Metaphor and Figurative Meaning Construction in Science and Technology (English and Spanish)

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Abstract

Metaphor is a cognitive tool that operates in both verbal and non-verbal communication, or in various modes simultaneously (Forceville, 2009, 2010). This paper explores the interrelation of conceptual, linguistic and visual metaphor in engineering as the research done in a bilingual terminological semantic study on science and technology metaphors shows (Cuadrado et al., 2015). Scientific and technical terms were analysed from dictionaries, databases and research papers by selecting those with a metaphorical basis; then, they were classified according to the type of metaphor they embody, establishing the conceptual metaphors underlying the metaphorical expressions, and the image schemas involved in the visual metaphors.

Keywords: Conceptual metaphor; linguistic metaphor; metaphor; multimodal metaphor in technical discourse.

1. Introduction

Cognitive linguistics claims that human thought and language are grounded in world experience and world interaction, accordingly discourse is a product of cognition and of social interaction. In recent times, the application of a cognitive approach to engineering communication has led to identify metaphoric and metonymic frames characterizing engineering discourse (e.g. Robisco and Cuadrado, 2013, in aeronautical engineering, Roldán-Riejos
and Úbeda-Mansilla 2006; 2013, in CE and architecture; Cuadrado et al., 2015, in a variety of engineering branches). This paper provides an analytical overview of the ongoing research project work: “Elaborating a Polytechnical Bilingual Dictionary of Metaphors: Spanish-English/English-Spanish” done by the UPM research group “DISCYT” (Estudios Cognitivos del Discurso Científico y Técnico). A detailed explanation of the method followed to identify key metaphors belonging to different technical areas is carried out below. Although the final study includes conceptual, linguistic and visual metaphors of over 10 scientific and technical areas (Aeronautical engineering, Agronomy, Architecture, Biotechnology, Civil engineering, Geology and Mining, Mechanical engineering, Nanotechnology, Naval and Maritime engineering, Sports and Telecommunications), in this paper we focus on the study of examples taken from civil engineering, agricultural engineering and industrial engineering. Forceville (2010:61) proposes three broad criteria to identify multimodal metaphor: (1) “An identity relation between two phenomena belonging to different categories. (2) The two phenomena understood as target and source respectively and are not contextually reversible. (3) At least one characteristic associated with the source domain is to be mapped on to the target domain”. Accordingly, this paper analyses the target and source phenomena identified as multimodal metaphor taken from the Bilingual Dictionary of Scientific and Technical Metaphors and Metonymies (Spanish-English/English-Spanish) Visuals are a powerful mode of communication in engineering and architecture (Roldán-Riejos and Úbeda-Mansilla, 2013). Representative cases are analysed from several points of view: multimodal (verbal and visual) metaphor, discourse analysis and translation into target language, highlighting cross linguistic variations between Spanish and English. Finally, some conclusions about the uses and possibilities of this type of study are developed.

2. Theoretical Framework

In physics, Ungerer and Schmid (1996: 149) discuss on the constitutive vs. explanatory role of metaphorical mappings in the conceptual metaphor THE ATOM IS A (MINIATURE) SOLAR SYSTEM as well as in computing science A COMPUTER VIRUS IS A BIOLOGICAL VIRUS. They conclude that labeling scientific or technological metaphor as constitutive (i.e. inherent to the expertise it expresses) or explanatory (i.e. illustrative for non-experts) is not apparent and depends on usage. For example, in the case of physics, the metaphor turns out to be constitutive to scientific theory and at the same time explanatory to non-specialists. In computing, the mapping can be taken as explanatory for the lay computer user but also constitutive because of the usefulness of the biological mapping to frame new concepts concerning the machine malfunction. During engineering training, the use of metaphors becomes gradually entrenched and therefore ends up being both constitutive and explanatory for the expert. This paper puts forward the ins and outs of a lexical and semantic study on scientific and technological metaphors and their terminological correspondences in English and Spanish. The theoretical approach adopted is Cognitive Linguistics, namely the Conceptual Theory of Metaphor (Lakoff, 1993) as well as Multimodal Metaphor (Forceville, 2009, 2010). It focuses not only on word level, but on the mental operations and structures involved in the construction of specific scientific and technical language. Thus, through an exploration that takes into account the diachronic and synchronic dimensions of language, this paper delves into terminological metaphors in both English and Spanish extracted from databases and specialized dictionaries. We illustrate some of the mappings and corresponding terms ultimately attempting to show their relations to cognitive and visual patterns common in engineering practice. For example, the general mapping ENGINEERING STRUCTURES ARE HUMAN BEINGS can give rise to submappings related to the subsequent behavior, problems and remedies affecting building structures (ENGINEERING TECHNIQUES ARE MEDICAL TECHNIQUES/ENGINEERS ARE DOCTORS). These analogies develop into a prolific lexical source for civil engineering (CE) vocabulary. Accordingly, the therapeutic mapping becomes an important metaphorical sub-mapping emerging from these conceptualizations, very rich in lexical production as in fatigue, pathology, stress, strain, collapse, etc. and their counterparts in Spanish: “patología”, “fatiga”, “fisura”, “fractura”, “colapso”. Other major source domains for CE mappings turn out to be: human anatomy, medicine, zoology, sociology (collective behavior), and also cooking (Roldán-Riejos and Molina 2015). Rather than shaping technical discourse, such mappings somehow motivate it (Caballero, 2014).

