

Is This a Metaphor? On the Difficult Task of Identifying Metaphors in Scientific Discourse

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ABSTRACT: This article focuses on the problem of metaphor identification in scientific language. In Conceptual Metaphor Theory, metaphors are often observed on the conceptual level. As in this framework there is no genuine linguistic definition of metaphor, problems occur in empirical work where metaphor identification in texts is required. Although there seems to be considerable agreement in intuitive judgements, most empirical work lacks a method which produces transparent and repeatable data. I will argue that a mixture of two possible identification strategies is often used intuitively: the “truth approach”, which marks as metaphorical expressions that are not actually true, and the “meaning approach” that takes the difference between primary and secondary meaning into account. While these intuitive identification strategies might be useful in some discourses, serious problems occur when metaphors have to be identified in scientific language. This is because in scientific theories “truth” is not easily identified and the meaning of a scientific term is sometimes not obvious. I argue for a methodological clear-cut distinction of the two possible approaches to metaphor identification, and for a careful reflection of the possible consequences of the different identification strategies.

Keywords: discourse analysis, metaphor identification, methodology, scientific language.

RESUMEN: Este artículo se centra en el problema de la identificación de la metáfora en el lenguaje científico. En la teoría conceptual de la metáfora, las metáforas se observan a menudo en el nivel conceptual. Como en este marco no hay definición lingüística genuina de la metáfora, surgen problemas en el trabajo empírico donde se requiere la identificación de la metáfora. Aunque parece haber acuerdo considerable en cuanto a los juicios intuitivos, el trabajo empírico carece de un método que produzca datos transparentes y repetibles. Discutiré que una mezcla de dos estrategias posibles de identificación esté utilizada de modo intuitivo: el «enfoque de la verdad», que marca como expresiones metafóricas las que no son verdad, y el «enfoque del significado» que considera la diferencia entre el significado primario y secundario. Aunque estas estrategias intuitivas pueden ser útiles en algunos discursos, los problemas serios ocurren cuando las metáforas tienen que ser identificadas en el lenguaje científico. Esto es porque en las teorías científicas lo «verdadero» no se identifica fácilmente y el significado de un término científico a veces no es obvio. Propongo una distinción metodológica neta de los dos enfoques posibles para la identificación de la

metáfora, así como una reflexión de las consecuencias posibles de las diversas estrategias de identificación.

Palabras claves: análisis del discurso, identificación de la metáfora, metodología, lenguaje científico.

1. Introduction

How can metaphors be identified in discourse? In the long history of metaphor research this problem was often neglected, partly due to the fact that most metaphor theories focused on easily identified creative metaphors. Conventionalized metaphors – which people are often not aware of – became of interest for cognitive linguists since Lakoff; Johnson's (1980) claim that metaphors are ubiquitous in language and thought. Lakoff; Johnson's groundbreaking work, however, relies on linguistic examples that have been made up or more or less coincidentally collected. The importance of more systematic empirical work – of using corpora to make more valid claims on the frequency and systematic nature of certain metaphors and therefore give Conceptual Metaphor Theory an empirical basis – has been pointed out by various scholars (Steen 1999 *a*, 1999 *b*, 2002 *a*, 2002 *b*; Deignan 1999, 2005; Charteris-Black, 2004; Semino *et al.*, 2004, Stefanowitsch, 2005, 2006).

Many scholars have already described the metaphors that structure texts and discourse (Gentner; Grudin, 1985; Baldauf, 1997; Nerlich *et al.*, 2002; Drewer, 2003; Döring; Zinken, 2005; Goschler, 2005 *a*). Metaphor in science has been a topic for historians, sociologists, and philosophers of science for decades, but most of the discussion has been rather theoretical. There have been only a few linguistic analyses of metaphor use in scientific discourse (Gentner; Grudin, 1985; Drewer, 2003; Semino *et al.*, 2004; Goschler, 2005 *a*). These studies have to face the problem that it is necessary to explain which expressions should be included in an analysis as metaphoric. Although it seems to be intuitively clear in many cases, it is often difficult to explain why exactly a certain expression is metaphoric and why others are not. I will describe two different approaches which are often used intuitively. Using three sentences taken from *Science* as examples for scientific language, I will discuss the validity and the shortfalls of these two approaches and argue for a careful and transparent use of a combination of these approaches.

