

Different Functions of (Deliberate) Metaphor in Teaching Scientific Concepts

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Abstract

'Deliberate metaphors' (Steen 2008, 2010, 2011, 2013) are a potentially valuable tool for knowledge mediation in academic lectures, since they supposedly force the addressee to consider the current topic from the point of view of the metaphor's source domain, thereby effecting a conceptual change (cf. Steen 2010: 58-60). Despite its potential in knowledge mediation, the theoretical framework of deliberate metaphor is still contested among different scholars (see Deignan 2011; Gibbs 2011, 2015a, 2015b; Steen 2011, 2015). This contribution explores candidates for deliberate metaphors in academic lectures by closely examining the metaphors' co-text and context, establishing different linguistic forms of deliberate metaphors. The main focus, however, is on examining the particular discourse functions of the various forms of deliberate metaphor in four different academic lectures (in biology, chemistry and psychology). The analysis reveals if and how deliberate metaphors are exploited in order to communicate scientific knowledge in these four lectures.

'Gezielte Metaphern' (*deliberate metaphors*) nach Steen (2008, 2010, 2011, 2013) sind möglicherweise wertvolle Instrumente zur Wissensvermittlung in universitären Lehrveranstaltungen, da sie die Adressaten förmlich dazu zwingen, das momentane Thema aus der Sicht der Ursprungsdomäne der Metapher zu betrachten, wodurch sie eine konzeptionelle Veränderung bewirken (vgl. Steen 2010: 58-60). Trotz ihres Potentials in der Wissensvermittlung ist das Konzept der gezielten Metapher unter Forschern jedoch noch umstritten (siehe Deignan 2011; Gibbs 2011, 2015a, 2015b; Steen 2011, 2015). Dieser Beitrag erforscht Metaphern in universitären Lehrveranstaltungen bezüglich ihrer möglichen ‚Gezieltheit‘/ ‚deliberateness‘, indem sowohl Kotext als auch Kontext des Metapherngebrauchs genau untersucht werden. Dabei werden verschiedene sprachliche Formen gezielter Metaphern herausgestellt. Das Hauptaugenmerk der Untersuchung liegt jedoch auf der Analyse verschiedener Diskursfunktionen der unterschiedlichen Formen von gezielten Metaphern in vier universitären Lehrveranstaltungen (der Fächer Biologie, Chemie und Psychologie). Die Untersuchung zeigt auf, ob und auf welche Weise gezielte Metaphern zur Wissensvermittlung in diesen Veranstaltungen eingesetzt werden.

1. Introduction

The use of metaphors in educational contexts has received considerable attention in research studies (e.g. Aubusson et al. 2006; Cameron 2003; Cortis/ Pollio 1999; Low et al. 2008), since Lakoff and Johnson (1980) postulated that metaphor allows us to understand abstract concepts in terms of more concrete ones. Especially at college level, teachers are primarily concerned with communicating abstract knowledge in form of scientific concepts that are unfamiliar to the students. This accounts for a multitude of investigations

examining metaphors in academic discourse. However, in recent years, a new classification of metaphors was proposed (cf. Steen 2008). One of the implications of this classification is that a particular kind of metaphor, deliberate metaphor, has a special status in communicating knowledge, since its function in discourse is to change the perspective of the addressee on the local topic by explicitly drawing attention to the source domain (cf. Steen 2010: 58-60).

Based on this new classification of metaphor and its implications, the present study takes a new approach on the nature and function of metaphor in academic discourse and combines the analysis of deliberate metaphors with aspects of discourse analysis. In four lectures held at a US-American college, deliberate metaphors were identified and their particular functions within the specific discourse contexts were analyzed. The results in section (4) show how deliberate metaphors are used by the professors as tools for teaching scientific concepts in different college lectures. I will point out different functions of those deliberate metaphors in the particular teaching contexts. Before I discuss the different uses and functions of deliberate metaphors in the lectures, I will outline the theoretical framework underlying the analysis. Specifically, I will first differentiate deliberate metaphors and non-deliberate metaphors in section 2. Subsequently, I will briefly introduce my corpus of college lectures and describe the method used to identify metaphors in general, and deliberate metaphors in particular (section 3). After the detailed discussion of excerpts from different US-American college lectures in section 4, I will summarize these findings in the conclusion (section 5).

