INFECTIOUS DISEASES ARE SLEEPING MONSTERS: Conventional and culturally adapted new metaphors in a corpus of abstracts on immunology[1]

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Abstract

In this paper we examine the role played by metaphor in a corpus of sixty abstracts on immunology from *Scientific American*. We focus on the distinction between conventional metaphors and culturally adapted new metaphors and discuss the role played by metaphor choice in the communicative purposes of the abstracts and their register features. We argue that one of the main strategies used to attract the reader's attention is the combination of highly conventionalized metaphors, which occur more frequently in the corpus, together with what we call "culturally adapted new metaphors", which display different degrees of creativity and are less frequent in the corpus. Conventional metaphors typically reinforce the world view shared by the scientific community and introduce basic ideas on the subject of immunology. Culturally adapted new metaphors include a cline from slightly new perspectives of conventional models, to highly creative uses of metaphor. Culturally adapted new metaphors appeal primarily to a general readership and not to the scientific community, as they tap human emotions and mythic constructions. These play a crucial role in the abstracts, as they contribute to persuasive and didactic communicative functions in the text.

Key words: abstract, immunology, culturally adapted metaphor, persuasion, corpus study.

Resumen

LAS ENFERMEDADES INFECCIOSAS SON MONSTRUOS DORMIDOS: Metáforas convencionales y metáforas culturales nuevas en un corpus de resúmenes de inmunología

En este artículo analizamos el papel desempeñado por la metáfora en un corpus

de sesenta resúmenes sobre inmunología publicados en la revista *Scientific American*. Nos proponemos estudiar la diferencia entre metáforas convencionales y metáforas nuevas adaptadas culturalmente y la relación entre la selección de diferentes tipos de metáforas y la función comunicativa que desempeñan en la caracterización de los rasgos concretos de registro de estos textos. Nuestro argumento principal es que una de las estrategias principales que se utiliza en estos textos para atraer la atención del lector es la combinación de metáforas muy convencionales, cuya frecuencia en el corpus es alta, junto con otras metáforas que definimos como "nuevas metáforas adaptadas culturalmente", en las que se pueden apreciar grados diferentes de creatividad y cuya frecuencia es menor en el corpus. Mientras que las metáforas convencionales refuerzan la visión del mundo de la comunidad científica e introducen ideas básicas sobre la inmunología, las metáforas nuevas adaptadas culturalmente están dirigidas a una audiencia general, reflejan la dimensión divulgativa de este tipo de texto y apelan a las emociones y los contenidos culturales míticos. Estas metáforas desempeñan una función crucial en los resúmenes, ya que contribuyen a la expresión de la función comunicativa de la persuasión.

Palabras clave: resúmenes, inmunología, metáfora adaptada culturalmente, persuasión, estudio de corpus.

1. Introduction

Metaphor plays a crucial role in scientific discourse, both as a constitutive instrument of new theoretical concepts and as a creative resource with a communicative and pedagogical purpose (Boyd, 1993; Charteris-Black, 2004; Parkinson & Adendorff, 2004; Reeves, 2005). Thus, Reeves (2005: 3) points out that:

> Metaphors are inescapable in science just as they are in everyday language. As human beings who must often draw from various domains of experience in order to make sense of new domains of experience, scientists are no different from the rest of us.

From a cognitive linguistics perspective metaphor provides us with powerful tools for understanding how scientists work out and communicate abstract ideas. Taking as a point of departure Lakoff and Johnson's (1980) and Lakoff and Turner's (1989) theory of conceptual metaphor, it can be said that the function of metaphor in scientific discourse is to facilitate –especially for non-scientists and science students– the understanding of

more abstract domains, such as time, state, causation, action, purpose and means, by using more familiar domains of experience, such as motion, entities and locations. According to Brown (2003: 12): "[Metaphor] helps to clarify the nature of scientific creativity and enables us to relate reasoning and communication in science to other domains of thought". This is achieved through the mapping of a source cognitive domain (e.g. BATTLE) onto a target cognitive domain (e.g. A DISEASE), which does not simply have influence on the way in which the latter is talked or thought about, but also on the way in which it is perceived, structured and experienced. The source domains in metaphors identified in abstracts on immunology mainly consist of the macroscopic entities, while the target domains consist of the generally microscopic elements which are under study.

At the same time, the metaphorical reasoning of scientific thought and imagination is constrained by one of the main characteristics of metaphor: the matching between domains is partial; therefore, it highlights certain aspects of the source domain and hides those which are not of the author's interest. Moreover, the inferences made by the reader depending on his or her background knowledge contribute to the power of metaphor. These implications make metaphor a creative force in scientific thinking.

