META-CITEC: a cognitive semantic database of conceptual metaphor in science and technology

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ABSTRACT
This paper describes the online database META-CITEC, which develops a cognitive semantic analysis of metaphorical expressions and conceptual mappings in science and technology. This work is grounded on Cognitive Linguistics and the Conceptual Theory of Metaphor (Lakoff and Johnson, 1980, 1993), which studies mental operations and structures involved in language, meaning and reason. Although Cognitive Theory of Metaphor has already been applied to scientific language in different works (Boyd 1993, Knudsen 2003), more studies need to be conducted to establish the complex interactions within metaphorical networks in this field. The building process of METACITEC has been carried out in three phases: firstly, scientific and technical terms have been analysed from different reliable databases and sources by selecting those with a clear metaphorical word-building; next, the most frequent sub-technical terms have been searched by means of the “Wordsmith” programme; finally, metaphorical terms have been categorised into the scientific databank according to the conceptual metaphors they manifest, establishing the source domains and the target domains, as well as the networks involved. The results of this paper shed light on the hypothesis of the metaphor-based conceptualization of scientific language, contributing to establish the role of metaphor in constructing new meaning within science and technology.

Introduction
The new electronic tool, META-CITEC consists of a cognitive semantic database containing both a dictionary of metaphorical terms and a glossary of conceptual metaphors providing the translation and definition of scientific and technical terms. Theoretically, this work is grounded on Cognitive Linguistics and the Conceptual Theory of Metaphor (Lakoff and Johnson, 1989, Lakoff 1993), which studies mental operations and structures involved in language, meaning and reason. Cognitive linguistics contributes to the study of language and mind with a theory of semantics which develops from three basic principles: Experiential Hypothesis (Johnson, 1987), the Cognitive Unconscious and the Theory of Metaphor (Lakoff and Johnson, 1980; 1999). The theory of metaphor explains the understanding of new areas or domains of experience through other more accessible domains, whilst cognitive theory—which studies mental operations and structures that are involved in language, meaning and reason—contributes with a theory of semantics which develops from basic level concepts, to image schemas and the operations used to manipulate them.

According to Lakoff and Johnson (1999), the three major findings of cognitive science are: (1) our mind is inherently embodied (Experiential Hypothesis); (2) thought is mostly unconscious and (3) abstract concepts are largely metaphorical. Today, it is generally accepted that these three findings can also be applied to scientific and technical language.

The Experiential Hypothesis (Johnson, 1987; 1997) is essential to understand the theory of metaphor. It assumes that meaning is grounded in and through our bodies, and much of our conceptual systems are either universal or widespread across languages and cultures. It maintains that central aspects of language arise from sensory, motor and other neural systems (Lakoff and Johnson, 1999). According to this theory, most abstract concepts are originated in pre-conceptual physical experiences. Johnson denominates them embodied schema or image schema (1987). The main pre-conceptual schemas (Lakoff, 1987: 267) are: the path schema, the container schema, the link schema, the force schema and the balance schema. Image schemas are one of the basic sources of metaphors (Ungerer and Schmid 1996). Thus, in Telecommunications, examples of metaphors based on pre-conceptual schemas are “high” and “low” applied to frequencies (originated in the up and down schema) whilst examples of metaphors based on basic physical experiences are “light is a pulse” and “light is absorbed”.

The Cognitive Unconscious theory is based on the assumption that most of our thought operates beneath the level of cognitive awareness. This explains the fact that, for many scientists and experts, most of the lexicalized metaphors analysed in this study are not considered as such.

With respect to the third assumption or principle of cognitive theory, that is, abstract concepts are largely metaphorical, this approach considers that metaphor and metonymy are two basic mechanisms for understanding and categorising the world, as well as an important and decisive tool in human capability of inferring and reasoning. It distinguishes three types of metaphors: conceptual metaphors, metaphorical expressions and image metaphors. Conceptual metaphors operate in our thought and can be defined as “a cross-domain mapping in the conceptual system” (Lakoff 1993: 203). Metaphorical expressions operate in our language and consist of particular words or phrases which can express a conceptual metaphor.
Finally, image metaphors map only one image onto another. This image is usually visual. An example of an image metaphor in science is “big bang”.