2. Metaphor – Definitions and Identification Strategies

The methodologies that have been used in metaphor analysis in general differ considerably. Whereas most of the earlier work was based on very small corpora that could be handled manually, now efforts are increasingly being made to work with large corpora which can be searched electronically (Deignan, 1999, 2005; Stefanowitsch, 2004, 2005, 2006). In both cases it is necessary to have at least an operational definition

of which expressions to treat as a metaphor. This problem is present no matter if one searches a small corpus manually or if one analyzes a sample of occurrences of lexemes in a large corpus. Most of the time there seems to be an implicit agreement on what to consider a metaphor and what not – and often it seems to be unproblematic. With the exception of some individual problematic cases, the question of how exactly to decide what is a metaphor and what is not has often been evaded.¹

Lakoff and Johnson's work, which pointed out the ubiquity and importance of metaphor in language and thought, is the starting point of most linguistic studies on metaphor. But it does not provide researchers of metaphors in discourse with a sufficient methodology to produce corpus-based data, hence, valid empirical evidence. Their definition of metaphor is: "The essence of metaphor is understanding and experiencing one kind of thing in terms of another." (Lakoff; Johnson, 1980: 5) They define metaphors as conceptual phenomena. Linguistic metaphors are in their perspective a secondary phenomenon which support their claim of the existence of conceptual metaphor. This is even more obvious in Lakoff and Johnson's latest work *Philosophy in the Flesh* (1999). They speak about terms, structures, and domains, not about words and sentences. It is the very point of their argument to place metaphors on the conceptual level. Although this is indeed the point that makes it interesting to study metaphors in language, it tends to neglect the linguistic side of metaphor. Therefore, their definition is not useful for identifying linguistic metaphors in discourse.

The lack of a proper definition and the related methodological problems has been pointed out by Gibbs (1999), Steen (1999 *a*, 1999 *b*, 2002 *a*, 2002 *b*), and Semino (Semino *et al.*, 2004) who are members of the "Pragglejaz" group. This group is working on the so-called "metaphor identification project" in order to produce more comparable data by providing a useful identification tool for metaphor in discourse. This is, to my knowledge, the first and only project that systematically approaches the problem of the identification of metaphor in language.² Steen (1999 *a*; 2002 *a*) tries to bridge the gap between linguistic and conceptual metaphor by providing a five-step procedure for interpreting linguistic data. The first step of his procedure – metaphor focus identification – is meant to extract the portions of discourse which are then analyzed. The other four steps are intended to arrive at a complete mapping on the conceptual level. This procedure is one of the very few attempts to give an explicit guideline for metaphor analysis.³ The first step of Steen's procedure, however, relies on two principles which have already been used in metaphor identification before:

...the focus is the linguistic expression used nonliterally in the discourse. This means that the focus expression activates a concept which cannot be literally applied to the referents in the world evoked by the text. (Steen, 1999 *a*: 61)

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1. There is a paragraph in Charteris-Black (2004: 35-37) on his method of metaphor identification. This is, however, more of a working definition of metaphor for his specific purposes.
 2. One of the few predecessors is Loewenberg (1981). Although her paper is addressing some of the issues raised here it is not concerned with conceptual metaphors and not aimed at corpus work.
 3. Another attempt to provide a methodology is going on in the social sciences. The methodology, which is now mostly used to interpret interviews, is called Systematic Metaphor Analysis (Schmitt 1997, 2000, 2003). It is comparable with Steen's five steps.

The two criteria which lead the metaphor focus identification in Steen's procedure are the nonliteral use of language on the one hand and the problem that the expression cannot be matched properly to the referents in the world on the other hand. The first criterion used here is *meaning* and the second one *truth* (or the so-called "referents in the world"). Both of these criteria can cause problems – especially in scientific discourse. I will now describe these two possible approaches to distinguish metaphorical from non-metaphorical expressions in more detail. I will name them the *truth approach* and the *word meaning approach*.

