds that linguistic metaphorical expressions such as these constitute one type of evidence for the existence of conceptual metaphors.

The second strand of research concerns studying metaphor in discourse and is often called "real world metaphor research" (e.g., Low et al., 2010). Researchers in this area have explored the ways in which metaphorical language is used in authentic communicative situations, such as education, science, or business, in order to perform different functions, such as persuading, explaining, entertaining or evaluating. This field of research re-establishes a language focus in metaphor research. Here CMT can be a possible means, not the end, and language is the main object of study. The main aim of this study being examining variations in metaphorical language used in two types of scientific discourse, it can be said to belong to this second strand of metaphor research: metaphor in discourse.

This research is motivated by the interest in the relation between science and language. More specifically, it is motivated by the interest in metaphor use variations between specialized and popular scientific written texts that share the same subject matter. These two text-types have clear differences on several levels. To name a few now, they have different purposes, they are usually written by and for people with different level of expertise in specialist areas, and they are staged differently. Factors like these can have a great influence on a writer's word choice and thus metaphors. Metaphor is expected to work differently in texts written for experts than those written for the general audience. The main aim of this paper is to explore the use of metaphorical language in the two text-types, to identify the main patterns of variation, and to explain them within a systematic approach to genre and register.

The study aims at answering the following questions:

- How frequent is metaphorical language in specialized scientific written texts/popular scientific written texts?
- Which metaphor types are most common in the two text-types?
- How is metaphor exploited to perform different functions in the two text-types? What are those functions?
- How can differences/similarities in metaphor use between the two text-types be accounted for in terms of components of genre and register (Deignan et al., 2013)?

2. Data and Methods

The data used in this research come from "real world" language use. These are written texts coming from four scientific disciplines: exact, life, social sciences and humanities. This research is based on two kinds of dataset: one consists of four popular scientific articles and the other consists of four research articles. Each article from the "popular" dataset has its corresponding research article that it is based on. Each pair shares the same subject matter. The topics that these texts deal with are the following: mathematics (prime numbers), medicine (Zika virus), social networks, and foreign language learning (see Appendix). Overall, the popular dataset contains 4007 words, and the specialized dataset contains 14,542 words.

After the texts to be investigated were collected, the next step was to identify all linguistic metaphors in them. The MIPVU procedure (Steen et al., 2010) was applied to both datasets comprising approximately 20,000 words. Having conducted quantitative analysis, the frequency and types of metaphors (indirect, direct, and implicit) in eight articles from specialist and non-specialist scientific discourse were determined. The two datasets were compared with each other and, where relevant, with larger reference corpora.

Simultaneously, the research took a qualitative look at the two datasets. Deciding on the functions of metaphorical languages in the two sets of articles was based on Boyd's major distinction between theory-constitutive and pedagogical metaphors (Boyd, 1993), which has guided much of the research on metaphor in academic discourse. This research also considered the functions that Semino (2008) mentions in her research on metaphor in science. These are persuasion, vividness, argumentation, and so on.

Genre and register play a large role in metaphor analysis. Specialist and popular scientific articles contrast, for example, in terms of what discourse communities are addressed (experts vs. a general educated audience) and in terms of the tenor of communication (peer-to-peer communication vs. communication between a better informed writer and a less informed readership). This research analysed the two types of articles in question in terms of genre and register, using a design proposed by Deignan et al. (2013). The premise is that differences in the components of genre and

register are reflected in differences in metaphorical language use, particularly in terms of frequency, types and functions. The research considered how it may be possible to account for these differences in metaphor use in terms of the main features of genre and register.

3. Analysis of the Datasets in Terms of Genre and Register

As already stated above, the aim of this paper is to examine metaphor use variations between specialist and popular scientific articles. In what follows, the data will be analysed within the framework based on the notions of genre and register, which was developed by Deignan et al. (2013). The framework includes the following notions: discourse community, function, staging, field, tenor and mode. As already stated, the belief is that differences in the components of genre and register are reflected in differences in metaphorical language use, particularly in terms of frequency, types and functions.

Concerning the four research articles investigated in this research, they are written by and for members of a specialist academic discourse community. The discourse community is restricted to those who have the interest and expertise to understand the content. This discourse community requires a threshold level of technical language that is not accessible to all speakers of English. In contrast, the discourse community of the popular scientific magazines is a lot wider. All of them are written for those who are not experts but rather the lay public that has a thirst for scientific knowledge or wishes to expand their understanding of certain scientific topics. As for tenor (the nature of the relationship between the members of the discourse communities), it is worth mentioning that the writers of the popular articles are taking on a mediating, illustrative role. This seems to be reflected in the different language choices made by each set of writers.