Several authors highlight the importance of metaphor as a constituent part of scientific discourse (Collin and Gentner, 1995; Duque García, 2000; Durán et al. 2005). Today, the cognitive theory of metaphor has been applied to the study of theory building in different scientific fields (Salager-Meyer 1990, in Medicine; White 1997; 2004, in Economy; Cuadrado and Berge 2005, in Physics; Roldán and Úbeda in Civil Engineering). However, although Cognitive Theory of Metaphor has been already applied to scientific language in different works (Boyd 1993, Knudsen 2003), there is a need to conduct more studies that allow to establish the complex interactions within metaphorical networks in this field. Therefore, we have developed META-CITEC, whose final purpose is to establish the role of metaphor in constructing new meaning within science and technology by determining the metaphorical mapping underlying this specific language, as well as to analyse the complex interactions within metaphorical networks found in this field.

Methodology and Description of the Corpus

The building of this electronic tool has been carried out into two different stages: (1) Creation of a bilingual dictionary of metaphorical terms; (2) Creation of a glossary of conceptual metaphors.

Creation of a bilingual dictionary of metaphorical terms:

At a first stage, different technical dictionaries were read and interpreted in order to select all these terms in which metaphor is involved. The corpus was selected from many sources and Electronic dictionaries on the web. 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. To identify the cases of technical metaphors, i.e. subject-specific language which probably may not be classified as metaphors by experts in the field, a thorough reading was carried out. All those entries involving a mapping of any sort were considered in the broadest sense as metaphors and, therefore, analysed and interpreted. First, the word was defined in general English and then, it was defined in the specific field of science and technology, thus establishing the conceptual mappings found. Then, data were annotated on various semantic levels: derivatives, compounds, related terms and type of metaphor. Finally, examples were provided to illustrate them.

With the purpose of contextualising the metaphorical terms, this research group is currently creating a corpus of relevant scientific and technical written texts containing more than 4 million words from the following scientific fields: telecommunications, agriculture, earth sciences, mining and aeronautics. Nowadays, corpus-based research has become one of the major paradigms in linguistics. Corpora not only make it possible to analyse the use of metaphorical terms within their own context, but also favour the identification of those semitechnical metaphors which are usually generated by other metaphors in real communication. Those terms will probably not be recorded in most specialized dictionaries. The analysis of the association of words and lexical constellations will provide basic information about the potential of metaphor to generate new metaphors and serve as a cognitive model in language and thought.

Creation of a glossary of conceptual metaphors:

The dictionary of metaphorical terms created by this project will provide the grounds to explore and determine the conceptual metaphors and mappings which give support to the language of science and technology. In this glossary, for a given metaphor, there is a page specifying the type of metaphor itself as well as the source domain, the target domain and the metaphorical terms involved in the conceptual metaphor. This analysis demonstrates that the metaphorical lexical units are not isolated and independent one from another but in many cases constitute connected complex semantic networks. Thus, in the field of telecommunications, words like circuit, pathways, routes, or channel are a part of the conceptual mapping: <TRANSFER OF INFORMATION IS TRANSPORT OF GOODS>.

Results and Discussion

The present version of METACITEC is expected to be launched publicly on the Web at the end of this year. In the run-up to the launch, this paper has discussed the linguistic approach to terminology proposed, introduced the corpus, focussing in particular on the cognitive approach research, and outlined the building up process of this Web application. METACITEC determines not only the translation and the definition of scientific and technical terms but it also establishes the metaphors underlying the conceptual systems analysed. Consequently, it also provides patterns to be used for the analysis and creation of new scientific and technical terms. The major contribution of this electronic tool is the creation of a bilingual new dictionary of lexical units which contains more than 3.000 metaphors related to the field of science and technology. This dictionary made it possible the elaboration of the glossary of the conceptual metaphors that draw upon a variety of basic conceptual domains, among which the land and sea transport of goods metaphors in the field of telecommunications was shown to illustrate the thesis that this view of science facilitates the cognitive handling and manipulating of scientific and technical concepts.

Conclusions

Research is in progress and final results are expected to confirm the theory that scientific metaphors are based
on human basic experiences, basic level categories and image schemas. It is also expected to show that conceptual metaphors provide mental models in science and technology, some of which have been developed to illustrate this thesis. As has been demonstrated, most of them are not independent, but constitute connected complex semantic networks. All this contributes to confirm the thesis that human reason is not purely literal, but largely imaginative and metaphorical.

References
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