3. The Truth Approach to Metaphor Identification

Most of the time it seems unproblematic to decide intuitively what a metaphor is and what is not. But where does that intuition come from? Since metaphors are not distinguishable from literal expressions syntactically, we must have some other implicit criteria to decide what a metaphor is. The fact that intuitional decisions about metaphors or non-metaphors do not greatly differ from person to person, or from metaphor analysis to metaphor analysis, even without an explicit method of metaphor identification suggests that most of the time people use the same criteria to identify metaphors.

These criteria that guide intuition are *truth* and *meaning*: Many explanations why an expression is a metaphor imply that the expression is not true. Thus, the first possible approach marks expressions as metaphorical which are not actually true. Therefore, I name it the *truth approach*. It is easy to ridicule this approach with minimal philosophical skills. Of course, we don't know any truth, it is highly questionable if there is something like "truth" at all. But we should take into account the fact that in most cases this approach works quite well. Of course a marriage is not really on the rocks, nobody is actually shooting down someone else's arguments, and Christmas is not (physically) drawing near. For these prominent examples this approach works just fine. It is also useful for analyzing corpus data. Deignan (2005) points out that the researcher sometimes can't exactly know if a certain expression *like cry on someone's shoulder* is meant literally or figuratively:

Sometimes the same expression may show different types of motivation in different contexts. The above citation of *cry on someone's shoulder* is in fact, very unlikely to be literally true, when a wider context is seen, and it is known that the speaker was a President of the United States, referring to a conversation with another national leader. (Deignan, 2005: 65)

Thus, the criterion of truth can be very helpful in distinguishing metaphorical from literal language. It is, in fact, the only possibility when it comes to expressions that can be either metaphoric or literal. This is because in these cases we are dealing with a problem of reference. If the situation we are referring to by using an expression like *cry on someone's shoulder* actually included the act of crying and a shoulder, then it is a literal statement. If in the situation referred to with *cry on someone's shoulder* included something other than actual crying, and there wasn't any contact with a shoulder, but some kind of complaining instead, then the expression was used metaphorically. A

decision about these expressions requires a certain knowledge about facts in the world. In some metaphor theories which focus on the pragmatic aspects of metaphor use like Searle's *standard pragmatic model* (Searle, 1979) and approaches to metaphor from the perspective of Relevance Theory (Sperber; Wilson, 1995; Carston, 2002) this difference has been marked as the difference between sentence meaning and utterance meaning. To decide if sentence and utterance meaning differ, the hearer/reader has to know or infer the intentions of the speaker/writer and/or he has to notice the unappropriateness of a literal interpretation of the sentence. This happens when the hearer/reader detects a clash of what s/he knows about the situation and the sentence meaning.

Practical problems arise especially in two certain fields of discourse: science and religion. Religion relies on what people *believe*. Whether people interpret passages of religious texts as metaphorical or literal depends heavily on their religious beliefs:

The issue of metaphor identification is not clear-cut in religious texts. We will recall that a metaphor arises from the semantic tension caused by shifting the use of a word from one context to another. Perception of domain shift in the case of religious metaphors may well depend on the belief system of the text receiver. This is because the semantic target is the spiritual domain and individuals will vary in the extent to which they have experience of this. (Charteris-Black, 2004: 176)

Therefore the question whether something is a metaphor or a literal description – like bread and wine being the body and blood of Christ in the Holy Communion – can even lead to schism among religious communities (Charteris-Black, 2004: 175).

Unlike religion, science is supposed to rely on what people *know*. But even most scientists would agree that this “knowledge” is never complete. Maybe it is better to say that in many cases science is dealing with something we don't (yet) know about. Thus, some scientific claims and theories – as well as religious claims – are not as easily identified as metaphors. This is especially true for contemporary scientific theories. In the history of science a great number of metaphors have been used in older scientific theories and discourses: the universe as clockwork and humans as complicated mechanical machines in the enlightenment, the soul and mind as a hydraulic system in Freud's theory of the self, the brain as a telephone switchboard in the first half and then as a computer in the second half of the 20th century. But the identification of these explanations as “mere” metaphors relies on what we know today. Since the theories connected to the metaphors above are not state of the art, they are easily identified as not true and therefore metaphorical.⁴ But how do we know this about contemporary theories? And how can we identify metaphors in current scientific texts? Let us consider some examples taken from *Science*:

Polyn *et al.* now show that reactivation of such stored representations occurs prior to a verbal report of recollection in a free recall paradigm.
(*Science* 23 December 2005: Vol. 310. no. 5756, p. 1865)

4. This does not imply that every scientific claim which is not true is metaphorical. False claims can be not metaphorical if there is no mapping between two domains involved.

