Magdalena Zawisławska

METAPHOR IN SCIENTIFIC LANGUAGE BASED ON THE EXAMPLE OF NATURAL SCIENCE

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The proposition that metaphor exists in scientific language, especially in the language of natural science, can initially raise many objections. Perhaps it would be less surprising in the search for metaphors in humanities. It is universally acknowledged that natural science presents the objective, "true" picture of the surrounding reality, quite contrary to the naïve folkloric view of the world. As a result, it would seem that metaphor has no place in it. Arutiunova wrote: "it is no coincidence that scientists **avoid the use of metaphor in their publications** *(bold emphasis in all quotes mine – M.Z.)* — they think metaphor constitutes no argument, furthermore: 'committing a metaphor' is comparative to committing a crime. (Arutiunova 1981: 140-141). Perelman also notes that "the scientific writing style rarely reverts to the use of metaphors" (Perelman 1971: 250). However, the analysis of texts from the domain of natural science — both popular-science and strictly scientific publications presents an entirely different situation — not only is metaphor used in these texts with reasonable frequency, but it also plays a significant role. Fojt claims that "the process of metaphorisation plays a significant role in the formation of terms, and as a result, it influences the expression of scientific theories" (Fojt 1998: 107). Similar claims have been made by Draft (Mac Cormac 2002: 353), Harré (Paton 2002: 270), Paton (Paton 2002, 270). Even Perelman, who does not consider metaphor to be a typical component of scientific language admits: "[. . .] when a scientist is faced with a new domain of research, he often allows himself to be guided by analogies. These analogies play a heuristic role – they act as creative tools which provide

the scientist with hypotheses which give direction to further analyses. Their most important feature is potency – they ought to open new perspectives for the research; however, in the end they should be eliminated, because the acquired results must be expressed in technical language, whose terms are derived from theories connected to the given domain." (Perelman 1971: 250).

The present article shall discuss the function of metaphor in the language of natural science and enumerate methodological problems connected with describing metaphors in scientific texts.

1. THE FUNCTION OF METAPHOR

According to Paton, metaphors can have the following functions in science:

– *catechretic — they can supply new terms to the theoretical vocabulary;*

– *ontological — they are involved in the formulation of hypothetical entities;*

– *didactic — they facilitate dialogue between a teacher and a student* (Paton 2002: 271).

Boyd, however, claims there are two types of metaphors in scientific language: *theory-constructive metaphors and pedagogical/exegetical metaphors.* According to Boyd, theory-constrictive metaphors are the most original metaphors in the language of science, because they help to shape a specific manner of conceptualization of the new objects or phenomena. Boyd claims that these types of metaphors cannot be paraphrased, because they represent the only way of speaking about the given object or phenomenon and thus fill a certain cognitive void — not only at the level of language, but also with reference to terminology.

Pedagogical/exegetical metaphors are used to explain the properties of the given phenomenon. They are neither original, nor argumentative — they are strictly descriptive and as such, can be paraphrased (Boyd 1993).

Knudsen observes that within the classification proposed by Boyd it is rather difficult to differentiate between the metaphor which constructs the theory and the pedagogical metaphor because both types of discourse (strictly scientific and that of popular science) use virtually the same types of metaphor and as a result, the boundaries between the two types become rather vague. Boyd points out that these two types of discourse only differ in the frequency of metaphors and the manner of their presentation. As a result, the metaphor may be **closed**, that is, one stops being aware of its metaphorical character and it becomes a stabilized concept; one might even say — a component of the system. An **open** metaphor is presented

as a foreign component of the discourse (for instance through the use of quotation marks) which is ambiguous and therefore needs to be supplied with an explanation. Knudsen emphasizes that frequently, a closed metaphor used in popular discourse transforms again into an open metaphor (Knudsen 2003: 1254).

1.1. CATECHRESIS

The most obvious and probably the least controversial function of metaphorization is its use in the naming of new objects and phenomena in scientific language. The majority of scientific terms are catechreses, which fill the voids in the lexical system, for instance: brainstem, cerebral cortex, thorns, end-brush, red giant, white dwarf, Baby Universes, DNA chain, trash DNA, progeny DNA, egoistic DNA, etc. It is typical for catechresis to lose their metaphorical character at a certain point and become simply a component of the lexical system.