In this paper we explore the role played by metaphor in a corpus of sixty abstracts on immunology from *Scientific American*. We set out from the basic assumption that scientific discourse not only provides a description of reality, but, more importantly, it constructs a world view of such a reality by providing a perspective on it. Furthermore, science as a field of study can be seen as a cultural system whose members share a set of common values and beliefs. Such constructed world views and shared systems of beliefs and values are reflected in the linguistic choices made by the writers and vary in time and across registers in order to adapt to changes in the social, cultural and political arenas. The field of study we have chosen within scientific discourse is the way in which scientists try to explain to a general public how the human immune system deals with disease. The text type we have chosen, the abstract in articles from *Scientific American*, a journal addressed to the general public, is particularly interesting for the analysis of the functions performed by metaphor. This is so because some of its main aims are to introduce in a clear and efficient way the main ideas of the article, and at the same time to persuade the reader and attract his/her attention. Thus, metaphors play an important communicative role in these (and other) scientific texts, since they provide the means of making accessible to non-

scientists and to students of science complex concepts by means of appealing to more familiar domains of experience (see, for example, Parkinson & Adendorff 2004). As Reeves (2005: 23) points out, metaphors "enable us to express the unknown or unseen via the known and the seen".

The present study draws from the insights of cognitive linguistics on the theory of metaphor, but follows an approach which is mostly discourse-pragmatic in nature, in that our main aim is that of exploring the communicative motivations for the choices of different types of metaphors in a specific corpus of scientific abstracts. Thus, we are interested in analysing how scientists use different types of metaphors to "bring science into familiar domains" (Reeves, 2005: 30) and how the choices of specific metaphors are connected to specific communicative functions.

2. Re-examining the role of metaphor in scientific discourse: a discourse-pragmatic approach

In this paper we take up some well-known approaches to metaphor in discourse (Werth, 1994 & 1999; Charteris-Black, 2004) in order to account for the communicative functions of metaphor in our corpus of scientific abstracts. Following Charteris-Black (2004) we focus on the pragmatic functions of metaphor in discourse, so that metaphors can be defined as follows:

> A metaphor is an incongruous linguistic representation that has the underlying purpose of influencing opinions and judgements by persuasion; this purpose is often covert and reflects speaker intentions within particular contexts of use. (Charteris-Black, 2004: 19)
>
> A metaphor is a linguistic representation that results from the shift in the use of a word or phrase from the context or domain in which it is expected to occur to another context or domain where it is not expected to occur, thereby causing semantic tension. (Charteris-Black, 2004: 19)

Bearing in mind these definitions of metaphor, we argue that the main communicative functions of metaphors in the abstracts of our corpus are, on the one hand to inform and reinforce the world view and the knowledge shared by the scientific community, and, on the other, to appeal to the non-specialist reader by means of creative metaphors which have a covert persuasive function.

Furthermore, the concepts of "incongruity" and "shift" in Charteris-Black's (2004: 19) definitions are central to a discourse-based view of metaphor, in that the degrees of incongruity and of distance between the domains that are linked account for the degree of creativity of specific occurrences of metaphorical expressions and for the differences in rhetorical and discourse function of the metaphors in the context of the register features of the text.

Our main objective in the present article is to re-examine the distinction between conventional and new metaphors in order to account for subtle differences which can be observed in the examples of new metaphors in our corpus and which account for the said different discourse functions of metaphor, the informative function and the persuasive function.

In our exploration of the various degrees of conventionality and newness of metaphors in the discourse of *Scientific American*, we draw from Boyd's (1993) distinction between "exegetical or pedagogical metaphors" and "theory constitutive metaphors". Boyd describes these two types of metaphors as follows:

> exegetical or pedagogical metaphors, play a role in the teaching or explication of theories which already admit of entirely adequate nonmetaphorical (or at any rate, less metaphorical) formulations (e.g. "electron cloud"). (Boyd, 1993: 485)

Theory constitutive metaphors, on the other hand

> constitute at least for a time, an irreplaceable part of the linguistic machinery of a scientific theory: cases in which there are metaphors which scientists use in expressing theoretical claims for which no adequate literal paraphrase is known. (Boyd, 1993: 486)

Constitutive metaphors have an important social and rhetorical function, in that when successful they become "the property of the entire scientific community, and variations on them are explored by hundreds of scientific authors without their interactive quality being lost" (Boyd, 1993: 487).

The pedagogical function of metaphor in scientific texts has been pointed out on numerous occasions (see, for example, Boyd, 1993; Brown, 2003; Parkinson & Adendorff, 2004; Reeves, 2005). As argued by Parkinson and Adendorff (2004) in their comparative study of academic and popularized science texts, popular scientific texts are useful for pedagogical purposes in that they make scientific texts more accessible to students and can be used

for the teaching of science and scientific writing. The language used in these texts is conceptually simpler than the language used in academic texts, which helps students understand complex scientific concepts. These scholars further point out that asking students "to 'translate' from popular to academic genres, and even frame their scientific ideas for a non-scientific audience is valuable to students in that it deepens knowledge of academic scientific register" (Parkinson & Adendorff, 2004: 394).