Dark energy, a hidden force that is blowing the universe apart, had varied dramatically over time and at one point even reversed direction.
(*Science* 20 January 2006: Vol. 311. no. 5759, p. 316)

The phospholipids form wormlike micelles in specific concentration ranges of mixed solvent systems, and under these conditions they behave like polymers for electrospinning.
(*Science* 20 January 2006: Vol. 311. no. 5759, p. 299)

Are these sentences correct – truthful – descriptions of the scientific subject? This question is clearly not a linguistic question and therefore not to be answered by linguists. Does this mean we are not able to investigate metaphors in science? One could come up with a solution to define the scientific terms in a way that makes it possible to distinguish the metaphorical from the literal use of this term. Then one could answer the questions above like this: since the word *store* in the first sentence can only be used for concrete objects, the claim that representations are stored is a metaphor. Or one could likewise say that *store* is a verb that can be used for concrete as well as for abstract things. Therefore the claim is a literal statement. It is questionable if this brings us any further. It is, however, close to the second possible criterion for identifying a metaphor, which is the *meaning* of a word.

4. The Word Meaning Approach to Metaphor Identification

Thus, the second approach to identify a metaphor – the *word meaning approach* – is to take “meaning” into account. Metaphors are not syntactically distinguishable from literal language. Therefore one has to look for metaphorical meaning whether on the level of words and morphemes, or on the level of utterances.

If we consider metaphor on a pragmatic level we argue that a metaphor is a certain kind of utterance. According to the *Standard Pragmatic Model of Metaphor Comprehension* a metaphor is an utterance where the utterance meaning differs from the sentence meaning, as John Searle explains (Searle, 1979). To perceive this difference between utterance and sentence meaning the hearer must take into account her/his knowledge about the world and about the things that are of relevance in the utterance. Thus, we have the factor “knowledge and truth” meshed into the metaphor identification again. While that might be appropriate for normal speakers and hearers, it is not a satisfying scientific criterion to identify metaphors in discourse. Therefore, to analyze meaning on the level of utterances implies judgments about situations and “truth” and is thus a kind of “truth approach”.

Hence, it is necessary to analyze the meaning of single words in certain phrases. But here another problem arises: what is the meaning of a word? It has been agreed that a word can have different meanings. Multiple meanings are in fact quite frequent, as dictionary entries show. If a word has two meanings that are totally unrelated we speak of polysemy. Clear cases of polysemy like the German word *Bank* or the English word *lie* are not of interest here. But there are also a great number of words with a so-called literal, sometimes also called primary or core meaning, and a so-called metaphorical

meaning. This is the case for words like *to store*, *dark*, *to behave* (all of them used in the examples from *Science* above).

But who decides which the literal or primary meaning of a word is? The difficult situation here is that speakers (and writers of dictionaries) seem to have strong intuitions about this question, and they seem astonishingly consistent. When uncertain about the primary meaning of a word, one can consult a dictionary. Thus, using a dictionary might be a reasonable shortcut to make a decision about the meaning of a word, and thus about its status as literal or metaphorical in a certain context. In fact, this is a methodology that has been used widely in metaphor identification procedures – at least as a first step toward the identification of a conceptual metaphor (Baldauf, 1997: 96-97; Charteris-Black, 2004: 36). Can one apply this methodology on one of the examples from *Science*?