T. Dobrzyńska emphasizes the difference between catechereses and proper metaphors. She claims that catecheresis does not possess this "semantic tension, which is characteristic for metaphors; it does not require a simultaneous actualization of the code meaning different from the one used at the moment: (Dobrzyńska 1994: 63-64). Her opinion is shared by Arutinowa, who uses the term *nominative metaphor* instead of *catecheresis.* According to her definition, nominative metaphor is based on the similarity of objects either within the category of function or some external, obvious characteristic, hence, it works in a demonstrative manner — it does not appeal to intuition, but to the sense of sight. [. . .] After fulfilling its nominative function, the metaphor disappears" (Arutiunova 1981: 138-139.) Meanwhile, according to Arutiunova, the proper, predicative metaphor is "a certain form of contingency, used not in order to search for a name, but to find a picture, a manner of individualizing or assessing an object or for making out the facets of its sense. (Arutiunova 1981: 139-140).

However, one ought to emphasize here that catechereses in the language of natural science differ amongst each other to a significant degree. For instance, in the Polish language, the term denoting the cortex — *"kora [mózgowa]"* is based on the visual comparison between the source domain (*"kora [drzewa]*" — treebark) and the target domain (the corrugated tissue of the brain). One might say that in the Polish language, this catechresis is based on a simple comparison — the brain's tissue (Polish: "kora") is corrugated in a manner similar to treebark (also "kora" in Polish).

However, catechresis can activate much more complicated connotations, for instance the term *black hole* as the description of a super-massive astronomic object. This term was not coined based on a simple comparison — there is no category within which a supermassive astronomic object is similar to a black hole, since it is a hypothetical entity, whose existence has been debated by physicists since the 18th century. So far, no one knows what such an object looks like and if it actually exists. The term *black hole* was proposed in the 1960s by John Wheeler. The earlier name — *frozen star* — was rejected. One might say that the creation of the term *black hole* was based not only on the act of transferring the meaning and filling a gap in vocabulary — it also became an image and a way of assessing the given object – which makes this catechresis more similar to a proper metaphor. The fact that this term is connected to a very distinct process of assessment and evocative imagery is confirmed by its "second life" in other domains of science or in other types of discourse, for instance:

– Polish society identifies itself and becomes involved on both private and national levels. There is a gap between the two — how should it be eliminated?

– There are two approaches to the goal of filling this gap, which sociologists have called **"a black hole."**[1]

Despite its many achievements, NASA is a wasteful and messy bottomless pit, which does not generate any profits and in a manner similar to a black hole, sucks in billion after billion of tax payer's money ("Czas" no 40 (959) 4^{th} October 2008).

1.2. METAPHOR AS A PEDAGOGICAL TOOL

Another role played by metaphor in language is its pedagogical function. Metaphor is frequently used in texts designed for non-professionals in order to explain very complex ideas in a fairly non-complicated manner. A good example here would be the following text describing the analysis of the human genome – the Human Genome Project:

The analysis of the largest human chromosome has been completed. It also constitutes the **publication of the last chapter in the Human Book of Life** – claim the scientists writing for *Nature* magazine.

The Human Genome Project (HGP) was created sixteen years ago. Americans decided that by 2005 they would have ***read*** *the entirety of the human genetic material. This decision gathered such enormous feedback from*

[1] http://www.euroregiony.pl/html/253.html

all over the world and so many countries joined the project that the first sketch of the ***transcript*** *of human DNA was created as early as 2000. Ever since that time scientists have been trying to further specify the acquired data and fill in all the gaps that have been created during the rapid transcription of the* ***letters.*** *[DNA] consists of millions of letters ordered into pairs on a double srand called the helix . [. . .] The human* ***"transcript of life"*** *uses four types of letters, specifically those marked as A, T, C and G. [. . .] While analyzing chromosome 1, scientists also discovered that the* ***"genetic recipe for a human being"*** *starts with the* ***letter C.*** *[. . .]What else is known about chromosome 1? It is more than six times longer that the smaller human chromosomes — 21 and 22 — and carries as much as 8 percent of our genome. If the* ***transcript*** *it contains were ever* ***printed,*** *then it would take up more than 60 thousand* ***pages*** *[. . .]*(M. Kossobudzka, *Największy ludzki chromosom rozszyfrowany,* "GW", 19.05.2006).