Our main argument in the present study is that metaphor contributes in a crucial way to these rhetorical-discursive functions, and thus plays a crucial role in the manifestation of the linguistic choices which characterise this writing as a text type with specific register features. We thus intend to distinguish, within the recurrent metaphors WAR, JOURNEY, PERSONIFICATION and REIFICATION, between conventional metaphors, which are used more frequently in the corpus and show a high degree of conventionalisation in the field of immunology (for example, A VIRUS IS AN AGGRESSOR, THE IMMUNE SYSTEM IS A PERSON, T CELLS ARE PROTECTORS) and culturally adapted new metaphors, which are less frequent in the corpus, indicate a shift in register use and show various degrees of conventionalisation and newness in the corpus (for example, A VIRUS IS AN INVADER, T CELLS ARE OFFICERS, INFECTIOUS DISEASES ARE SLEEPING MONSTERS).

If we compare the classification of metaphors we propose in the present paper with Boyd's categories of metaphor in science, it can be argued that our category of conventional metaphors includes numerous examples of Boyd's theory constitutive metaphors, that is, those metaphors which are used by scientists to express "theoretical claims for which no adequate literal paraphrase is known" (Boyd, 1993: 486).

Examples of this kind of metaphors are "programmed cell death" and "natural killer". Our category of culturally adapted new metaphors includes two types of metaphors which are not theory constitutive metaphors but include Boyd's (1993) exegetical or pedagogical metaphors. Within this category, we have thus identified, first, metaphors which provide a popularised version of a theory constitutive metaphor, such as for example, "cell suicide" instead of "programmed cell death" and "killer T cell" instead of "natural killer". Second, we have identified creative instances of metaphor use, such as A VACCINE IS THE MAGIC BULLET. In the former type of pedagogical metaphor, the content of theory constitutive

metaphors is rhetorically exploited in order to reactivate their content in new popularised expressions with a potential pedagogical function. However, in the latter, creative uses of metaphor are introduced, not necessarily for a pedagogical purpose but, rather, for a persuasive purpose. Both uses enhance the rhetorical colour of *Scientific American*.

3. Data and methodology

3.1 Data

The present study examines metaphors in a corpus of 60 abstracts from the on-line version of the journal *Scientific American*. The abstracts were selected by carrying out a search of the key words "immunology" and "immune system", in order to restrict the field of analysis of metaphors to the topic of immunology and immunology-related diseases. This means that the abstracts cover a wide range of subtopics dealing with recent discoveries and explanations of specific features of immunology. The abstracts can be grouped under three main sub-topics (1) the functioning of the immune system, in particular, the behaviour of T cells and related cells that play important roles in the immune system, (2) the defense of the immune system in specific diseases such as HIV, allergy, cancer or autoimmune diseases, and (3) the role and function of infectious agents in the process of disease. The abstracts cover a fifteen-year time span, from 1993 to 2008.

3.2 Methodology

In order to examine the metaphors in the corpus, we first identified the different instances and classified them according to the following categories:

a. Types of metaphors according to functionality and cognitive features: orientational, ontological and structural metaphors. For this distinction we have followed Lakoff and Johnson's (1980) original classification of metaphor types.

b. Types of metaphors according to conventionality: conventional metaphors and culturally adapted new metaphors.

c. Types of metaphors according to level of analysis in discourse: micro-metaphors (identification of source and target domains), and megametaphors, together with the process which gives rise to the realization of extended metaphors.

Once the metaphors were identified, we calculated the frequency of the types referred to above, with particular attention to the frequency of functional-cognitive types and the frequency of the two types of metaphors according to degree of conventionality. The approach thus draws partly from the resources of corpus linguistics in the identification and quantification of subcategories of metaphors, but is mainly a discourse-based approach, in that we are interested in exploring how the occurrence of metaphor types is related to their function in the abstracts.

3.3 Features of conventional and culturally adapted new metaphors

The main claim put forward in this paper, as pointed out before, is to propose a revision of the distinction between conventional and new metaphors, in order to account for different degrees of conventionality or newness.

In order to establish this distinction we have examined the following discourse dimensions of analysis of the metaphors in the corpus:

- The frequency of metaphor types according to conventionality in the corpus.
- The discourse level at which they occur.
- The expectation whether the metaphor will occur in a more specialised text or a less specialised text.
- The degree of creativity of the metaphors.

In order to confirm the expectation whether a metaphor could occur in a more specialised text or would only be expected in a text addressed to the general public, an informant test was carried out by a specialist in immunology.[2]

The test consisted in, for each metaphor, answering the question whether that expression could be expected to be used in a specialised publication in immunology.

Taking into account these dimensions, we argue that conventional and culturally adapted new metaphors can be distinguished as follows. The details of these differences are discussed in sections 5 and 6 as follows:

Discourse features of conventional and culturally adapted new metaphors:

1. With regard to the definition and identification of conventional metaphors:
   1.1. Conventional metaphors occur frequently in the corpus.
   1.2. Conventional metaphors occur both at the micro-propositional level and at the discourse level (as megametaphors in Werth's (1994 & 1999) terms or key metaphors in Charteris-Black's (2004) terms).
   1.3. Conventional metaphors do not signal a departure from prototypical generic and register features.
   1.4. Conventional metaphors are expected to occur both in specialised texts, such as Science, and in less specialised texts such as Scientific American.
   1.5. Conventional metaphors do not constitute instances of creative uses of language in that they form part of an expected, conventionalised register pattern.
2. With regard to the definition and identification of culturally adapted new metaphors:
   2.1. Culturally adapted metaphors occur less frequently in the corpus.
   2.2. Culturally adapted metaphors occur at the micro-propositional level.
   2.3. Culturally adapted metaphors introduce a register modification based on relevant socio-cultural experience.
   2.4. Culturally adapted metaphors are not expected to occur in specialised texts.
   2.5. Culturally adapted metaphors are instances of creative uses of language.