Polyn *et al.* now show that reactivation of such *stored representations* occurs prior to a verbal report of recollection in a free recall paradigm.
(*Science* 23 December 2005: Vol. 310. no. 5756, p. 1865)

The word that could have a metaphorical meaning here is *stored*. One could argue that *to store* has a meaning distinct from the one here, where it is not used to describe real items (like in a warehouse or the like), but for *representations*. Looking up the entry for *store* (as a transitive verb) in an online dictionary, the Merriam-Webster Online, confirms this:

- 1: **LAY AWAY, ACCUMULATE** <*store* vegetables for winter use> <an organism that absorbs and *stores* DDT>
- 2: **FURNISH, SUPPLY**; *especially* : to stock against a future time <*store* a ship with provisions>
- 3: to place or leave in a location (as a warehouse, library, or computer memory) for preservation or later use or disposal
- 4: to provide storage room for : **HOLD** <elevators for *storing* surplus wheat>
(<http://www.m-w.com/cgi-bin/dictionary>, 12.4.2006)

Indeed, the concrete meaning of *to store* is highlighted. Nevertheless, storing can occur not only in a location like a warehouse or library, but also in a *computer memory* (3). If this is one of the literal meanings of *to store*, why should *stored representations* be metaphorical? Or should we assume that because this meaning is listed as a third meaning it is distinct from the primary meaning listed under (1)? Another online dictionary, Dictionary.com, lists the meaning of *to store* as something you do with the computer under (4):

tr.v. **stored, stor-ing, stores**

1. To reserve or put away for future use.
2. To fill, supply, or stock.
3. To deposit or receive in a storehouse or warehouse for safekeeping
4. *Computer Science*. To copy (data) into memory or onto a storage device, such as a hard disk
(<http://dictionary.reference.com/search?q=store>, 12.4.2006)

In the online version of the Cambridge Advanced Learner's Dictionary, however, the computer-linked meaning of *to store* is listed first – suggesting that this is the primary meaning:

store (KEEP)

verb [T usually + adverb or preposition]

to put or keep things in a special place for use in the future:

The data is stored **on** a hard disk and backed up on a floppy disk.

I stored my possessions **in** my mother's house while I was living in Spain.

I've stored my thick sweaters and jackets (**away**) until next winter.

Squirrels store (**up**) nuts for the winter.

(<http://dictionary.cambridge.org/define.asp?key=78487&dict=CALD>, 12.4.2006)

Therefore, it is still questionable if *store* in *stored representations* is used in its primary or secondary meaning and if the phrase is therefore used literally or metaphorically. It seems that dictionary entries can only confirm or correct a speaker's intuition about the meaning of a word – which is very useful and even necessary if one is not a native speaker of the language one is analyzing – but they can't give us genuinely new information about a word or phrase being metaphorical or not. If dictionaries are to serve as the only source, other criteria must be invented. For instance, one must decide which entry in the list is still a primary and which one is a secondary meaning. Obviously, dictionaries differ and therefore the results of a metaphor analysis would depend greatly on the dictionary that is used. Since entries in most dictionaries are probably also based on speaker's intuition, the intuition of the writers and their informants, dictionaries might be a slightly better source than our own intuition, but the method is not genuinely different. Intuition, however, seems not a satisfying criterion for a scientist, so what we need is a scientific criterion that enables us to identify the primary meaning of a word without any intuition, or a scientific explanation of where exactly the strong intuition comes from. Some dictionaries, however, include more than just intuition in their entries, such as the frequency of the use of a word in its different senses and etymological information.⁵

These things are precisely the factors that could in fact influence speaker's intuition. One possible explanation for our intuition about the primary or literal meaning of a word could be the frequency of a word's use in a certain sense. Alice Deignan's work shows that this criterion is not enough and can even be misleading:

While non-metaphorical senses may be psychologically primary and historically prior, contemporary corpus data shows that metaphorical senses of some words are used as frequently as, or even more frequently than, non-metaphorical senses. (Deignan, 2005: 94)

5. Steen shortly discusses the advantages of two dictionaries – the COBUILD English Language Dictionary and the Concise Oxford Dictionary – and points out similar differences in listing orders depending on an estimation of frequency or a logical order (2002 *b*: 24).