2. Forms of metaphor

Within the framework of the Cognitive Metaphor Theory (CMT), metaphor is regarded as involving not only language, but also thought. The basis for this claim is the observation that we use sets of metaphorical expressions which belong to a more familiar or more concrete domain (source domains) in order to talk about a more abstract or less familiar domain (target domain). Based on this linguistic evidence, scholars of CMT assume that there are also mappings between the source and the target domain on a conceptual level. As Gibbs (1994: 261-264) points out, a number of metaphor scholars also presume that those cross-domain mappings postulated by the founders of CMT (Lakoff/Johnson

1980, 1999) are activated every time we encounter a linguistic metaphor in writing or speech. Over the past 15 years, however, the assumption that every linguistic metaphor triggers a cross-domain mapping at the conceptual level has been criticized by various scholars (e.g. Bowdle/Gentner 2005; Glucksberg 2001; Glucksberg/Haught 2006). The observation that not every linguistic metaphor may actually be processed as a metaphor on the conceptual level was termed “the paradox of metaphor” by Steen (2008: 214). In fact, studies carried out by Gentner and Bowdle (2001; Bowdle/Gentner 2005) suggest that especially conventional metaphors, which are at the heart of the claims made by Lakoff and Johnson (1980; see also Lakoff 1993), are often not processed by comparison. In order to resolve the apparent paradox that language items can be seen as metaphorical on the linguistic level although they may not be processed as metaphors on a conceptual level, Steen (2008, 2010, 2013) proposes a model of metaphor that adds a third dimension to the existing two-dimensional model of metaphor as a phenomenon of language and thought. Steen calls this essentially pragmatic level the *communicative* dimension of metaphor (2008: 221). The communicative dimension pertains to a basic function – or the lack of it – of metaphor in discourse: on the one hand, there are metaphors which do not exhibit a clear communicative function. They seem to be used more or less accidentally and/or because there are no conventionally used literal expressions for the respective topic. These metaphors are, as Cameron puts it, “just the way to say it” (2003: 100). On the other hand, there seem to be metaphors that are not used accidentally, but deliberately – in order to fulfill a particular function in the respective discourse event. Steen (2008) calls this latter kind of metaphor *deliberate metaphor* (and, accordingly, the former type *nondeliberate metaphor*). According to Steen (2008: 222), deliberate metaphors are used to “change the addressee’s perspective on the referent or topic” by inviting the addressee to consider the target domain from the perspective of the source domain. As Steen (2008) also points out, those are the metaphors that are actually meant *as* metaphors.

Since academic discourse, or more specifically, courses at university level, primarily deal with communicating abstract knowledge, the notion of deliberate metaphors seems to be of particular value when investigating how the professors teach abstract (scientific) concepts. Given the nature of deliberate metaphors in discourse, we might presume that they explicitly offer a familiar or more concrete domain that the students are supposed to adopt in order to

consider a new or abstract scientific concept from the point of view of the metaphor's source domain. Thus, we might expect professors to use metaphors deliberately as a teaching tool. In fact, this explanatory or pedagogical function of metaphor in general has been identified as a central function of metaphors in specialist and popular science articles (Knudsen 2003; Semino 2008). Popular science articles and college lectures share crucial aspects, namely that the writer/speaker possesses a more profound scientific knowledge about a topic that s/he tries to communicate to a less knowledgeable audience. Hence, we would expect the pedagogical function to play a central role in college lectures as well. We also expect metaphors with a pedagogical function to be used *deliberately* by the professors. In order to inspect whether deliberate metaphors in academic discourse indeed fulfill such a function in college lectures, this paper is dedicated to the analysis of this particular type of metaphor in its respective discourse context.

However, despite its appeal and an intuitive agreement that some metaphors are used more deliberately than others, the notion of deliberateness is a controversial and fuzzy concept (see the discussions in Deignan 2011; Gibbs 2011, 2015a, 2015b; Steen 2011, 2015). Although Steen (2008, 2010) and especially Krennmayr (2011) give some hints as to how we can identify deliberateness using linguistic clues, the aspects they mention neither constitute an exhaustive list, nor are they always free of possible researcher bias. Yet, as Deignan et al. (2013: 22) conclude after their summary of the problems regarding the notion of deliberate metaphors, it is useful to point out apparently deliberate uses of metaphors when we are concerned with the particular functions of the metaphors at hand. Thus, in my analysis of the different functions of metaphors in teaching scientific concepts, I will focus on deliberate metaphor and explicitly state in each case what linguistic or contextual evidence supports my assumption that the respective metaphor is used deliberately. Before we can discuss a metaphor's deliberateness, though, we need to identify a given lexical unit as metaphorical. This identification procedure will be made transparent in the following section (3.), in which I will also introduce the corpus I compiled for the investigation.

3. Corpus data and method

The linguistic data the following analyses will be based on come from my current PhD research. The project under the title of “Metaphor in Academic Discourse: Different forms and functions in the communication of knowledge in US-American college lectures” aims at analyzing academic discourse and the role of metaphor in the communication of knowledge. The investigation is exploratory and involves the analysis of 27 lectures filmed at a US-American college in the following subjects: Biology, Chemistry, Psychology, and Philosophy. The analysis combines the Cognitive Metaphor Theory and Discourse Analysis.