4. Results

Results of the search of metaphor types in the corpus are shown in tables 1 to 5 and figure 1. Table 1 shows the number and frequency of types of metaphor according to type of functionality. The distribution of the total number of metaphors is shown in A, while the distribution of different metaphors (omitting repeated instances) is shown in B. A total of 359 metaphors were identified. Of these, 5 are orientational metaphors (1.4%), 298 are ontological metaphors (82.8%) and 56 are structural metaphors (15.8%). The most frequent category is, by far, that of ontological metaphors, followed by structural metaphors and, finally, by orientational metaphors.

Type of metaphor by functionality								
	Orientational		Ontological		Structural		Total	
A. Total number	5	(1.4%)	298	(82.8%)	56	(15.8%)	359	(100%)
B. Different metaphors	5	(1.9%)	234	(88.6%)	25	(9.5%)	264	(100%)

Table 1. Types of metaphor by functionality.

Ontological metaphors include mostly PERSONIFICATION, CONTAINER and OBJECT metaphors. Structural metaphors include mostly JOURNEY and WAR metaphors. The five orientational metaphors we have identified are CONTROL IS UP, POWER IS UP, ILLNESS IS DOWN, EVOLUTION IS UP and GOOD IS UP.

Table 2 shows the number and frequency of the most frequent source domains. The most frequent source domain is WAR (83), followed by PERSON (79), JOURNEY (53) and OBJECT (37). Table 3 shows the number and frequency of the most frequent target domains. The most frequent target domain is the HUMAN BODY (101), followed by ILLNESS AND DISEASE (68), the IMMUNE SYSTEM (58) and EXTERNAL MICROORGANISMS (44).

Most frequent source domains								
	WAR		JOURNEY		PERSON		OBJECT	
A. Total occurrences	83	(23.1%)	53	(14.8%)	79	(22%)	37	(10.3%)
B. Different types	56	(21.2%)	19	(7.2%)	67	(5.4%)	32	(12.1%)

Table 2. Most frequent source domains.

Most frequent target domains								
	HUMAN BODY		ILLNESS & DISEASE		THE IMMUNE SYSTEM		EXTERNAL MICROORGANISMS	
A. Total occurrences	101	(8.1%)	68	(18.9%)	58	(16.1%)	44	(12.2%)
B. Different types	82	(31%)	46	(17.4%)	48	(18.1%)	26	(9.8%)

Table 3. Most frequent target domains.

Table 4 shows the number, frequency and distribution of metaphors according to degree of conventionality and newness. The most frequent category is that of conventional metaphor, with 239 occurrences, while 120 occurrences of culturally adapted new metaphors have been identified. No significant differences are observed with regard to the distribution of these two types when considering the presence of repeated instances of metaphors.

Type of metaphors by conventionality-newness					
	Conventional metaphor		Culturally adapted new metaphor		Total
A. Total occurrences	239	(66.6%)	120	(33.4%)	359 (100%)
B. Different metaphors	175	(66.2%)	89	(33.7%)	264 (100%)

Table 4. Types of metaphor by degree of conventionality vs. newness.

5. Discussion

In this section we discuss the results of the analysis of metaphor in our corpus of abstracts on immunology and we examine in detail the discourse features of conventional and culturally adapted new metaphors Thus, we analyse the discourse level at which they occur, their nature with regard to register features, especially the compatibility of the metaphor with a specialised register, and the degree of creativity of the metaphor. We also suggest how the two different types of metaphors co-occur in order to create extended metaphors and achieve two different communicative goals.

5.1. Choice and function of typical conventional metaphors

With regard to the difference between conventional and culturally adapted new metaphors, we have seen in section 4 above that conventional metaphors are twice as frequent in the corpus than culturally adapted new metaphors.

With regard to compatibility with specialised registers, conventional metaphors were identified by our informant as being possible in such registers. We argue that the function of conventional metaphors is, on the one hand, that of reinforcing the world view and knowledge of specialised

scientists, and, on the other, that of presenting as a background framework metaphorical mappings which are conventionalised in standard academic discourse. In this sense, the general function of these metaphors within this type of scientific discourse can be said to be mainly expository, though they also have a covert persuasive function in their appeal to specialised scientists and to a general academic audience.

Examples (1), (2) and (3) illustrate the use of conventional metaphors as specialised terms. These are examples of what are traditionally known as "constitutive" metaphors, in that the metaphorical expression is a key term in the theory which explains the given phenomenon.