Metaphors fulfilling pedagogical functions are figurative — they are based on a comparison or an analogy. In the discussed type of metaphor, the sender reveals the source domain (which is LANGUAGE in the quoted text), which becomes a source of the lexis transferred to the target domain (DNA). The sender assumes that the recipient is familiar with the source domain. As a result, the sender introduces a string of analogies between the source and target domains (for instance between the language and the deoxyribonucleic acid) and enumerates all the instances in which these two domains are alike.

LANGUAGE	DNA
letter →	*nucleotide*
word →	*codone*
sentence →	*gene*
chapter →	*chromosome*

1.3 THE MODELING FUNCTION OF METAPHOR

The modeling function is undoubtedly the most important feature of metaphor in scientific language. Fojt described it the following way: "I shall argue that metaphorisation processes play a **constituitive** role in concept formation by virtue of which they influence articulation of scientific theories. [. . .] Once a given metaphor is established in some discipline it specifies a framework for research. It provides inferentially useful patterns for further theory articulation. It also sets forth a range of plausible explanations for theoretical problems — some solutions are acceptable under a given

understanding while others have to be discarded. Hence — mataphors can be said to guide reasoning by predetermining scientific research. (Fojt 1998: 108).

Metaphor with a modeling function does not consist in the transferring of single lexemes from the source domain nor in an impromptu formation of a name for a new object or phenomenon, which shall gradually become a term (as is the case with catechresis). This metaphor consists in transferring the entire conceptual structure from the source domain into the target domain together with the appropriate terminology. In certain aspects, the maker of a model shapes the target domain as a mirror image of the source domain, hence he refers to it with the words that are primarily used to refer to the source domain. This might be connected to a real similarity between the domains, however, the said similarity might be only postulated by the sender — this way, he creates a hypothetical model of the given object or phenomenon (such an action was referred to by Paton as an ontological metaphor). Good examples to present here might be the metaphor of BRAIN AS COMPUTER borrowed from the domain of neurology and psychology or the metaphor of ORGANISM AS AN ENTERPRISE borrowed from the domain of biology; see:

BRAIN AS A COMPUTER

[. . .] the basic ***operational unit*** *of the mind and the brain is the* ***module — the cognitive processor which computes****, in strictly specified parts of the cortex, equally* ***strictly specified types of information. The modules, which work automatically*** *and independently from one another are informationally impenetrable, i.e. they use sources of information exclusive only to them. The results of their* ***operations*** *are transferred to the so-called* ***central processor****, which encompasses more complex cognitive functions (for instance: processes involved in decision-making) and cannot be pinpointed in the brain* (Jodzio 2003: 38).

ORGANISM AS AN ENTERPRISE

The theory of a disposable body states that it is the task of the mortal body to enable the dissemination of the immortal reproductive cells. It ponders the manner in which an organism should ***distribute its resources*** *— primarily energy — in order to both ensure its own survival as a unit and* ***produce progeny*** *which shall enable the survival of its genes after its death. In principle, an overly large investment in the maintenance of somatic cells is*

unprofitable because it depletes the resources which might be used for reproduction. *In short, immortality leads to lower fertility because the organism's* ***resources*** *are* ***used*** *for the maintenance of somatic cells. Aging is the* ***price*** *the organism pays for* ***investing*** *in reproduction* (Strosznajder, Mossakowski 2001: 12).

What conditions should be met in order to conclude that a metaphor fulfills the modeling function? It seems that the vocabulary of the source domain has to be transferred to the target domain in a consistent manner and should encompass entire fragments of the text or even the whole text, i.e. it should not be limited to one utterance. In principle, the name of the source domain should not appear in the text. However, the name of the source domain is present in the texts which dispute the given model (for instance the claim that the brain is NOT a computer), demonstrating a lack of similarity between these two domains; see:

[. . .] the latest discoveries seem to indicate that biological networks function via continuous dynamic changes of states [. . .] and not as a result of simple algebraic calculations. ***The term "processing of information" can only be a metaphor used to describe the process of auto-modification, and not the calculation of a result in a "biological computer"*** (Górska et al. 2005: 71).