Metaphorical expressions are described as the linguistic expressions of conceptual metaphors, while image metaphors are defined as metaphors resulting from the mapping of an image schema from a source domain onto the image schema from a target domain (Lakoff, 1987). Our brain uses the internal structure of the mental images in
mapping one image onto another. This mapping is only possible when both images are structured in terms of a general shape of the same sort; for this reason this shape must be represented in a flexible manner to fit in an image mapping. According to Lakoff (1987), it is more topological than picture-like, in the sense of generalizing over specific geometric shapes. However, the concept of image metaphor adopted in this study differs with Lakoff’s one-shot mappings in some important ways: firstly, they are conventionalized, and secondly, they can generate more metaphors or be semantically related to other metaphors. They can also be mapped as metaphor-metonymies being both figures often interlinked in a continuum.

Our analysis looks into the most imaginative image metaphors and the most outstanding and consistent conceptual metaphors from the point of view of its lexical productivity within the areas studied. Examples of the conceptual metaphors established in this study are «CIVIL ENGINEERING TECHNIQUES ARE MEDICAL TECHNIQUES>>, «ROCKS ARE SOCIAL ENTITIES>>, «THE BUILDING IS A FLEET OF SHIPS>>, or «SPORT TECHNIQUE IS WAR STRATEGY>>. Examples of the image metaphors and metonymies found are “tree structure”, in computer programming, “teeth” in machinery, or “crown” in botany. Since non verbal and image metaphors are considered as structure mappings at the conceptual level, special attention is paid to their interaction with conceptual metaphors. This study contributes to support the hypothesis of the metaphor-based scientific and technical communication, and especially of the importance of the role of imagination and mental imagery in the construction of meaning in this field.

3. Methodology

Drawing from recognized empirical methods (Pragglejaz Group, 2007; Cameron, 2008; Steen, 2007), the examples were examined according to the main tenets of conceptual metaphor and conceptual integration theory (Deignan, 2005; Gibbs 2008, Lakoff, 1993; Lakoff and Johnson, 1999; Steen 2007; Fauconnier and Turner, 2008).

In addition to previous known metaphor identification methods (e.g. The Metaphor Analysis Project, Pragglejaz Group, 2007), our approach is based on frequency use, contextual clues and specialised and general dictionaries. For practical reasons, we started by structuring the diverse metaphorical cases gathered and subsequently homogenized them into a common system for all disciplines.

The first step in this study was to take the decision about whether a specific term conveys or does not convey a metaphorical meaning. This procedure involved the following stages:

a. Hand searching of metaphorical terms in specialized dictionaries based on informed intuition. In this process, a first selection was made including those words clearly being concerned with common objects, parts of the human body, names of animals, etc, applied to concepts of science and technology.

b. Definition and decomposition of the metaphorical terms into their semantic components to:

- Determine the literal meaning (or meanings) of the word in non-scientific language.
- Determine the meaning in the area of science and technology. Categorizing and sub-categorizing the word in the specific field it belongs was essential to know to what extent the term was metaphorical, since it provided the information about specialized knowledge.
- Contrast the specific scientific and technical meaning and the basic meaning of the term in general language, and finally,
- Decide whether the scientific meaning provides more information than the basic meaning, and whether the term cannot be completely understood if only the general meaning is applied.

c. Etymological analysis: The final principle we adopted to base our claim for the categorization of a term as a lexicalized metaphor was the analysis of the word origin, thus avoiding a possible over-interpretation of the data as metaphors when they were not. This made it possible preventing “Metaphors’ false friend” from occurring. For example, the word ear (“espiga”) in agronomy could be considered to be a metaphor originated in the parts of the human body. However, this word comes from éar (Latin acus, meaning husk of corn), and nor from éare (Latin auris, meaning “the organ of hearing in humans and animals”). A diachronic approach is especially relevant in the oldest areas of science and technology, since frequently they are not based on metaphors but a source of metaphors, as in the case of culture.
3.1. Description of the referential corpus used in the hand searching:

At a first stage, different technical dictionaries were surveyed in order to select all those terms in which metaphor may be involved. This search was completed with Electronic dictionaries on the web, mostly corpus-based. All the terms selected from the technical dictionaries analysed constitute technical or sub-technical vocabulary, i.e. they appear systematically in this specialised language and in all of them metaphor is involved in their formation.

The corpus was extracted from the best known dictionaries on the web (http://diccionario.raing.es/, edited by Real Academia de Ingeniería, and http://www.fao.org/faoterm/en/, among others) as well as on paper sources. The scientific and technical paper updated dictionaries that were surveyed and consulted to translate and compare meaning are the following:


Finally, some of the monolingual general dictionaries consulted are The Oxford English Dictionary (1989), Diccionario de la Real Academia de la Lengua (2001, 2014), and Collins English Dictionary (2006), which have helped to clarify the metaphorical meaning of the terms studied and provided additional entries of scientific and technical terms.

