MODELS IN SCIENCE AS METAPHORS OF THE WORLD AND OF THE HUMAN BODY.

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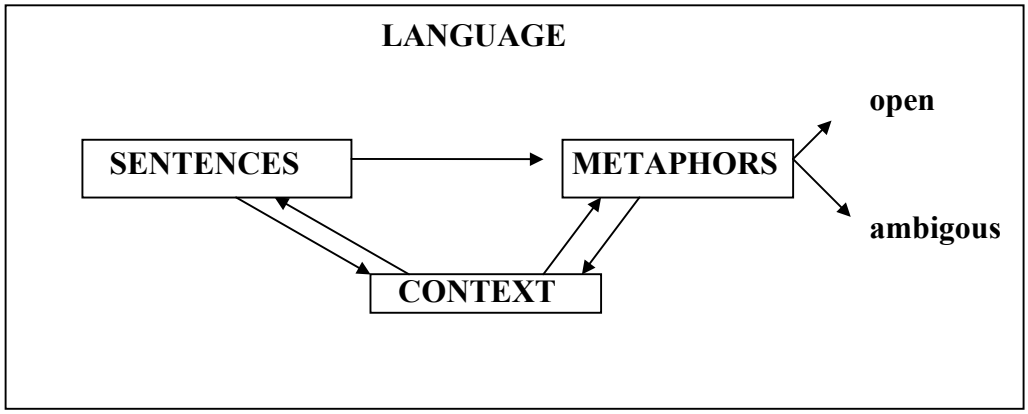
Abstract

During the last years many interesting suggestions have been developed in order to show the existence of a strict relation between the production of metaphors in communicative languages and the activity of modeling in science. This will be shown general epistemological considerations and an impressive example in mathematics. Finally we shall try to sketch the necessity of recognizing a biological origin of this activity. In this perspective, metaphorization and modeling activities are "strategies to survive" and not merely abstract conceptualizations.

The strange link between metaphors and models in science.

Many interesting books and papers have introduced this topic in the past years[1]. We have already treated this topic in a previous paper[2] published in the Proceedings of the Udine Girep and ICPE Conference in 1995. We refer the reader to this contribution for more details. In this paper we limit ourselves to explain the folowing summerizing scheme.



This structure shows that a specific language is full of sentences among which some are recognized as metaphors only by a context capable to understand them. The best metaphors are those which are full of ambiguity within a specific context and open to different contexts. After these short and even schematic considerations, we can now enter into the core of our epistemological reflections, that is the parallelism between metaphors in languages and models in science. Let's start simply making the following substitutions, inside the previous scheme on metaphors and language:

LANGUAGE ---------- > THEORY

SENTENCES --------- > SCIENTIFIC ASSERTIONS

METAPHORS --------- > MODELS

CONTEXT ---------- > SCIENTIFIC COMMUNITY

Of course it is obvious that this is only a rough starting point, because in our epistemological frame even a scientific theory, its principles and laws, and even its mathematical tools, can be interpreted as a sort of "big metaphor"[4]. But only to start, we can simply list what we consider the common properties between metaphors and scientific models:

1) Both metaphor and scientific model are powerful information compressors.
2) They both generate new meanings, new knowledge.
3) They lie.
4) As a metaphor makes semantic shifts and meaning substitutions (from the greek μεταφερειν), as a scientific model makes these shifts and substitutions from an empirical domain to another; both obtain this result under the interpretation of a context (the linguistic or the scientific community).
5) The metaphorical level can "freeze" and become literal: the metaphor becomes a *name;* the scientific model can "crystallize" and become a datum, an empirical fact, an *object*.

A metaphorical flight from physics to mathematics: an impressive example.

In order to enforce our arguments, we could analyze some historical cases coming from physics: for reasons of space, we are compelled to refer the reader to other papers[2,3]. In this one we limit to present a very interesting example, developed by Giuliano Ippoliti when he was a student of mine, in which a physical reasoning can obtain a famous mathematical result in a metaphorical way[5]. We think that this approach could have an important valence in mathematics and physics education, and the writer has seen this fact in many situations at school during past years. And here is the example. Let's consider the falling down of an object of mass m from a height h along two different paths: a vertical and a quarter of a circle of radius h (see fig.1).

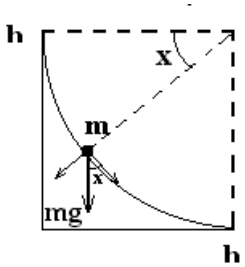
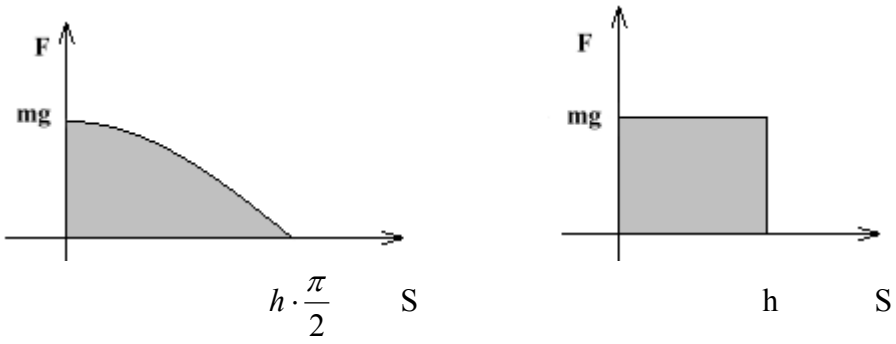
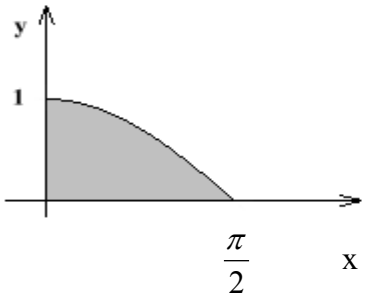


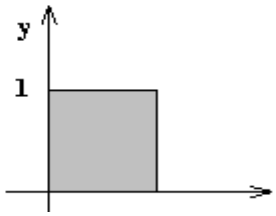
fig.1

From the conservativity of the gravitational field we know that the two works along the paths are equal. In the first case the effective force is the gravity mg, while in the second is mgcosx. Then, if we plot these two forces in function of the path, we obtain these graphics (fig.2 and 3).