A central characteristic of a genre is that it has a specific and recognizable function, or purpose. The function of writing for all four academic journals and four popular science magazines is informative. Nevertheless, there is a distinction within this informative function between writing for peer experts and writing for a less informed readership. Peer experts are assumed to have an equal level of background knowledge. The writer needs to bring background concepts and the new findings of a research closer to the wider public by simplifying and carefully choosing his/her words. To illustrate this, the following sentence from the popular article on prime numbers can be considered:

(1) Primes, the numbers divisible only by themselves and 1, are the building blocks from which the rest of the number line is constructed, as all other numbers are created by multiplying primes together.

With this sentence, the *New Scientist* writer tries to explain the essence of prime numbers to the general reader. No such or similar explanation is available in the

corresponding research article on prime numbers. Later in this chapter the author will show how metaphorical language is exploited to serve this explanatory function in all four popular science articles.

There is pressure on writers of popular scientific articles to make them interesting and newsworthy by dramatizing information and making their writing attractive. This is reflected in the very titles of the four articles investigated in this study, such as "Mathematicians shocked to find pattern in 'random' prime numbers" and "Is social networking making us stupid?". Moreover, the beginning sentences of the articles try to catch the reader's attention, such as "The time has come to drop the squishy language previously used to describe the Zika virus" or "Mathematicians are stunned by the discovery that prime numbers are pickier than previously thought". The purpose of scientific literature is also to inform and persuade peers as to the validity of observations and conclusions. Popular science attempts to inform and convince scientific outsiders of the significance of data and conclusions and to celebrate the results.

There is general agreement that genres have distinct and identifiable stages. Research articles and popular articles take different steps to achieve their purpose. The research articles all follow the well-documented stages of their genre, beginning with an abstract, then an introduction, a description of background conditions, followed by methods, results, discussion and conclusion. The staging of popular science articles is not strictly defined. All the popular articles in this research start with the central and most dramatic piece of information. This is followed by presenting the findings of the research articles. This research has investigated whether particular uses of metaphorical language are characteristic of various stages of the research article and popular scientific articles.

The field, often understood as the subject matter of texts, of each pair of articles is related but definitely not identical. The popular science articles in this research cite findings reported in the research articles they are based on, and only those. They interpret the scientific findings for a general audience, trying to capture the accuracy of science, while making the language more accessible. Three of the four popular articles mention very briefly the research methods employed by the researchers, while the fourth one – the article about prime numbers – does not speak of the methods at all. This can be explained by the fact that methods that mathematicians usually use when conducting research are not likely to be easily understood by a general, not mathematically-oriented, reader. Popular science articles, as stated before, tend to discuss wider implications of scientific findings in terms of human lives. The research articles, on the other hand, deal with their findings in detail. They refer to a number of similar works. The researchers show how they identified the existing gaps in their fields and why it is worthwhile to try to fill the gaps. They spend a good deal of space presenting and evaluating the methods that they use to achieve the research objectives.

At its simplest, mode denotes whether a text is written or spoken. When first looked at, the mode of the two datasets would seem identical; they are written and published in magazines or journals as opposed to books. Both registers exhibit intertextuality, referring to other texts as sources throughout. However, a thorough investigation of the four popular scientific articles reveals that their sources are more often from spoken discourse than written. It appears that science journalists prefer to quote what scientists say rather than what they write. This may be due to the possibility that the spoken word is more likely to stimulate the reader's interest in the topic. Moreover, the tendency for speaking to foreground feelings and attitudes (Leech, 2000) may help to satisfy the need to emphasize the dramatic and sensational in popular scientific publications. All the popular scientific articles investigated in this research include a number of direct quotations from follow-up interviews with the researchers. This can also play a significant role in the frequency, types and functions of metaphorical language.

4. Analysis of Metaphor Variations in the Datasets

4.1. Number of metaphorically used tokens

One of the objectives of the present research is to investigate the degree to which metaphor is present or absent in specialized and popular scientific written texts. The raw frequency of metaphorical expressions, often called *metaphor density*, the proportion of metaphorical language to the total number of words, has been assessed.