A metaphor with a modeling function is reversible, i.e. the source domain can become a target domain in a different domain of science, for instance ORGANISM AS A SOCIETY, SOCIETY IS AN ORGANISM in sociology. It does not seem that the target domain was more abstract than the source domain — the target domain in scientific language is simply an object for analysis. For instance: the human body is no more abstract than a machine or a computer, which does not change the fact that biology describes it using the abovementioned metaphors. On the other hand, computer sciences describe a computer as similar to a human being.

The metaphor with a modeling function can later become a basis for the entire sequence of co-related metaphors with pedagogical function, which are used to explain the properties of a new phenomenon to the recipient; see:

Our mind is a product of a network of neurons, ***which depend upon them to a greater degree than the operational system Windows depends on a processor, memory and other components of the computer.*** *[. . .] However, we still do not know how this biological network which constitutes the brain actually* ***processes information****. The mind may be a kind of* ***supercomputer*** *but it does not function in a similar*

manner. One of the reasons for this is the complexity of inter-neural communication: the signals are ***coded*** *in two forms: electrical and chemical. It cannot even be clearly determined, which parts of the brain would constitute* ***software*** *or* ***hardware*** (Aneta Brzezicka, Marcin Rotkiewicz, *Śmierć duszy,* "Polityka", issue 50 (2482) from 11^{th} December 2004, special edition Niezbędnik Inteligenta, p. 29).

2. METHODOLOGICAL PROBLEMS IN DESCRIBING METAPHOR WITHIN SCIENTIFIC LANGUAGE

The majority of publications on metaphors use literary texts for analysis because it is universally believed that the metaphor is a phenomenon typical for the poetic style of writing. This point of view was questioned by Lakoff and Johnsons in the book *Metaphors we live by*, in which they demonstrated that metaphors occur frequently and that it constitutes an operation on the terminological level (consisting in perceiving one cognitive domain through another, for instance LOVE IS DEATH, which is later displayed at the level of the language) (Lakoff, Johnson 2003). However, regardless of the change on the manner of describing metaphor in cognitive linguistics, it still lacks a precise definition and differentiation from other similar expressions (for instance metonymy, analogy, comparison). Bogusławski observes: "as we know, the term 'metaphor' is used in a variety of ways; it can encompass either a wider or narrower circle of facts. In the wider interpretation, the term metaphor can even refer to an explicit comparison. In any case, every situation in which an expression is used in a different manner than the one accepted as fundamental, according to a certain principle within a given class and when the given instance of usage and the class can be said to posess a 'common feature', justifies the use of the term 'metaphor'. As a result, the label 'metaphor' can refer to many different things, including certain terminological uses (for instance "a mechanical horse"), hyperboles, litotes, circumlocution and a multitude of others." (Bogusławski 1971: 113).

When analyzing scientific texts, it is quite important to differentiate between metaphors and analogies. This task is difficult because in many publications the definitions of metaphors and analogies overlap; see: "[...] analogy occurs only when one can establish a certain similarity of relations and not only a similarity between objects. When one claims that A is B (this man is a fox) – then we are not dealing with an analogy but a metaphor, which is a condensed analogy and which shall be discussed later. A typical pattern of an analogy shall consist in the claim that **A is related to B the same way C is related to D.** A and B as well as C and D can be

quite different — in fact, their heterogeneity is necessary if the analogy is to be something more than a simple proportion. [...] **a metaphor occurs (in accordance with the analogy: A is related to B the same way C is related to D) when in order to indicate A one shall describe the relation of C to B or if one observes that A is a type of C"** (Perelman 1971: 248-250).