My analysis here will be based on one lecture each from biology and chemistry, as well as two lectures from psychology. The video data of these four lectures was first transcribed and then analyzed for metaphor use. The transcription rendered a corpus containing authentic discourse data of roughly 38,000 words. Metaphor identification was carried out on the basis of the Metaphor Identification Procedure (MIP; Pragglejaz Group 2007) and its more recent extension, the MIPVU (Steen et al. 2010). In the case of the psychology lectures, the identification procedure was carried out throughout the entire lectures. In the rest of the data, only excerpts (including those that will be discussed here) were subjected to detailed metaphor identification. For our present purposes it is not necessary to identify each and every possible metaphor in the data, but to make sure that what I identify as metaphor is indeed classified as such.

The basic procedure of the MIP and the MIPVU to find linguistic metaphors in a given text can be summarized in the following way: The researcher examines the text on a word-by-word basis, identifying the contextual meaning of each lexical unit. This meaning is compared to the unit’s other meanings by using a dictionary. If the lexical unit has a more basic meaning, i.e. “a more concrete, specific, and human-oriented sense” (Steen et al. 2010: 35), it is compared to the contextual meaning. If the contextual meaning is sufficiently distinct from the basic meaning, but can be related to it by some form of similarity, the lexical unit is marked as a metaphor related word (cf. Steen et al. 2010: 25).

Unlike the MIP, the MIPVU also accounts for *direct metaphors*. Direct metaphors are particularly important for the current analysis, because they are usually used deliberately. In contrast to indirect metaphors, the lexical unit constituting a direct metaphor is not used with a meaning different from its basic meaning.

However, there is still a cross-domain mapping involved, since the word is used in order to be compared to a more basic referent or topic in the text. Such direct metaphors may appear in the form of a simile (A is like B), as in “Life is like a roller coaster”. In this example, the word *roller coaster* does not indirectly refer to a transferred meaning of the word, but directly refers to the ride in an amusement park. The specific context of the sentence “Life is like a roller coaster” indicates that we are supposed to compare this literal meaning of *roller coaster* to the topic *life*. It is precisely this comparison, which qualifies similes as forms of (direct) metaphors. In direct metaphors, cross-domain mappings are also involved, but this is not caused by a word which is incongruous in its immediate context. This is different in indirect metaphors, as the meaning of the linguistic metaphor does not refer to its literal or basic meaning. Instead, the meaning of metaphors like *attack* in “Lakoff attacked my argument” is indirect. In this example, *attack* refers to its contextual sense, which could be paraphrased as “strongly criticize”. However, this meaning is different from its basic sense, “physically harm”. Since the basic meaning is not the intended meaning here, but can be used to understand *attack* in the example via comparison with its contextual sense, the word *attack* is said to be used indirectly. There are no two senses involved in the use of *roller coaster* in the example “Life is like a rollercoaster”. In this specific construction, the basic meaning of the word *roller coaster* is also its contextual meaning¹. Similes and other linguistic forms of direct metaphors will be discussed in detail in the analysis of the lectures (section 4). Additionally, the example “life is like a rollercoaster” also illustrates

¹ Note that there are two different senses of ‘context’ involved here. In a narrow sense of ‘context’, the word *roller coaster*, in the example provided, indeed has a contextual meaning which is also its basic meaning: a ride in an amusement park. This is due to the word *like* in this particular construction. In a wider sense of the word ‘context’, however, we are supposed to compare a ride in an amusement park with the topic *life*. We will probably come to the conclusion that this tells us that life can have a lot of big and sudden changes. ‘A situation in which there are many big and sudden changes’ is in fact the other meaning of the word *roller coaster*, which is conventionalized (see Macmillan Online Dictionary). This other conventionalized meaning is not the word’s basic meaning, but a metaphorical one. If the contextual meaning of *roller coaster* in this sentence was not its basic meaning, the simile would be odd: “Life is like a situation in which there are many big and sudden changes”. The simile form only works, *because* the contextual sense is also the basic sense. This is different in “Lakoff attacked my argument”. Here, it would not make any sense if the basic sense was also the contextual meaning: “Lakoff *physically harmed* my argument”. Instead, only a transferred, indirect, meaning of *attack* makes sense as the contextual meaning in this example: “Lakoff *strongly criticized* my argument.”

the deliberateness of (direct) metaphors. The form “A is like B” sets up an explicit comparison between the two domains LIFE and ROLLERCOASTER and therefore urges the addressee to consider life from the perspective of a rollercoaster, changing the addressee’s view on the topic *life*. This process is, in a nutshell, Steen’s definition of deliberate metaphor (cf. Steen 2008: 222).