(1) *CELL SUICIDE IN HEALTH AND DISEASE*
… the ability of individual cells *to self-destruct* when they become superfluous or disordered. This critical process, today called apoptosis, or *programmed cell death*, was overlooked for decades. (imm021)[3]

(2) CD4+ T cells fall into two different categories: *naive cells and memory cells*. (imm008)

(3) A second set, the *helper T cells* that seem to coordinate the immunologic assault, bears the protein CD4 instead. (imm031)

In example (1) we find the metaphors A CELL IS A LIVING ENTITY THAT COMMITS SUICIDE in the title of the article, and A CELL IS A MACHINE ("programmed cell death"). These metaphors provide interesting examples of the process by which a new metaphor is introduced in an academic field and is later substituted by the specialised term, in this case, "apoptosis". Thus, our informant explained that while the expression "cell suicide" was possibly used as a specialised term when the phenomenon was first discovered, at present, this phenomenon is referred to technically either by the term "apoptosis", or by the metaphorical expression "programmed cell death". Thus, the expression "cell suicide" has become informal and non-specialised. The self-destruction metaphor can be understood both in connection to the "suicide" metaphor and to the "programmed death metaphor".

In example (2) we observe another instance of metaphorical expressions which are conventionally used as specialised terms "naive cells and memory cells". These metaphors refer to whether the cell has had previous contact with an external microorganism or not. As we shall see, memory cells are also referred to in the abstracts in a non-specialised way as

"experienced cells". The expression "helper T cell" used in example (3) is also specialised.

Examples of highly conventionalised metaphors which form part of the specialised register of immunology are those in examples (4) to (10):

(4) We see all comers in the mid- Manhattan HIV clinic where I work, from healthy asymptomatic *carriers* of the virus to emaciated men and women suffering from the late *stages* of AIDS. (imm034)

(5) Drugs employing antibodies that *recognize* proteins found only on cancerous cells tend to *work* more effectively when paired with a second type of antibody that *targets* immune cells. (imm034)

(6) So far in the U.S. alone, AIDS has *killed* more than 350,000 people. (imm060)

(7) Yet at the same time, *this mechanism* creates a problem for the individual: some of the molecules to which the system can react are constituents of the body's normal tissues. Because such responses would be harmful, the immune system *must go through a series of modifications* that prevent self-destruction. This process is known as tolerance induction. (imm051)

(8) And destruction of CD4 cells *renders a patient vulnerable to unusual opportunistic infections* (OIs) that are rarely seen in healthy humans. Most patients who die from AIDS *succumb* to one or more OIs. (imm002)

(9) …the typically long *delay* between infection and *the onset of AIDS*. (imm040)

(10) … mutations in the gene that *codes* for emerin. (imm019)

In examples (4) to (10) we observe instances of PERSONIFICATION ("antibodies that recognize proteins", "AIDS has killed", "opportunistic infections") OBJECT ("carriers of the virus"), and MACHINE ("work more effectively", "go through a series of modifications") ontological metaphors, and of JOURNEY ("late stages of AIDS", "typically long delay between infection and onset of AIDS"), WAR ("antibody that targets immune cells", "renders a patient vulnerable") and LANGUAGE CODE ("the gene that codes") structural metaphors.

Numerous conventional metaphors identified in our abstracts are conventional metaphors which form part of standard academic discourse. In this sense, we find typical examples of PERSONIFICATION ("immunology embraces", "Immunologic research is pointing toward") and

REIFICATION or OBJECT ("to fit immunology into the classical paradigm") metaphors to refer to scientific research and theories, as in examples (11) and (12):

(11) Yet the field of immunology *embraces* more than just the nature and prevention of infections. Immunologic research *is pointing* toward new approaches for treating cancer and diseases that result from lapses or malfunctions in the immune response. (imm047)

(12) In that sense, it is easy *to fit immunology into* the classical paradigm of the unidirectionality of science, proceeding from the basic to the applied. (imm045)

Example (13) illustrates the use of the metaphor SCIENTIFIC RESEARCH IS A JOURNEY ("step by step"), in addition to other metaphors discussed above. Example (13) also provides an interesting example of the conventional use of a metaphor typical of academic writing in general terms, SCIENTIFIC THEORY IS A PAINTING ("depicted in broad brush strokes", "sketched out") in this particular register of immunology:

(13) *Depicted in broad brush strokes*, the HIV virus does its damage by killing vital immune cells, called CD4+ T cells. Now for the first time scientists have sketched out in much finer detail how this process occurs, *step by step*. (imm006)

We argue that these metaphors, because they have become conventionalized, do not constitute creative uses of language any longer. Because of their frequency and their relation to key underlying themes in immunological research, these metaphors occur both at the micro-propositional level and at the higher discourse level as key metaphors, as we shall show in section 5.3.