It is also difficult to differentiate between a metaphor and a comparison. Based on the existing definitions, it would seem that the two phenomena are very close; see: "With greater or lesser confidence, a metaphor of this type *(predicative metaphor — M.Z.)* **can also be inferred from a comparison** based on the parallel relation between various phenomena: *a storm (wind) sounds similar to the howl of an animal* → the *storm (wind) howls like an animal* → the *storm (wind) howls.* The process of similarization in this type of metaphor is based on a fully described feature." (Arutiunova 1981: 142 -143).

The definitions of all the figures mentioned above, that is, a metaphor, analogy and comparison, emphasize the similarity between two objects or phenomena, which in the traditional terminology referring to metaphors would be called a topic and a carrier. As an example, one might consider the following quote from Jakobson: "The development of discourse [...] can progress along two semantic lines: one topic is connected to the other either via **similarity** or by adjacent placement. **The metaphorical way** seems to be the most appropriate term in the first case, whereas the most fitting term in the second case is **the metonimic way**; the reason for this belief is that the most condensed form of these connections is either a metaphor or a metonymy" (Jakobson 1989: 169).

The similarity between the topic and the carrier was also emphasized by T. Dobrzyńska. She claims that in order for the receiver to understand the metaphorical utterance and to preserve the utterance's coherence, the following conditions ought to be fulfilled: the receiver has to: "1) identify the subject of the utterance — 'topic' – 'main topic' of the metaphor (X); 2) recall the opinion on the topic Y-a — 'carrier', 'auxillary topic' of the metaphor; 3) choose certain features of Y-a, which in the given situation can be ascribed to X, then transfer them to X. (These of course will not include all possible features of Y-a, because Y is not identical to X, **they are merely similar in a certain aspect**" (Dobrzyńska 1994: 16).

The issue of similarity as an important part of the definitions of metaphor was discussed by Ritchie in his 2006 publication *Context and Connection in Metaphor*, in which he analyzes several examples of metaphors. I shall

discuss only one of them: *encyclopaedia is a jungle.* According to a dictionary definition a *jungle* is "a humid tropical forest with a great variety of trees, a multi-layered system of forest-stand, a multitude of lianas and epiphytes and an underdeveloped layer of shrub and undergrowth." an *encyclopaedia* is "a publication encompassing a set of information from all the branches of knowledge or from one domain, arranged as entries in an alphabetical or subject order." The discussed metaphor seems to be simple and understandable. However, one ought to note that the literal meaning of the lexemes *jungle* and *encyclopaedia* do not have any semantic elements which might be considered similar. Ritchie observes that this metaphor was created as a result of an initial metaphorisation of the two domains. "*Jungle* must first be understood in a metaphorical way — generally as a thick accumulation of something, not just as an accumulation of plants. That is not all — one also has to create a conceptualization of information and knowledge as a material object which can be thick and tangled.

Thus, the metaphor '*encyclopaedia is a jungle'* does not contain a direct transfer of carrier features to the topic. The carrier features must first be metaphorized and the abstract topic must also be conceptualized in a proper way so that the metaphor can exist at all. This issue is more complicated in scientific language, which often describes very abstract beings or phenomena.

Max Black, who analyzed metaphor in scientific language also criticizes the comparison theory of metaphor, see: "the main drawback of the comparison theory is its haziness which borders on verbosity. [...] A metaphorical utterance is not a surrogate of a formal comparison or any other literal utterance because it possesses its own value and potential. We often say 'X is M' by evoking certain relationships between M and L (or rather with an infinite sequence L_1, L_2, L_3...) when it would be difficult to construct a metaphor by finding literal similarities between M and L. In such cases, it would be more reasonable to say that a metaphor **creates similarities instead of defining those that already exist**" (Black, 1971: 227).

3.CONCLUSION

The analysis of texts from the domain of natural science indicates that the metaphor constitutes one of their most significant components and one of the fundamental tools for communicating new information and explaining phenomena. Further research on this issue ought to include a more formalized classification of the functions of metaphor in scientific texts, because the divisions suggested by Paton and Boyd are nor fully separate and the types of metaphor they proposed overlap. It shall also be necessary to reformulate

the issue of similarity between carrier and topic in the existing definitions of metaphor, because otherwise the majority of phenomena described in the analyzed texts (except for very conventional expressions such as *cerebellum*) will not qualify to be called metaphors.

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