For example, Deignan presents a corpus search for the word *hunt* in a corpus:

...the sample shows that the use of *hunt* which many speakers might think to be the main use, to talk about pursuing and killing animals, only represents about a third of the sample... (Deignan, 2005: 8)

Thus, the so-called main or primary meaning of a word does not need to be the most frequently used one.⁶

Another argument for the primary meaning of a word is the argument of historical priority. This one comes from historical semantics and has been fleshed out by Eve Sweetser (1990). She shows that if a language has only one established meaning for the word *see* it means visual perception. In a great number of languages, *see* also has the meaning “to know” or “to understand”. And in every language where this is the case, the meaning of “visual perception” was there first. Thus, in this case we have convincing evidence for a “primary” meaning.

Some researchers have also pointed out another criterion to claim a primary meaning of a word, namely priority in language acquisition. It has been argued that children learn the primary meaning of a word first. Thus, when they acquire the word *to see*, they learn the meaning of seeing as perceiving something with one’s eyes first, and later they learn the secondary meaning of seeing as understanding (as in *I see your point*). Christopher Johnson describes this process as conflation (Johnson, 1999).

Thus, the argument of the meaning first acquired by children as the primary meaning in combination with evidence from historical semantics forms a solid basis for the claim of a primary meaning of a word.⁷ If one takes into account different kinds of evidence for the primary meaning of a word, one can collect good arguments for the claim of a primary vs. a secondary (metaphorical) meaning. But besides the practical problem that it is very time-consuming to find that kind of converging evidence for every single word, another problem arises in certain discourses. Again, we get in trouble with scientific language. Child language is not so useful here because children just don’t use most of the words that are frequent in scientific language. If they use these words only in one sense (the primary meaning), this would be a questionable basis for an argumentation about scientific terms. Of course it is to expect children do not use *dark* in the sense of *dark energy* as the scientist does. And it is also obvious that we don’t find this meaning of *dark* in language of several hundred years ago, because they didn’t know about black energy – just like children.

The only thing that can be taken for granted is that we do, then, have two distinct meanings of the word *dark*. This is something we can find in dictionary entries (the Merriam-Webster Online Dictionary lists eight distinct meanings for the adjective *dark*).

6. I would like to thank Daniel Casasanto (Stanford) for pointing out this phenomenon to me in the first place.

7. It is important to note that these arguments are presented here in a kind of backward argumentation: Johnson and Sweetser don’t want to show how to discover the primary meaning of a word but show how metaphorical mapping is grounded in experience and how this experience and thus the mapping occurs in many languages and cultures.

Thus, although it is difficult to claim a “primary” meaning of a word based on the order of dictionary entries, the claim that distinct meanings of a word exist is less problematic. If we take it as given that we have two or more distinct possible meanings of a certain word, another possibility to distinguish between the literal and the metaphorical is the distinction between concrete and abstract meaning. This distinction is often seen as identical to the distinction between primary and secondary meaning. Maybe this is because both are based on the same theoretical assumptions. The concrete versus abstract distinction developed directly out of the basic assumptions of Conceptual Metaphor Theory: it is assumed that metaphors are crucial for our structuring of the world, and that metaphoric structuring is based on basic (mostly bodily and sensory) experiences. Therefore, metaphoric mapping occurs in one direction only – from concrete to abstract. This is also known as the unidirectionality hypothesis. This theoretical argument is an explanation for how humans can understand and structure things they cannot experience directly, such as time, economy, or the universe. It is closely connected to the arguments for a primary meaning of a word presented above: historic priority and priority of acquisition, but theoretically it is not just the same argument. It seems to be a logical consequence to say that if a word is used in its abstract sense (as opposed to its concrete sense), and the concrete sense is used to structure the abstract domain, then the word is used metaphorically. But again, this argumentation mixes the conceptual level with the linguistic level. To take a conceptual assumption as a premise for a linguistic assumption is dangerous, because the argument becomes circular and therefore unfalsifiable. Turning around a theoretical point to create a methodology which proves that very point empirically generates a circular argumentation. Thus, if we take the concrete-abstract distinction that was originally a theoretical point to explain metaphor on a conceptual level as the basis for identifying linguistic metaphors in discourse, we can only find concrete-abstract mappings and nothing else.