5.2. Choice and function of culturally adapted new metaphors

Within the category of culturally adapted new metaphors, we have distinguished two sub-types of metaphors depending on the following criteria: on the one hand, we have identified metaphors which seem to be instances of expressions which are becoming conventionalized for the specific register of texts such as *Scientific American*, in that they occur several times in the corpus and form part of conventional ontological and structural underlying key metaphors, such as PERSONIFICATION, OBJECT,

JOURNEY and WAR. These metaphors, however, are not expected in specialised texts, according to our informant. Such metaphors evoke socio-cultural information which is accessible from frame knowledge which introduces slight shifts in the register in order to adapt the concepts to specific socio-cultural situations which are either simpler or with which the general reader will be familiar. A typical and recurrent example of this kind of metaphor is the expression "killer T cell" in example (14):

(14) These *killer T cells* attack the rapidly dividing cells. (imm052)

This expression was initially used as a specialised term (for example, it can be found in publications of the 1980s) but is hardly used in this way in specialized publications. The corresponding specialised term is "natural killer" or the Latin term cytotoxic. Curiously, the specialised term "natural killer" –also metaphorical but completely conventionalized in present-day specialised discourse in immunology– does not occur in our corpus, while the expression "killer T cell" occurs several times to refer to a type of lymphocites. This seems to suggest that the expression "killer T cell" is favoured over the specialised term "natural killer" because the former may have a more informal, more affective connotation which triggers the persuasive and pedagogical functions rather than the merely informative one.

The second type of culturally adapted new metaphor we have identified is a type of metaphor which occurs only once in the corpus, is not expected in specialised publications, indicates a radical shift in the kind of socio-cultural knowledge that is evoked and shows a highly creative use of language. An example of this kind of metaphor is found in example (15) to refer to the treatment of a disease:

(15) (…) the monster was not *slain* but only *asleep*. (imm046)

In examples such as these, a completely different discourse register is drawn from (fairy tale stories) in order to describe an abstract or complex concept in a highly evaluative and subjective way. These metaphors tap our knowledge of myths and our feelings and emotions related to deeply ingrained cultural constructs.

We have found that the difference between culturally adapted new metaphors which are in the process of conventionalization for this register, such as A T CELL IS A KILLER, and highly creative new metaphors such

as AN INFECTIOUS DISEASE IS A SLEEPING MONSTER, is not a clear cut distinction, but rather it can be described as a cline from more conventional less creative instances to less conventional more creative instances. In between the two extremes there are numerous interesting examples of metaphors which draw from familiar source domains in the field of immunology, such as WAR, and introduce interesting variations according to recent socio-cultural experience. A good example of this kind of metaphor is the one found in example (16):

(16) Normally, the immune system is able *to distinguish friend from foe*, ignoring the body's own components and attacking *foreign invaders*. Unfortunately, the *immunologic weapons* can, *like friendly fire*, sometimes turn against the self, causing severe illness and even death. (imm029)

In example (16) we can observe the use of a variation of the WAR metaphor by evoking recent cultural knowledge on war, the concept of "friendly fire", which co-occurs with other WAR metaphors. This metaphor can be distinguished from culturally adapted metaphors which are on the more conventional end of the cline, such as "attacking", "immunologic weapons", "foreign invaders", also within the WAR overarching theme. In fact, these metaphors occur several times in the corpus.

Examples (17) and (18) illustrate further occurrences of culturally adapted new metaphors which may be classified as intermediate stages of creativity and departure from expected register features. Most of them introduce modifications at the micro-propositional level within common overarching themes, such as WAR and JOURNEY:

(17) NAIVE IMMUNE CELLS WITH *"FALSE MEMORIES" FIGHT LIKE OLD PROS*
T cells are the killers of the immune system, but like all *good soldiers*, they need experience before they can perform effectively. Indeed, T cells that have *fought* a particular infection before are much better than their *inexperienced counterparts* at clearing it from the body. (…) Researchers have discovered that some seemingly naive T cells are just as effective against infection as their *experienced brethren*. (imm009)

(18) RETROVIRUSES CROSS LITTLE BRIDGES TO INFECT NEW CELLS
MOVING ON UP: Yale researchers, using electron microscopy, have visualized viruses *traveling* from infected cells to healthy counterparts *via*

> *tiny bridges* (…) Previous studies found that viruses are *ferried* from infected to healthy cells by dendritic cells, which are cells that can transport germs without becoming infected themselves (…) Infected cells draw the filopodia in and actually suck in the tips of the filaments. Then, according to Mothes, "*viruses 'surf'* along filopodia to efficiently infect cells by using the underlying retrograde flow of action". (imm005)

Thus, example (17) illustrates the use of very specific metaphorical mappings within the WAR metaphor, which include the PERSONIFICATION of the immune system cells as "good soldiers". Example (18) shows variations of the JOURNEY metaphor with adaptations to specific socio-cultural knowledge, such as "bridges", "ferries" and "surfing".

Example (19) illustrates an interesting case, in which a complex abstract source domain, ICT technologies and INFORMATION metaphor, is used to make sense of a complex target domain, how immune response takes place. The fact that an abstract domain is used to make another abstract domain familiar can be explained because the field of ICT technologies, although abstract and complex is much more familiar to the general reader than the specific process involved in immune response.

(19) Cellular ZIP Codes

> Now new research, reported today in the *Proceedings of the National Academy of Sciences,* reveals that *just as ZIP codes direct mail to particular communities, special molecules that sit on cell surfaces guide the cells through the bloodstream to their tissue destinations*. (imm016)

In this example we find the metaphors MOLECULES ARE ZIP CODES, CELLS ARE MAIL and TISSUES ARE COMMUNITIES.