Table 1 shows the distribution of metaphorical language across the four popular scientific articles, while Table 2 does the same for the four research articles.

As Table 1 and Table 2 show, metaphorical language use is overall more frequent in the popular science dataset than in the research one. On average, the popular articles use approximately one metaphor-related word in every 10 running words. In the research articles, there is approximately one metaphor-related word in every 12 words. Looking at the articles separately, some pairs of articles produce a more dramatic difference in the frequency than the others.

The biggest difference in the frequency of MRW's is found between the popular article on the Zika virus and its corresponding research article. Metaphorical words in the popular article amount to 11.2% of all words it contains, or one metaphorically used word in every 15 running words. The metaphor density in the research article on the Zika virus is much lower. The total number of MRW's that it employs equals to only 4.15% of the total number of words, that is, one metaphorical word in every 24 running words.

Table 1: Distribution of metaphor-related words (MRW's) in the four popular scientific articles

Popular article	Total number of words	Total number of metaphors	Percent
Prime numbers	869	116	13.30%
Zika virus	932	63	11.20%
Social networks	1119	170	15.20%
Foreign-language learning	1087	72	6.60%
All four together	4007	421	10.50%

Source: The author of this paper

Table 2: Distribution of MRW's in the four research articles

Research article	Total number of words	Total number of metaphors	Percent
Prime numbers	4500	504	11.20%
Zika virus	2794	116	4.15%
Social networks	3724	366	9.80%
Foreign-language learning	3524	230	6.50%
All four together	14542	1216	8.36%

Source: The author of this paper

The study found that all the components of genre and register influenced this variation in metaphor use. The points where the writer of the popular article tries to catch the non-expert reader's attention are most notably full of metaphor. This can be observed in the following instances of metaphorical language, which are in italics.

(1) "The time has *come* to *drop* the *squishy* language previously used to describe the Zika virus."

(2) "Senior scientists... argue in an article *rushed* to print..."

By using these metaphors, the writer creates the atmosphere of noteworthiness and urgency. He wants his readers to continue reading the article, and to not get bored after a few sentences. He wants them to get the message in its entirety and employs somewhat dramatic expressions that include metaphor. Such metaphors are not present in the research article.

Moreover, a great deal of space of the popular article is taken up by direct quotations from the interviews with the researchers. These parts of the article coming from

spoken discourse also employ a higher number of MRW's than some other parts. One example is the part when the writer describes factors that the researchers used to determine if the exposure to the Zika virus caused birth defects. It is illustrated in the following excerpt:

(3) "We really want to do our very best to *make* sure that pregnant women *hear* the message that we're *giving* them... We are also *launching* further studies to determine whether children who *have* microcephaly born to mothers infected by the Zika virus is the *tip* of the *iceberg* of what we could *see* in damaging effects on the brain.''

In contrast, the Zika research article and the other three research articles contain no direct quotations from spoken discourse. In general, direct quotations are rarely used in specialist scientific writing because scientific disciplines regard the phenomena, data, and theories described as the important contribution rather than the unique language the original author may have used. Scientists are more likely to clearly state an author's idea and present both the context and the idea in a paraphrase. Given the presence of a large number of metaphors in direct quotations in the popular article on the Zika virus, the absence of direct quotations in the corresponding research article may be one of the reasons behind the significantly higher frequency of metaphor in the popular article.

What may also be partly responsible for a very small number of metaphorically used tokens in the Zika research article is its very scientific sub-discipline, medicine. A large number of content words in the article were non-metaphorical medical terms. Some of them can have only a non-metaphorical meaning[1], such as *foetus*, *rubella*, *pathogen*, *cataract*, *microcephaly*, *teratogens, epidemiology, prenatal ultrasonography* and many others. On the other hand, some medical terms in the article could have been used as metaphorical but not in this context. These are, for example, *virus* (a computer virus)[2], *birth* (birth of an idea), *death* (the death of all hopes), *skin* (skin of fruits), *cell* (the memory cell of a computer), infectious (an infectious laugh). The popular scientific article contains only several of these terms, since its aim is not to go into details about what happens in a human body with microcephaly, but to stress the importance of prevention efforts. When discussing the wider implications of the findings, the popular article employed a significant number of metaphors.

4.2. Metaphor types

This section explores the distribution of the main types of metaphors across the two datasets. The three main types are indirect, direct, and implicit metaphors (Steen et al., 2010). There are also two additional types of metaphor-related words: metaphors that

[1] Unless they are used as novel metaphors.