For my discussion of the functions of deliberate metaphors, I will provide crucial excerpts of my data. As to notational conventions used in these excerpts, only those metaphors that are of importance for my present analysis are highlighted, using a combination of italics and bold print. Since I am primarily concerned with deliberate uses metaphor, the occasional linguistic signals which provide evidence for deliberateness are underlined. As my examples of deliberate metaphors as a teaching device occur in particular real-life contexts, we have to take these contexts into account when examining the metaphor use. Thus, I will also include aspects of discourse analysis in the discussion of examples. Therefore relevant (non-metaphoric) expressions are highlighted using bold print only (without italics). The fact that I have authentic video material enables me to carry out such a multi-faceted analysis, considering different factors of text and context. These advantages of analyzing authentic language use compensate for the small drawback that relying on recording devices brings with it: the loss of some data due to parts that are inaudible. This rare problem usually only involves individual words, which are marked in the excerpts by a question mark in brackets. My discussion of the examples always involves an analysis of language as well as making inferences about the conceptual level, based on the language use. In order to mark this difference, I follow the usual cognitive linguistic convention of using small capitals for conceptual units.

4. Analysis of the forms and functions of (deliberate) metaphors

In the following subsections, I will provide examples of different forms of possibly deliberate metaphor use. I will point out the linguistic and contextual clues that lead me to assume deliberateness and afterwards discuss the functions of the deliberate metaphors in each particular teaching context.

4.1 Deliberate metaphor in molecular biology

The first example is taken from a class in molecular biology. The topic of this particular lecture is the activation of the DNA transcription process. In the excerpt below (example 1), the professor is explaining the structure of transcription factors.

- (1) So you could actually make sort of *Frankenstein* hybrid transcription factors with cloning techniques, um, where you sort of, let's say you had several different activators, you could sort of **mix and match** DNA binding domains and activation domains and, um, and sort of make new transcription factors (...).

Transcription factors control the DNA transcription process. They do so by binding to specific sequences of the DNA and activating the transcription process, which is accomplished by also binding to other proteins. This means that the structure of transcription factors contains at least two areas (or domains), one which is responsible for DNA binding and one responsible for activation. What the students do not seem to know is that those areas work independently and can be separated as well as reassembled. The professor tries to communicate this idea by using the metaphor *Frankenstein hybrid transcription factors*. By calling those transcription factors which result from separating and reassembling areas of different transcription factors *Frankenstein hybrid transcription factors*, the professor sets up a comparison between what a biologist can do to transcription factors and what the character Frankenstein in Mary Shelley's novel does to human body parts. Instead of simply saying that parts of the transcription factors can be separated and reassembled, the professor chooses to compare that to the work of Frankenstein. Using FRANKENSTEIN as a source domain for the process of separating and reassembling transcription factors is quite unconventional. Thus, the professor coins a novel metaphor. Since the professor seems to actively create a new metaphor, it is rather safe to assume that he did this deliberately. However, deliberateness of metaphors is mainly about the effect a metaphor has on the part of the addressee. In this case, the novelty of the metaphor is probably salient enough for the addressee to notice the source domain FRANKENSTEIN and to actively compare it to the target domain. This allows the students to think of biological processes that are invisible to the human eye, and hence more difficult to comprehend, in terms of something that is probably familiar to them (the basic plot of the novel *Frankenstein*). Since Frankenstein reassembles human body parts to design a

new creature, this process is easier to imagine and understand – it is more human-oriented. We are much more familiar with our own body than with parts of submicroscopic proteins. Thus, this comparison might help the students to understand the processes involved in creating new transcription factors. We can therefore assign an explanatory or a pedagogical function to the deliberate use of the *Frankenstein* metaphor.

However, the use of this particular metaphor might also suggest that this process is unorthodox and results in something unwanted and dangerous. After all, our knowledge of the novel includes that Frankenstein's experiment goes different from what he imagined and results in the creation of a monster. Although the professor points out what he intends the students to map from the source domain FRANKENSTEIN to the target domain CREATING HYBRID TRANSCRIPTION FACTORS in the immediate co-text, namely that *mixing* and *matching* is involved, this does not prevent students from possibly mapping more aspects, as for example the above mentioned negative features of dangerousness and unintended results, from the source to the target domain. Yet, the professor does not seem to wish to convey this view, because over the course of the lecture, the creation of new transcription factors is explained as something useful and positive. This example therefore demonstrates some of the advantages and pitfalls of using deliberate metaphors in teaching science. On the one hand, the *Frankenstein* metaphor probably helps students to understand the biological processes the professor is trying to explain. On the other hand, this particular metaphor might lead to a certain moral evaluation – due to the negative connotation the word *Frankenstein* carries – of the processes that is not intended.