Some of the culturally adapted new metaphors which can be found half way on the creativity and unexpectedness cline are metaphors which use expressions which are typically more informal and colloquial than the language that characterises more specialised texts on immunology. A good example is illustrated in example (20):

(20) HIV Attacks Both Experienced and Naive T Cells

> In response to HIV infection, the body *deploys troops of combatants* known as CD4+ T cells to carry out *a counter attack*. Somewhere down the line,

> however, *HIV gains the upper hand*, dismantling the T-cell system and leaving the body defenseless against the opportunistic infections that characterize AIDS. Exactly *how HIV brings the immune system to its knees* has been the focus of much research. (imm008)

In example (20) we find informal idiomatic expressions such as "gains the upper hand" and "brings the immune system to its knees", within the general frame of the WAR metaphor. A further interesting feature of this extract is the co-occurrence of the specialised conventional metaphor "naïve T cells" together with the non-conventional expression "experienced T cells".

Finally, we have identified a few very creative instances of metaphorical expression, which involve the use of metaphors which draw from source domains which constitute radical departures from the typical expected themes of immunology. These examples of new metaphors are listed in examples (21) to (24). All of them are ontological metaphors involving PERSONIFICATION or OBJECT metaphors. The metaphor heads each of the extracts:

(22) THE IMMUNE SYSTEM IS AN ALCHEMIST'S DREAM
> *The immune system is an alchemist's dream*. Its multifaceted methods of attacking such intruders as bacteria or viruses offer researchers an abundance of compounds and molecular strategies that can extend the scope of medical intervention. Using our knowledge of the immune system, we can strengthen its response to a given antigen, direct it to combat an overlooked foe or, in cases of organ rejection, forestall misguided attacks. When successful, these attempts give rise to *a kind of gold* in therapies to prevent and to treat disease. (imm054)

(22) THE EARLY IMMUNE SYSTEM IS AN EARLY VINTAGE WINE
> More than 500 million years ago a set of specialized enzymes and proteins evolved to defend our primitive ancestors against assaults from the outside world. If a microbe breached the shell of some Cambrianera fauna, the members of *this early vintage immune system* would stage a savage but coordinated attack on these interlopers. (imm025)

(23) INFECTIOUS DISEASES ARE SLEEPING MONSTERS
> Throughout the world infectious diseases have always been the leading cause of human death. Malaria, tuberculosis, infectious diarrhea and many other illnesses still exact an awful toll in suffering and mortality, particularly in the developing world. For a time, it was widely assumed that infectious diseases had been brought under control in at least the

industrialized nations. Yet the appearance of AIDS and the recent resurgence of tuberculosis, including the evolution of strains resistant to many drugs, vividly illustrate that *the monster was not slain but merely asleep*. (imm046)

(24) A VACCINE IS THE MAGIC BULLET
What they‘ve been looking for, for nearly 20 years, has been a quick kill – *the ‘magic bullet‘* that‘s going to provide a stable vaccine for malaria, says John B. Dame, an associate professor in the department of infectious diseases at the University of Florida. (imm030)

5.3. Extended metaphors, megametaphors and the interplay between conventional and culturally adapted and new metaphors

To end this discussion, we wish to illustrate the discourse structuring of extended metaphors and the relations between micro-propositional conventional and culturally adapted new metaphors. Figures 1 and 2 illustrate how the megametaphors THE RELATIONSHIP BETWEEN THE HUMAN BEINGS AND MICROBIAL WORLD IS WAR and DISEASE IS A JOURNEY are structured.

In Figure 1, we observe how the WAR megametaphor takes place by means of a combination of conventional metaphors (FIGHTING OFF A DISEASE IS A BATTLE, BACTERIA ARE DANGEROUS ENEMIES, IMMUNOTHERAPY IS A WEAPON), culturally adapted metaphors (AUTOIMMUNE DISEASE IS FRIENDLY FIRE, A VIRUS IS A CULPRIT, BACTERIA ARE OVERLOOKED FOES) and culturally adapted new metaphors (A VACCINE IS THE MAGIC BULLET).

Figure 2 shows a similar structure for the megametaphor A DISEASE IS A JOURNEY, with conventional metaphors such as SCIENTIFIC RESEARCH IS A JOURNEY, THERAPY IS A DESTINATION and EVOLUTION IS A JOURNEY, culturally adapted metaphors such as THE HIV VIRUS IS A FERRY PASSENGER, HIV INFECTION IS A FERRY TRIP and T CELLS ARE HIV'S HIDING PLACE and culturally adapted new metaphors (A VIRUS IS A SURFER).