[2] Examples of possible metaphorical meanings in other contexts are given in parentheses.

are both direct and indirect and MRW's that signal a potential cross-domain mapping (Mflag); and there are two subtypes: borderline cases of metaphor (WIDLII); MRW's due to possible personification (MRW, PP). All of these have been identified in the two datasets of popular and research articles by using the MIPVU procedure. Table 3 and Table 4 report the relative frequencies of metaphor types across the specialist and popular dataset, respectively.

Table 3: Distribution of metaphor types across the popular articles

	Popular article				
Metaphor type	***Prime numbers (869 words)***	***Zika virus (932 words)***	***Social networks (1119 words)***	***Foreign-language learning (1087 words)***	***Overall (4007)***
All MRW's	***116***	***63***	***170***	***72***	***421***
Indirect	***97 (83.60%)***	***63 (100%)***	***167 (98.20%)***	***72 (100%)***	***399 (94.80 %)***
Direct	16 (13.70%)	0	2 (1.20%)	0	18 (4.30%)
Indirect + Direct	1 (0.86%)	0	0	0	1 (0.20%)
MFlag	2 (1.72)	0	1 (0.60%)	0	3 (0.70)

Source: The author of this paper

Table 4: Distribution of metaphor types across the research articles

	Research article				
Metaphor type	Prime numbers (4500 words)	Zika virus (2794)	Social networks (3724)	Foreign-language learning (3524)	Overall (14542)
All MRW's	504	116	366	230	1216
Indirect	504 (100%)	116 (100%)	366 (100%)	230 (100%)	1216 (100%)
Direct	0	0	0	0	0
Indirect + Direct	0	0	0	0	0
MFlag	0	0	0	0	0

Source: The author of this paper

As can be inferred from the tables, the use of metaphorical language in both datasets largely means the use of indirect metaphor. This type of metaphor contributes by far the greatest proportion to the total count of metaphor-related lexical units. Indirect metaphor seems to be the prototypical case of metaphor-related language. Out of the total number of 399 indirect metaphors in the popular dataset, only 5 of them were borderline cases that were coded as MRW, WIDLII (When In Doubt, Leave It In). The additional code "possible personification" (MRW, PP) was added to 9 instances of

indirectly used metaphors in this set. The overall number of 1216 indirect metaphors in the four research articles included 21 WIDLIIs and 17 occurrences of metaphor-related due to possible personification.

While the research articles exploit only indirect metaphor, the popular scientific articles employ a considerable number of the other types of metaphor. Direct metaphors accompanied by metaphor signals are particularly important in the popular article about prime numbers, and to some extent in the article about social networks. There is not much likelihood that the nature of prime numbers is a topic that many readers of popular science articles are familiar with. The writer of the article wants to bring the new developments in this field closer to the general educated public. Direct metaphor use is perfect for this explanatory purpose. Its use in popular science is widespread to aid the readers' conceptions of the scientific concepts under discussion. Consider the following sentences from the article.

(4) *Just as Einstein*'s *theory* of *relativity* is an *advance* on *Newton*'s *theory* of *gravity*, the Hardy-Littlewood conjecture is essentially a more complicated version of the assumption that primes are random – and this latest find demonstrates how the two assumptions differ.

In sentence (4), there is a local referent shift, from prime numbers to the theory of relativity. The lexical units *Einstein, theory of relativity, Newton, and theory of gravity* are incongruous with the topic of prime numbers. However, we see that the incongruous lexical units can be integrated within the overall referential framework by means of comparison, signalled by the phrase *just as*. In the next step, we see that the comparison is non-literal or cross-domain, the source domain being physics and the target domain mathematics. The writer uses the source domain of well-known scientific discoveries to make an analogous comparison with the findings regarding prime numbers. What is already known, that prime numbers are randomly distributed on the number line, is talked about in terms of *Newton's theory of gravity*. And, what has just been discovered, that certain prime numbers appear in patterns, is talked about in terms of *Einstein's theory of relativity.* In this way, the author wants the readers to understand this advance in mathematics through understanding this particular advance in physics that took place at the beginning of the 20th century, when Albert Einstein revolutionized the way scientists think about space and time. Here, indirectness in conceptualization is directly expressed by direct language. All content words within this stretch of text are coded as direct metaphors. The metaphor signal *just as* is coded as Mflag.