4.2 Deliberate metaphor in evolutionary psychology

Apart from leading to wrong inferences in terms of connotation, a problematic use of deliberate metaphors may even result in a wrong conceptualization of the topic at hand. This may have happened in example (2), which I will analyze in the following discussion. This example of deliberate metaphor use is taken from a class in evolutionary psychology. The session deals with the concept SPERM COMPETITION. The idea of sperm competition in human beings arises from the fact that two or more different males are able to try to fertilize the egg of a single female, for example by mating in close temporal proximity.

Throughout the lecture, the professor provides evidence from different studies which suggest that males have evolved in ways that are adaptive to sperm competition, which in turn supports the idea that sperm competition indeed exists. In example (2a) below, the professor relates laboratory research on the concept SEMEN DISPLACEMENT, which is assumed to be one of the adaptive mechanisms enabling males to succeed in sperm competition.

(2)

- a. There are even these labs where they've got these latex vaginas and these you know perfectly sculptured penises and they have these little thrusting machines where they can adjust the angle and the force and the speed. And then they've got this liquid substance that perfectly simulates semen and they find that penises are perfectly designed for displacing the semen of other men. It's like this *pile-driver*: it **goes in** and just kind of *shoots it out to the side* and you do find more vigorous penile thrusting following a period of absence from one's partner.

The professor starts out by describing the setting of a laboratory experiment that investigates the human penis as a semen displacement device. In the study the professor refers to, researchers have used artificial penises and vaginas in order to test if the human penis is in fact able to displace semen that was left in the vagina by a different male. The study also investigates which parts and mechanisms of the penis are crucial in the displacement process by manipulating different features of the artificial penises (Gallup et al. 2003, reported in Goetz/Shackelford 2006)². Once the professor has summarized the setup of the laboratory study, he states the conclusion of the experiment: Penises are perfectly designed for semen displacement. He then uses a deliberate metaphor that compares the penis to a *pile driver* in order to explain in how far the design of the penis helps displacing other men's sperm. The deliberate metaphor has the form of a simile and thus sets up an explicit comparison, forcing the students to consider the target domain (PENIS MECHANISMS) from the perspective of the source domain (PILE DRIVER). The professor proceeds by clarifying which aspects of PILE DRIVER are supposed to be mapped onto the

² According to the professor himself (personal communication), what he explains in the excerpt of example (2a) is based on an edited volume by Platek and Shackelford (2006), in which two different chapters (one by two of the initial researchers, Gallup and Burch, and the other one by Goetz and Shackelford) describe or refer to the original study by Gallup et al. (2003).

target domain. Apparently, the two domains share that they “go in” (into the ground and into the vagina, respectively) and shoot “it” out to the side. The “it” is supposedly the soil in the source domain and the semen left behind in the vagina by other men in the target domain. Although the target domain in itself is quite concrete and the process of vaginal penetration is probably familiar to most students, the idea that the form of the penis and the manner of penetration is supposed to displace possible left-over sperm from rival males is presumably unfamiliar to the students. We would expect that their concepts of penis and penetration still relate to a folk idea about (the purpose of) sex that do not include expert concepts of adaptive mechanisms to secure maximal reproductive success (even in the case of multiple mating partners of females). Thus, the metaphor of the pile driver that supposedly *shoots soil out of the ground* while ramming a pile into it seems to be a helpful comparison. In both cases, something new is supposed to take up space and displace something else that is already inside. This may help the students to consider the penis as more than a device to fertilize the egg and thus result in a cognitive change in regard to their concept of the function of the penis.

However, upon closer examination, the metaphor has several problems in furthering the students’ understanding of the target domain. First of all, the source domain does not exhibit the characteristics ascribed to it by the professor. When a pile driver drives poles into the ground, the soil is usually not visibly displaced. The device does not normally “shoot” anything “out to the side”. Typically, the poles slide into the ground quite slowly and it cannot be seen where the soil previously taking up the space ends up. Despite this incorrect portrayal of the source domain, the metaphor may still be understood and produce the intended change in perspective, because the professor spells out the designated mapping. Even though the aspects he wants the students to map onto the target domain are not present in the source domain, the explanation that immediately follows the metaphor might further the students’ understanding of the topic. Yet, another – more important – problem is that it is precisely the professor’s explanation that communicates a wrong understanding of how a penis actually performs the semen displacement. The penis does not “shoot” anything “out to the side” either. According to the study the professor is referring to, the laboratory experiments show that “the frenulum of the coronal ridge makes possible semen displacement by allowing semen to flow back under the penis alongside the frenulum and collect on the