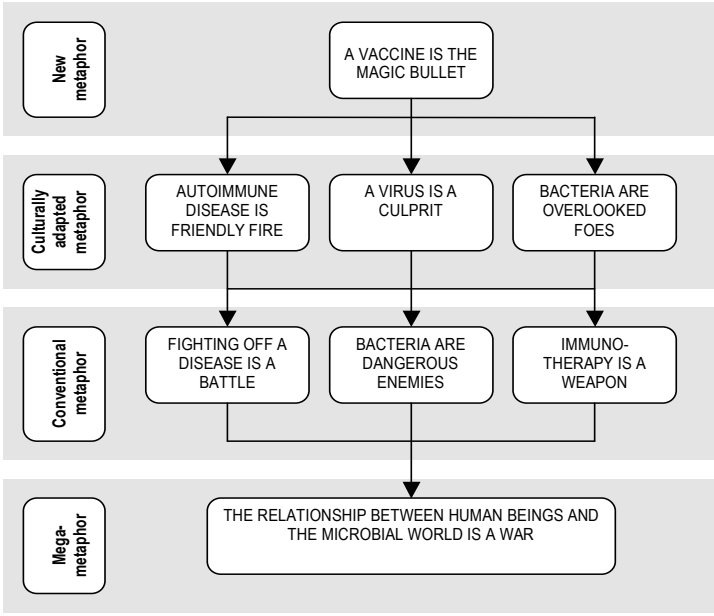

Figure 1. THE RELATIONSHIP BETWEEN HUMAN BEINGS AND MICROBIAL WORLD IS A WAR extended metaphor structure – an idealized view.

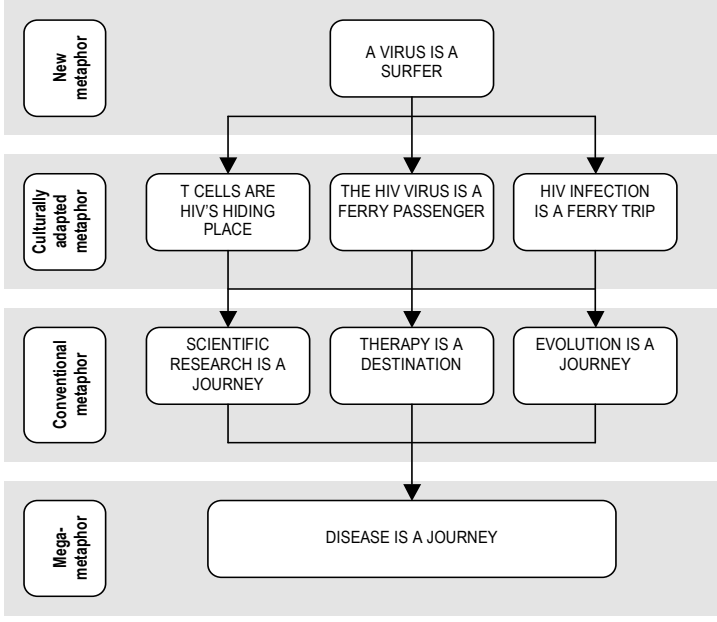

Figure 2. DISEASE IS A JOURNEY extended metaphor structure – an idealized view.

6. Conclusion

In this paper we have examined the metaphors in a corpus of abstracts on immunology and have proposed a revision of the distinction between conventional and new metaphors. Thus, we have argued that abstracts on immunology addressed to the general public, such as those examined in *Scientific American*, characteristically display a combination of two main types of metaphors according to degree of conventionality, but that the less conventional metaphors also show a cline in newness, unexpectedness and creativity. While standard conventional metaphors such as VIRUSES ARE AGGRESSORS, THE IMMUNE SYSTEM IS A MACHINE, SCIENTIFIC RESEARCH IS A JOURNEY occur more frequently in the corpus and are expected in more specialised registers as well as in *Scientific American*, what we have defined as "culturally adapted new metaphors" occur less frequently in the corpus and would not be expected in a more specialised publication. However, we have noticed differences in degrees of newness and creativity between metaphors such as A T CELL IS A KILLER, AN EXTERNAL MICROORGANISM IS AN INVADER, which seem to be conventionalized for this register, and other more creative metaphors which occur only once, such as INFECTIOUS DISEASES ARE SLEEPING MONSTERS, which evokes, through PERSONIFICATION, a very different register as a source domain for the metaphor.

Finally, we have argued that the different types of metaphors perform different discourse functions in the abstracts. Thus conventional metaphors perform an overt expository function and a covert persuasive function directed at specialised readers, while culturally adapted new metaphors are much more evaluative and affect-loaded and have an overt expository and covert persuasive function directed at the non-specialist reader.

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NOTES

[1] The research carried out for this paper is part of a research project financed by UAM-CAM for the year 2008 (CCG07-UAM/HUM-1829).

[2] Our informant is a PhD. in Biochemistry by the Universidad Complutense de Madrid (his thesis is entitled *T-cell receptor usage in pathologic processes*, year 2000). He has worked in immunology related diseases from 1993 to 2003. From 2003 to 2006, he has worked on the tridimensional structure of allergens. His level of English is intermediate, with a good understanding of specialised academic discourse in English. We wish to express our thanks to the informant for his invaluable collaboration.

[3] The code number used in each example indicates the topic (immunology) and the number of abstract in the corpus. Thus "imm001" stands for abstract 1 in the corpus of abstracts of immunology.