As stated above, none of the research articles uses direct metaphor. All of 1216 metaphor-related words in the specialist dataset are used as indirect metaphors. It is important to note here that direct metaphors are connected to the use of deliberate metaphor (e.g., Steen, 2011), that is, all direct metaphors are used deliberately as metaphors. The lack of direct and signalled metaphors in the research articles can be

related to the formality of specialist scientific language which implies the limiting use of deliberate metaphor (Low, 2008). There is reason to assume that expert scientific prose uses metaphor in a less explicit and deliberate way than popular science. Metaphor use in expert scientific writing can be said to be more backgrounded and conventional. The presence of the explanatory and illustrating function in the set of popular articles seems to be reflected in the use of direct metaphors, such as the one explained above. Conversely, the absence of such functions in the genre of research articles seems to be reflected in zero uses of direct metaphor. Moreover, in the popular texts, the writer takes on the role of instructor, and this is linguistically realized where metaphors are explicitly signalled, again such as in the example (4).

4.3. Communicative functions

Having investigated the frequencies and types of metaphorical language in the specialized and popular scientific articles, this research narrows down its focus on the communicative functions of metaphor in the two datasets. It is now well known that metaphor has different dominant functions in different genres (e.g., Semino, 2008). This research attempts to find the most frequent and prominent functions of metaphor in each of the two text-types, concentrating on topic-specific metaphors in each pair of articles.

The first important function of metaphors that was spotted in the popular dataset is an introductory function. The writers of all the four articles know that the intended reader is not an expert. They think of the reader as a person with a good all-round education, but with no specialized knowledge and possibly no exceptional passion for the disciplines in question. This means that readers have to find their articles appealing to start reading. This is the most probable reason why the writers use catchy metaphors to attract attention at the very beginning. This is clearly illustrated in the following opening sentences of the article on prime numbers (5) and the Zika virus (6), and in the title of the article on social networks (7).

(5) Mathematicians are *stunned* by the discovery that prime numbers are *pickier* than previously thought.

(6) The Centers for Disease Control and Prevention *said* Wednesday the time has *come* to *drop* the *squishy* language previously used to describe the Zika virus.

(7) Is social networking *making* us stupid?

All these metaphors seem to have the function of highlighting the evaluative function of the articles, which they sensationalize. This appears to be related to the overall function of the genre, which is to entertain, through dramatizing and stressing the newsworthiness of topics and involving the reader. Such metaphors do not occur in the research articles. This may reflect the field and function of this genre, which discourage sensationalism.

The predominant function of the entire popular dataset is a pedagogical function (Boyd, 1993). Pedagogical metaphors play a role in teaching and explaining scientific theories and ideas. They have at least an interpersonal function since they serve to explain aspects of science to lay audience, and possibly induce reconceptualization in learners. Such metaphors are often used in a specifically vivid way, aiming to provide the general reader with a comprehensible and memorable account of the phenomena. Consider the following sentence taken from the popular article on prime numbers:

(8) Primes, the numbers divisible only by themselves and 1, are the *building blocks* from which the rest of the number line is *constructed*, as all other numbers are created by multiplying primes together.

These metaphors, *building blocks* and *constructed,* serve to help the lay audience understand what prime numbers actually are. Prime numbers are talked about in terms of "pieces of wood or plastic used by children to build things with", which is the basic meaning of the expression *building blocks*. Its contextual meaning is "one of the basic parts that something is made from and cannot exist without". Using this pedagogical metaphor, the writer aims at facilitating visualization for the novice reader. None of this information is conveyed, in any form that could be seen, in the corresponding research article because it is assumed to be shared knowledge for their discourse community.

Direct metaphors are a rich source of pedagogical metaphors. Two of the four popular articles use direct metaphors. All of them are utilized for pedagogical purposes. The use of direct metaphors in the popular article on prime numbers described earlier (when the writer correlates the new findings regarding prime numbers with Einstein's theory of relativity) is one example of a pedagogical direct metaphor. Another example is a direct metaphor employed in the article about social networks:

(9) Social networking probably isn't making you smarter. In fact, it could be making you dumber by supplying answers and insights without requiring any actual thinking, so that your analytic powers begin to *waste away <u>like</u>* an *unused muscle.*

This simile in the form of a direct metaphor signalled by *like* is used to make a description more emphatic and vivid. It compares some aspects of the topic with a familiar concept. This metaphor plays a pedagogical role in that it explains how our analytic powers deteriorate by including an alien but well-known domain, that of how our muscles work. The writer wants the readers to know that if we don't train our brain, it will, just as atrophied muscles, lose one of its functions. Drawing a parallel to well-known matters, metaphor makes complex concepts easier to grasp.