anterior of the shaft behind the coronal ridge” (Goetz/Shackelford 2006: 176-177). This means that due to the thrusting, the semen basically gets “scooped up” by the penis and is pulled out of the vagina rather than “shot out”. It may be the case that the professor’s misconception of the manner in which the penis can achieve the goal of semen displacement stems from the fact that “more vigorous penile thrusting”, as the professor calls it, is indeed necessary. As Gallup et al. (2003: 281) specify, the more vigorous thrusting has to involve deeper thrusting, most of all. However, the idea that more force is involved might have led the professor to the erroneous assumption that the semen is displaced in a sudden and forceful manner, as implied by the metaphor “shoot out”. The aspect of great force is implied by “more vigorous thrusting”, which was indeed reported to be often present in sexual encounters when the males faced a situation that may have involved sperm competition. This finding is the result of a survey, also carried out by Gallup et al. (2003), which is reported in the same chapter of the edited volume the professor refers to (Goetz/Shackelford 2006: 177), and might have contributed to the misconception on the professor’s side. This might also explain the choice of the metaphor’s source domain pile driver. The hammer of a pile driver does exhibit great vigor when driving the piles into the ground. Therefore, the metaphor does capture some aspects of the manner associated with the penis when displacing semen. Since both *pile driver* and *shoot out* imply great force, this aspect of penile thrusting (in certain circumstances) is then, in all probability, understood by the students. However, the deliberate metaphor *pile driver* and the subsequent metaphorical elaboration using the phrase *shoot out* fail to communicate the central and crucial mechanisms of the penis that, according to Gallup et al. (2003), enable males to displace the semen of potential rivals.

Intriguingly, the professor does not end his explanation of the semen displacement theory with the metaphors illustrated in example (2a). He continues the explanation by rephrasing what he has said before, as shown in example (2b):

- b. **In other words**, if you’re away from your partner for a while, when you come back, in your sex there’s much more penetration than usual, so it’s almost as if...**ok I know there’s a risk here of some other junk being in here and we gotta take care of that**. None of this is conscious except at my house [students are laughing].

The formulation “in other words” indicates that the professor feels the need to rephrase his previous explanation. Hence, he does not seem to assume that his deliberate metaphor use was sufficient for teaching this particular scientific concept. At the same time, the vagueness of the professor’s description provided in example (2b) may indicate that the professor’s main aim is not necessarily that the students understand the exact fashion in which the penis performs semen displacement. The expression “more penetration” might refer to a number of manners of penetration – speed, vigor, duration, etc. – and the phrase “take care of that” is also not specifying the way in which this is supposed to happen. However, the professor uses another useful teaching device in example (2b): humor. Beginning with “ok I know...”, the professor jokingly voices the unconscious thoughts or intuitions a man may have after being away from his partner for a period of time. He then warns against a possible misunderstanding of the action as being consciously performed, by adding a joke about his personal sex life. The laughter of the students, apart from bringing some comic relief, may also indicate that they have understood the professor’s point. This additional explanation of the idea of semen displacement suggests that the professor’s focus may not so much be on the specific manner in which the displacement is performed. Rather, the professor seems to intend to make the students understand the overall theory of semen displacement, thereby transforming the students’ lay perspective on the purpose of mating into a more complex, academically informed concept. By using humor and voicing assumed evolutionary-determined intuitions of males in his second part of the explanation (example 2b), the professor creates a scenario which is probably easy to understand for all students, whereas the source domain PILE DRIVER in his previous deliberate metaphor may not even have been known to everyone. This, in combination with humor – possibly to attract the students’ attention – may facilitate a cognitive change on the side of the students. They may alter their concept of mating as a reproductive process to the concept of mating as a reproductive process that includes diminishing the possibility of other men’s sperm being more successful with the same woman. In turn, this reformed concept of mating supports understanding the unfamiliar theory of sperm competition as the bigger picture the professor is trying to communicate.

So far, we have seen deliberate metaphors that were used for explanatory reasons. Despite their pedagogical functions, these metaphors also bore possible

problems for the students' accurate understanding of the local topic. However, we do not have evidence that the problematic aspects of the deliberately used metaphors, which consisted of the danger of unintended and/or wrong mappings, are actually taken up by the students in their (future) reasoning about the scientific concepts at hand. At a cognitive level, however, the deliberate metaphors in examples (1) and (2) were also novel metaphors and therefore probably more salient than other parts of the professors' explanations. At the linguistic level, we found proof of deliberateness in the simile form of the metaphor in example (2). In example (3) below, we will be faced with a more interactive part of a chemistry lesson during which a student takes up the metaphor used by the professor in order to reason about subatomic particles. Unlike the examples discussed so far, example (3) features metaphors that are neither instances of novel metaphors (on a cognitive level) nor are they examples of direct metaphor use (on a linguistic level). However, as I will argue below, evidence of deliberateness in the metaphor use can also be found in examples of indirect and conventional metaphors. In the case of example (3), it is the accumulation of linguistic metaphors from the same source domain over stretches of the chemistry lecture and the resulting coherence in the use of metaphors that may be seen as evidence for deliberateness.