Furthermore, although it seems mostly unproblematic, it is not always clear what is concrete and what is abstract. As I have tried to show in another article, this depends on the level on which a certain thing is described. Different discourses can vary in what they treat as known and concrete and unknown and abstract. Not even the body is always “concrete”: when it comes to medical explanations of diseases, cells, genes, or brain functions, these things are described in metaphors with source domains like war, communities, human beings, space and containers, technology, books, and others, as many metaphor analyses by different scholars have shown (Goschler, 2005 b). Therefore, especially in scientific language, the concrete versus abstract meaning distinction is sometimes hard to make. Thus, if one wants to produce a water-tight empirical and theoretical argument, the shortcut of defining the concrete as the primary and the abstract as the secondary meaning is not appropriate. But if we accept the assumption that concrete versus abstract meaning is equal to literal versus metaphorical meaning, that seems to allow us get a grip on many of the cases. Let’s consider the examples from *Science* again:

Polyn *et al.* now show that reactivation of such *stored representations* occurs prior to a verbal report of recollection in a free recall paradigm.

Store has a clearly concrete meaning as in *store objects in a warehouse*. Here it is used in a more abstract way, since representations are not objects one could grasp and carry around. Thus, one could argue that this sentence is a good candidate for a spatial metaphor connected with a reification of an abstract thing.

How would the concrete versus abstract meaning criterion work for the second example from *Science*?

Dark energy, a hidden force that is blowing the universe apart, had varied dramatically over time and at one point even reversed direction.

(*Science* 20 January 2006: Vol. 311. no. 5759, p. 316)

Similarly, one could say that *dark* is here metaphorically used because dark energy is not dark in the sense of *a dark color* or *a dark room*, which would be the concrete or primary meaning. But how do we know this? What does *dark energy* mean exactly? Here we are dealing with another serious problem of metaphor identification in scientific discourse: in order to identify a word or phrase in a sentence as metaphorical, one has to understand the sentence which contains the word or phrase. Even this can be problematic in scientific discourse if the linguist is not familiar with the field in question. If one doesn't know what a scientist means by *dark energy*, one can hardly decide in which sense it is used. The same problem occurs if the researcher doesn't understand the direct context of a word or a phrase. Consider the third sentence taken from *Science*:

The phospholipids form wormlike micelles in specific concentration ranges of mixed solvent systems, and under these conditions *they behave* like polymers for electrospinning.

(*Science* 20 January 2006: Vol. 311. no. 5759, p. 299)

It is possible to identify the word *behave* as a candidate for a metaphor, because it is used together with polymers, which are not living beings and therefore cannot "behave" in the concrete sense. Therefore one could argue that this is a personification. However, it is difficult to describe the metaphor, because the whole sentence is not easy to understand if one is not familiar with the scientific claims it relates to.

How can this dilemma be solved? Can the researcher ask the scientist what s/he means by certain words, phrases, and sentences? But to ask if *polymers* really *behave*, or if that is "only" a metaphorical description would mean to go back to asking if the sentence is true, thus, if it describes something that is real in the world. This would mean mixing judgements about truth and word meaning again. Semino, Heymann and Short, who describe the problems of metaphor identification in a corpus of doctor-patient conversations about cancer, also struggle with this problem: They argue that talking about tumors as *travelling* in the body and *coming back* could be metaphorical, assuming that "the concepts referred to by the expressions coming back and travelled do not apply literally (in the relevant discourse world) to the concepts referred to" (Semino *et al.*, 2004: 1278). Semino *et al.* combine these considerations about scientific facts with an analysis of the semantic content of the words *coming back* and *travelling*. Thus, they combine the word meaning approach with the truth approach. It seems that there is no way of avoiding this aspect. But I think it is crucial in every point of the metaphor identification procedure to reflect on whether one refers to a violation or alteration of

truth or word meaning. In other words, the researcher has to reflect if s/he uses the *truth approach* or the *word meaning approach* or a combination of both to metaphor identification.