Pedagogical metaphors were not found in the research articles. They use specialized metaphors more often than the popular dataset. This finding can be interpreted in such a way that an expert, when describing discipline-related topics, automatically produces more theory-constitutive metaphors (Boyd, 1993) than a science journalist. These metaphors are needed for theory modelling and filling terminological gaps. The most frequent theory-constitutive metaphor in the specialist data set is the *acquisition*

metaphor. In the acquisition metaphor the process of learning is talked about and possibly seen as if it was the process of obtaining a physical property. According to Paavola et al. (2004) in this metaphor the human mind is seen as a container of knowledge and learning is a process where the learner (or his teacher) is filling the container with knowledge. Sfard (1998) claims that the historical roots of the acquisition metaphor can be located in the era when documented information was a scarcity: production or reproduction of written documents was expensive. This metaphor structured a new domain and provided vocabulary for the phenomenon for which scientists did not have any alternative terms. The research articles about social networks and foreign-language learning abound in metaphorical expressions that realize this systematic metaphor – LEARNING IS ACQUIRING A POSSESSION. The following are examples from each article, respectively:

(10) . . . without *acquiring* the causal knowledge or the reasoning processes that were responsible for this behaviour.

(11) *Acquiring* sensorimotor skills and conceptual knowledge in adulthood alters the human brain's gray matter structure in task-relevant areas.

The corresponding popular articles show preference for the metaphorical phrasal verb *pick up* to convey the same meaning. The term does not occur in the research articles. Searching for the term in the Corpus of Contemporary American English, which contains specialist as well as more popular texts, the author found that metaphorical *pick up* hardly ever occurs in the specialist section of the corpus. This suggests that the term may be peculiar to popular writing. The use of this metaphor in the two popular articles investigated in the present research seems to have the function of making the contents of the article more understandable as well as more interesting to a layperson, which is connected to the overall function of the genre.

5. Conclusion

This paper looked at the ways in which metaphorical language use differs between specialized and popular scientific written texts. The first type of text is written by scientists for their peers, and the second one is usually written by journalists for an educated but not specialist readership. The author identified metaphor-related words using a systematic procedure for metaphor identification, MIPVU (Steen et al., 2010) and investigated the two datasets within the framework of genre and register (Deignan et al., 2013).

The first aim of this research was to determine the frequency of metaphorical language in both the specialist dataset and the popular one. Overall, the popular articles employ metaphor more frequently. The separate analyses of each pair of articles showed that some of them exhibited a bigger difference in the frequency of metaphor use than the others. This difference is largely influenced by all the components of genre and register,

and especially by mode (use of direct quotations in the popular articles), field (more non-metaphorical technical terms in the research articles), and function (sensationalizing the news in the popular articles and explaining complex phenomena).

The second aim of this research was to explore the distribution of the main types of metaphor across the two datasets. While the research articles use exclusively indirect metaphors, the popular articles also employ direct metaphors and metaphor signals. The writers employ direct metaphors mostly for explanatory purposes, to make complex content more accessible to the general non-specialist public. The absence of direct metaphors in the specialist dataset is indicative of the overall absence of explanations of concepts already familiar within their expert discourse community.

Finally, the main functions of metaphors differ between the two datasets. Metaphors in the popular set are used predominantly for pedagogical purposes, to explain complex scientific phenomena. Another important function of metaphors in this set was to attract the readers' attention and provoke their curiosity. Such functions of metaphors were not found in the specialist dataset. Here, metaphors have a predominant theory-constitutive function.

Using a framework for analysing variation in metaphorical language use that is based on the notions of genre and register proved to be exceptionally useful in this kind of research. This coherent framework of genre and register allowed the author to describe variations in metaphorical language use in the two datasets more fully and systematically. This research found that the differences in the components that influence genre and register are indeed reflected in the differences in metaphorical language use. The present research demonstrated how metaphor studies can benefit from deepening the already existing link between metaphor use and factors such as topic, audience, the relationship between participants, functions of texts, and so on.