4.3 Deliberate metaphor in nuclear chemistry

The next excerpts in example (3) are taken from general chemistry, an introductory chemistry class. The topic of the lecture is nuclear chemistry. The professor is concerned with explaining the behavior of subatomic particles and the nucleus in order to make the students understand what kinds of radioactivity exist and how they happen. Interestingly, the professor often personifies the subatomic particles as well as the nucleus in his explanations, which is illustrated by example (3). In the following analysis, I will consider the use of personification in different parts of the lecture and argue that the accumulation of those metaphors suggests a deliberate use of metaphor. I will start with examples (3a) to (3c), in which the professor tries to explain the behavior of one of the most common radioactive particles, the beta particle, which is essentially an electron (or a positron). A student is confused, because in his understanding, in the example they are discussing, a proton is needed to change from Iodine to Xenon, and not, as the professor states, an electron. In his

explanation, the professor clarifies that they have a neutron, which is a composite of a proton and an electron. By becoming a proton, the neutron loses the electron, which is the beta particle. This process is described metaphorically by the professor in (3a) and again in (3c), after a student asks for further clarification (3b).

(3)

- a. Prof: And so, we've got an actual nuclear particle, falling apart. And when the neutron falls apart, *spits out* an electron, it becomes a proton. And that's how we can go from Iodine 53 protons to Xenon 54 protons and *spit out* the electron. It's because one of the nucleons has changed the *identity*. (...)
- b. Student: So, the Iodine is losing a neutron, but it *kicks off* an electron?
- c. Prof: (...) It's just that one of the neutrons becomes a proton. And in that process, you know, *pukes out* an electron.

As I already mentioned above, all of the professor's metaphors in example (3a) and (3c) are instances of indirect metaphors. In example (3a), the professor's first use of *spit out* suggests that he compares the behavior of a neutron to that of a living being. His second use of the phrase is less clear, since it refers to "we", suggesting that he and the students spit out the electron in the process of doing an equation (on the board). However, as we will see in the following, the professor's usual pattern is to ascribe human features to the subatomic particles and the nucleus. He concludes his explanation process of where the electron comes from by ascribing an identity, something that is usually exclusively ascribed to human beings, to a nucleon. This demonstrates that he is not only personifying neutrons, but different subatomic particles. Describing subatomic particles in terms of human characteristics, and their behavior in terms of human behavior, allows the students to draw on a familiar domain when trying to understand ideas and processes of chemistry that are not at all perceivable with any of our senses. In fact, the nature of subatomic particles is still being examined by scientists. One of the major problems of investigating those particles is actually that they can barely be made perceivable.

Personification is a rather common type of metaphor and the mapping between the broad source domain HUMAN BEINGS on the one hand and the target domain SUBATOMIC PARTICLES on the other hand may therefore be characterized as conventional. However, some of the particular linguistic metaphors (probably

spit out and *puke out*) could also be seen as novel extensions of this rather general conventional mapping between human features and any number of other phenomena. These novel extensions were then probably used deliberately by the professor with the intention to make the students consider subatomic particles from the perspective of human characteristics.

Interestingly, when the student checks if he has understood the concept correctly in (3b), he seems to adopt the professor's use of personification. This may indicate that the student has indeed adopted this view on subatomic particles and uses the metaphor in order to reason about the topic at hand. Furthermore, he does not simply repeat the metaphorical expression that the professor has used before verbatim, but comes up with his own linguistic metaphor *kick off*. The metaphorical expressions *kick off* and *spit out* not only share the source domain person, but also the underlying image schema of actively getting something away from the body. Even though the professor's metaphor suggests a movement from inside the body, while the student's metaphor indicates motion starting at the surface of the body, the core aspect "movement away from the body" is present in both metaphors. Although the student uses a metaphor that supports the important aspects of the target domain, his understanding of the process the professor is trying to explain still seems to be unsatisfactory. Hence, the professor elaborates on the issue (3c), reminding the students that the number of nucleons does not change from Iodine to Xenon. He then concludes his elaboration by more or less repeating his statement from (3a). As we can see in (3c), the professor restates that the process of becoming a proton involves that the neutron loses an electron. Ridding itself of the electron is again described metaphorically, this time using the phrase *puke out*, which also has person as its source domain. Additionally, the metaphor is almost a near-synonym to the professor's original metaphorical expression *spit out*, and it is also based on the image schema mentioned above. It seems to be the case that using metaphors that draw on bodily experiences like spitting and puking are intended to help the students to better grasp the chemical processes at hand, but as we have seen in the student's reaction in (3b), the understanding might only be partial. Hence, we may again classify the professor's metaphors as having an explanatory or a pedagogical function. However, we are now also in a position to see that such a pedagogical function may not always completely fulfil its aim in teaching scientific concepts at university level.