It is very important to distinguish between two processes: the intuitional recognition of a metaphor and the analytical identification of a metaphor in a text or spoken language. Intuitional recognition is based on a combination of knowledge of truth (facts in the world) and the meaning of a word. In order to develop an analytical approach, one has to separate knowledge about facts in the world and semantic knowledge – and in this analytical procedure one can then distinguish between the *truth approach* and the *word meaning approach*. As I have shown already, both approaches work in many cases but cause problems with specific examples or discourses – especially in scientific discourse, as is also shown by Semino *et al.* (2004). Some metaphors can be identified only via the *truth approach*, others only via the *word meaning approach*. Unfortunately, two neatly distinguishable types of metaphor do not exist. Nevertheless, there are tendencies. First, there are sentences with truth conditions. If these truth conditions are violated by facts in the world, we are confronted either with lies or with non-literal language such as irony, sarcasm, or metaphor. To distinguish these types of speech acts we have to take the knowledge and the intentions of the speaker (and the hearer) into account. This is a purely pragmatic problem. Other cases rely more on the use and combination of certain words with certain meanings. Such is the case for most of the examples from *Science*. In these cases, it is necessary to take the word meaning into account. We can find both kinds of expressions in scientific discourse. The problem is that in the case of expressions that can be literal or metaphorical, we might not know the “truth”. In the case of semantic violations we have to make decisions about word meaning. Here another problem arises: the problem of understanding the meaning of scientific terms.

5. Conclusion

Metaphor identification is difficult. Although intuition is surprisingly coherent, intuitional decisions always mix knowledge about the world and knowledge about word meaning. This causes problems in scientific discourse, because one has to distinguish between whether the author/speaker is making a scientific or a linguistic point when identifying a metaphor in a scientific text, theory or argument. To claim that a scientific argument is metaphorical because it is not true in reality is a scientific claim and calls into question the appropriateness of the scientific argument. To claim that a scientific term is a metaphor because it represents a secondary meaning of the used word is a completely different point, because it is a linguistic observation. It does not automatically question the scientific term or the argument connected with it. It only gives a clue of what might be a metaphorical conceptualization, and this conceptualization can be more or less appropriate.

Therefore we need more than intuition in the metaphor analysis of scientific texts. The *truth approach* is not sufficient – it has to be avoided or carefully reflected and distinguished from semantic arguments. A consequently semantic argumentation, i.e. the

word meaning approach, would be a better basis for metaphor identification in scientific discourse. But once the researcher tries to find valid linguistic criteria to distinguish metaphorical from literal expressions, another problem arises, namely how to claim one primary meaning for a word. This problem is serious in any context, as has been shown by Steen (2002 *b*: 24-25), but it is extremely serious in scientific contexts, because here normal identification strategies for the primary meaning of a word are prone to fail.

There seems to be no systematic “trick” for identifying metaphors in scientific discourse. Any linguistic analysis, however careful, leaves doubts about what this analysis means for the scientific concepts.⁸ Thus, even more stock has to be put in the following steps – in Steen’s work step two to five – of the analysis (Steen, 1999 *a*).

What is most important in any identification procedure is to keep the different identification methods distinct. In the linguistic decision about the status of a word or phrase as metaphorical, the *truth approach* and the *word meaning approach* must be clearly distinguished for the analysis. Furthermore, the linguistic criteria for a metaphor must be analytically separated from judgements about a certain scientific discourse or argument. In a further step, these different approaches to metaphor identification can be combined again – maybe as different steps in a procedure such as Steen’s (1999 *a*) five-step-procedure. For scientific discourse, however, the evaluation of a scientific argument as metaphorical or literal has to be added. That means that a purely linguistic analysis can’t provide information on how exactly the use of certain linguistic expressions and the points made in the text are connected. Therefore, after a metaphor analysis of scientific texts, a critical reading of the texts themselves is necessary.

Thus, I argue for a purely linguistic analysis with purely linguistic criteria for metaphor as the first step in metaphor identification. This, however, can be only the starting point for any work on metaphors in discourse. In order to get to the interesting points of metaphorical conceptualization, more analytical steps have to be added (in Steen’s procedure step two to five). For a complete analysis of a certain scientific discourse, different approaches and cooperation with different disciplines seems absolutely necessary.

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8. Whether the metaphors occurring in scientific texts have anything to do with scientific arguments, is another question that can be approached in discourse analysis – but then at least basic scientific knowledge or cooperation with scientists is required. The psychological reality of these metaphors can only be established by means of genuine psychological evidence (for example from experiments).

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