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Appendix

This appendix contains the list of 8 articles that constituted the author's corpus for metaphor analysis.

1. (a) "Mathematicians shocked to find pattern in 'random' prime numbers", written by a physical sciences journalist, Jacob Aron. The article appeared in the New Scientist magazine on 14 March 2016. It is 859 words long and included one illustration: a picture of little blocks with numbers on them.
https://www.newscientist.com/article/2080613-mathematicians-shocked-to-find-pattern-in-random-prime-numbers

(b) Oliver and Soundararajan (2016) "Unexpected biases in the distribution of consecutive primes''. The article appeared in PNAS, a multidisciplinary scientific journal. It numbers 4,500 words, not including references, tables and notes. http://arxiv.org/abs/1603.03720

2. (a) "CDC confirms Zica causes severe birth defects'', written by a infectious diseases and public health reporter, Helen Branswell. This article was published on 13 April 2016 in STAT, a publication focused on finding and telling compelling stories about health, medicine, and scientific discovery. The article contains 925 words and one illustration: a mother displaying a photograph of her daughter, who was born with microcephaly.
https://www.statnews.com/2016/04/13/zika-birth-defects-causes

(b) Rasmussen, Jamieson, Honein and Petersen (2016) "Zica virus and birth defects – reviewing the evidence for causality". The article was published online in the New England Journal of Medicine. It contains 2,794 words, not including references. https://www.statnews.com/2016/04/13/zika-birth-defects-causes

3. (a) "Is social networking making us stupid?", written by a social sciences journalist. This article appeared on 6 February 2014 on Phys.org, an internet portal that provided the latest news on science. The article is 1,119 words long. It has a picture of the Thinker, a nude male figure of over life-size sitting on a rock with his chin resting on

one hand as though deep in thought and is often used as an image to represent philosophy.
http://phys.org/news/2014-02-social-networking-stupid.html

(b) Rahwan, Krasnoshtan, Shariff and Bonnefon (2014) "Analytical reasoning task reveals limits of social learning in networks''. The article was published in the Journal of the Royal Society Interface. It numbers 3,724 words, not including references, tables and figures.
http://rsif.royalsocietypublishing.org/content/11/93/20131211

4. (a) "What happens in the brain when you learn a language?", written by Alison Mackey, a professor of linguistics at Georgetown University and Lancaster University. It was published on 4 September 2014 in the Guardian. It contains 1,097 words and one illustration: a picture of a woman using electrophysiology to examine the inner workings of the brain during language learning.
https://www.theguardian.com/education/2014/sep/04/what-happens-to-the-brain-language-learning

(b) Mårtensson et al. (2014) "Growth of language-related brain areas after foreign-language learning". The article appeared in the NeuroImage Journal. It contains 3,524 words, not including acknowledgements, references and figures. http://www.ncbi.nlm.nih.gov/pubmed/22750568

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UPOTREBA METAFORA U NAUČNO-ISTRAŽIVAČKOM I NAUČNO-POPULARNOM TEKSTU

Sažetak: *Ovaj rad se bavi analiziranjem metafora u autentičnoj prirodnoj upotrebi jezika. Upotreba metafora varira u zavisnosti od više činilaca, a neki od njih su kontekst, tema, sagovornik i način komunikacije. Cilj ovog istraživanja je da ispita sličnosti i razlike u korišćenju metafora između dve vrste teksta: naučno-istraživačkog i naučno-popularnog. Istraživanje se zasniva na analizi osam naučnih radova iz četiri naučne discipline, a to su egzaktne, prirodne, društvene i humanističke nauke. Iz svake discipline analizirana su po dva teksta, od kojih je jedan naučno-popularni članak koji je napisao novinar za opštu javnost, a drugi je naučno-istraživački rad koji je napisao naučnik za druge naučnike. Za identifikaciju metafora u svim tekstovima korišćen je MIPVU, sistematična i transparentna procedura za identifikaciju lingvističkih metafora. Rezultati ovog istraživanja ukazuju na to da se metafore upotrebljavaju znatno drugačije u ove dve vrste teksta. Razlike se tiču učestalosti, vrsta i funkcija metafora. Varijacije u upotrebi metafora u velikoj meri se mogu objasniti u odnosu na razlike u elementima koji čine žanr i registar.*

Ključne reči: *analiza metafora, nauka, popularna nauka, MIPVU, žanr, registar.*

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