Then if we choose in an appropriate way the units of measurement in a way such that mg = 1 and h = 1, then the two graphics become the following (fig.4 and 5).

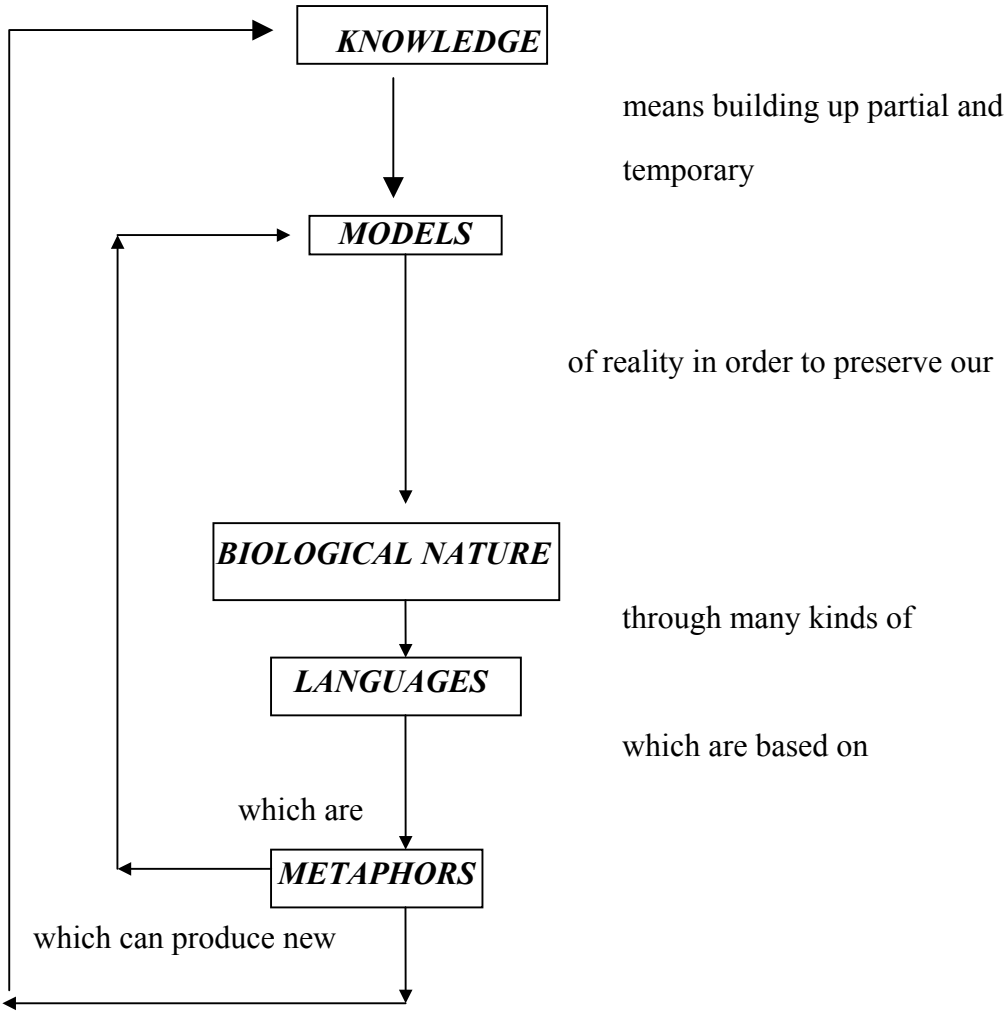




And remembering that the geometrical meaning of physical work is given by the area of these two figures, we obtain, in a pure metaphorical way, through a reasoning coming from physics, the well known mathematical result that the area of the function y = cosx in the interval considered is equal to 1.

Metaphor as a strategy to survive: the biological challenge.

In this final chapter we can only briefly sketch the core of our epistemological proposal, in which metaphors (and therefore, models in science) are not simply linguistic adornments but are mechanisms embodied in our biological structure, permitting us to have a powerful strategy of surviving. There are recent and convincing studies coming from neurosciences which can establish this point: for obvious reasons of space we cannot examine them and, as we have often made before, refer the reader to some important references[6]. We limit only to show an interesting scheme where all the most important concepts of our epistemological frame are summerized.



From this point of view, metaphors are not simply and only a pretty linguistic adornment, but, more fundamentally, a strategy through which a living system try to survive, managing in a easier way packets of informations rather than big bundles of them.

References.

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[2] F. de Stefano, "The idea of matter as a metaphor in scientific modelling, in *Teaching the Science of Condensed Matter and New Materials*, M.Michelini, ed., Forum, Udine (1996)

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[4]G.Lakoff and R.Nuñez, "Whrere Mathematics Comes From", Basic books, New York (2000)

[5] F. de Stefano, G. Ippoliti, "Metafora e dimostrazione matematica", in *Didattica nelle scienze e informatica nella scuola*, **211**, 15 (2001)
[6] A.Damasio, "Descartes' Error", Avon Books (1992); H.Maturana and F.J.Varela, "El Àrbol del Conocimiento", Debate (1984)