4. Analysis and results

In the quantitative study, we analysed over 150,000 terms, more than 10,000 of which were found to have a clear metaphorical basis. These terminological metaphors are the result of either metaphorical expression or of image metaphors.

4.1. Metonymic examples

In metonymy there is only one mapping, instead of two, typical of metaphor, and various relations can be established. For example, Sp. testigo (literal English: “witness”; technical English: “core boring”) in figure 1, refers to a piece of extracted material to be tested and to draw conclusions about it. Its meaning implies a CAUSE/RESULT relation, since a piece of material is examined to take a certain decision.

Another metonymic example is illustrated by figure 2: Sp. capa de rodadura (literal English: “rolling coat”; technical English: “wearing course”) referred to the pavement layer most affected by traffic, where the relation is PART/WHOLE, since this part stands for the whole road.

Metaphorical expressions are described as the linguistic expressions of conceptual metaphors. Some examples of metaphorical terms involved in the conceptual metaphor <<SOIL IS A LIVING ORGANISM>> (<<EL SUELO ES UN ORGANISMO VIVO>>) are soil age, soil fertility, mature soils, immature soils, young soils, old soils and soil skeleton, that refers to the physical structure of mineral soils.

Soil is defined as the upper layers of unconsolidated rock material and decaying organic matter at the surface of the earth. In spite of not being a living organism properly, we can talk of soil fertility, which refers to its nutrient supplying properties which enhance plant growth. Thus, we can also refer to soil age, age defined as the lifetime, the period of existence, or the time that any person, animal or vegetable has lived. Soil age can be observed in its profile or cross-section. The cross-section of soil is composed of horizons or layers that contain soils of different ages and composition. Although the age of soil cannot be exactly measured, it can be more or less established by the amount of weathering that it has been exposed to, or, by determining to what extent the parent material from which it is originated has been converted to horizons. Thus, older soils present more and thicker horizons than younger soils. An old soil is formed by horizons that are more different from each other than horizons from young soils. For soils, as for persons, there are also ways to determine their lifetime in terms of maturity. Accordingly, soils are classified into mature soils, immature soils, young soils and old soils.


Image metaphors are defined as metaphors resulting from the mapping of an image schema from a source domain onto the image schema from a target domain (Lakoff, 1987). They are abundantly used in science and technology. Our brain uses the internal structure of the mental images in mapping one image onto another. This mapping is only possible when both images are structured in terms of a general shape of the same sort; for this reason this shape must be represented in a flexible manner to fit in an image mapping. According to Lakoff (1987), it is a more topological than picture-like, in the sense of generalizing over specific geometric shapes. However, the concept of image metaphor adopted in this study differs with Lakoff’s one-shot mappings in some important ways: firstly, they are conventionalized, and secondly, they can generate more metaphors or be semantically related to other metaphors. They can also be mapped as metaphor-metonymies being both figures often interlinked in a continuum. Thus, soil horizon constitutes a metonymy derived from the concept of horizontal.
Examples of the image metaphors and metonymies found in the corpus are “tree structure” (estructura en árbol), in computer programming, “teeth” (dientes) in machinery (see figure 3), or “root hairs” (pelos radiculares) and “crown” (corona) in botany, that refers to the totality of the plant's aboveground parts, including stems, leaves, and reproductive structures.

![Figure 3. Example of image metaphor. Teeth (dientes). Source: http://www.weiku.com/products/14333166/Standard_diameter_straight_teeth_machinery_spur_gear.html.](image)

5. Conclusion

This study proves that engineering discourse is highly metaphoric and borrows from multiple metaphoric domains other than the typical engineering jargon. This paper has established the interrelation of conceptual, linguistic and visual metaphor. Given that metaphor is a cognitive mechanism that operates dynamically, we have found diverse layers of metaphorization. Thus, port, plant, bridge, are polysemous words that depending on the context can appear in different strata of metaphorization.

Metaphor has a multimodal nature and therefore can appear in different scenarios activating various perception codes. This applies to conceptual, linguistic, or visual metaphor (Forceville, 2010). To illustrate such representations, we have established the typology of “image metaphor” that basically triggers a visual image rather than the semantic network typical of conceptual metaphor. On the one hand, verbal metaphors can be image metaphors triggering mental images, and on the other, images presuppose a lexical counterpart.

Visual metaphor/metonymy has been found to be one of the main modes of communication in technical discourse sometimes overlapping with lexical metaphor. Metonymy is used with metaphor or alone, often with a strong visual dimension.

Finally, metaphor is a cultural phenomenon and as such it has to be accommodated according to the language. For example, we have observed no systematic linguistic correspondence of Spanish into English or vice versa. The nature of mappings does fluctuate and metaphorical realizations in one language could be metonymic or plainly literal in the other.

References

Forceville, Ch. (2009). Non-verbal and multimodal metaphor in a cognitivist framework: Agendas for research. In Forceville and Urios-Aparisi...