So far, we have just considered one short excerpt from the lecture and looked at a few instances of metaphors used by the professor that happen to share the source domain PERSON. This short excerpt alone does not necessarily prove that the professor is deliberately using metaphor, or more particularly, personification, in order to facilitate the understanding of subatomic particles and the nucleus. However, as the class proceeds, we find more instances of this explanation strategy. This is illustrated in examples (3d) and (3e) below. Example (3d) occurs after the professor introduced a new particle, the positron, in order to explain positron annihilation, which is another kind of radioactivity.

- d. Every positron that's ever *born* has one fake in store. One fake. It will have this happen to it: It will *find* that much more common version of itself – an electron. It will *find* it.

On a linguistic level, the professor's metaphors in (3d) are again instances of indirect metaphors. On a conceptual level, the metaphor *born* seems to be a conventional metaphor. According to the Macmillan online dictionary, it is used for the process of human birth in its basic sense, but more abstract senses like ideas being born are also listed. Thus, using the expression *being born* to map this process onto a non-human process does not seem to be completely novel. Looking up *find* in the same dictionary does not give us an undisputable answer in regard to the conventionality of the mapping in (3d). However, the examples used for the different senses only involve human agents or agents of human-lead organizations/institutions. Thus, we might classify *find* in (3d) as involving novel mappings and, in accordance with *spit out* and *puke out* in (3a) and (3c) above, classify it as a novel extension of the personification present in all excerpts of example (3).

If we look at the metaphors in (3d) more closely, we can see that apart from being born, the aspect of intentional acting is mapped from the source domain PERSON onto positrons. This metaphor probably helps to understand why positron annihilation is an inevitable process once a positron is emitted. If we did not think of positrons as intentionally searching for an electron, we might think that the two particles do not necessarily have to collide with each other in cases of positron emission. This again exemplifies the explanatory function of deliberate metaphors in science teaching. However, subsequent questions from students indicate that this metaphor seems to have led to the assumption that positron annihilation is a very common process. Thus, the professor has to

clarify that positron emission is rather uncommon to begin with. As example (3e) illustrates, he does so by using personification again.

- e. You have to have an *unhappy* nucleus in its whole in order for something like this to happen. (...) And they have to be, they have to be unstable in the whole nucleus for it to want to *spit* something *out*. And the thing that it *spits out* is going to be to some extent dependent upon what the source of its problem is.

In order for positron emission to happen, many different aspects of a nucleon have to be unstable. Since this seems to be a complex phenomenon, the metaphor *unhappy* is probably quite suitable to help the students understand that a lot of things need to come together for positron emission to take place. From our experience as human beings, we know that usually several things have to happen to make us unhappy. A single aspect going wrong in our lives does not normally lead to unhappiness. After this new instance of personification, which again captures a different aspect of the source domain person in order to explain an aspect of nucleons, the professor proceeds by repeating the metaphor *spit out*. However, this time, it is used to further describe the nucleon and not, as we have seen in (3a) and (3c), a subatomic particle. Just as the previous metaphors, the ones used by the professor in (3e) are also indirect metaphors. The only metaphor that has not been discussed so far is *unhappy*, and on the conceptual level, we can classify this metaphor as also being conventional. So far, the professor's metaphors discussed here are all indirect metaphors that also share the common source domain HUMAN BEINGS. Several of those metaphors are also quite conventional, whereas only some seem to be novel extensions of the mappings between source and target domain. Although in his teaching of scientific concepts, the professor uses mainly indirect conventional metaphors, which by themselves are not particularly salient in discourse, his metaphors still seem to stand out and invite the students to consider the topics at hand from the source domain (HUMAN BEINGS) perspective. That this indeed seems to be the case is indicated in (3b), where a student actually uses a semantically related metaphor in his question in order to reason about subatomic particles. In part, the professor's deliberateness of metaphor use seems to be due to some of the novel extensions, but mostly, it seems to be the accumulation of metaphors forming a coherent set of expressions from the same source domain that suggests a deliberate pattern with a pedagogical function here.

Later on in the lecture, we find further evidence that the professor deliberately uses metaphors involving personification in order to explain the scientific concepts he tries to communicate. This time, the deliberateness of the first two metaphors highlighted in (3h) is more easily detectable due to the metaphor's linguistic form "A = B". This will be discussed in more detail below. In regard to the context of the example, in (3h) the professor again has to clarify a concept after a student signals that he has not yet understood it (3g). In the excerpt below, the student struggles with comprehending the concept of K-capture, yet another kind of radioactivity.

- f. Prof: Yes, that's right. So, when you do this, you gonna take carbon and you gonna make it into boron.
- g. Student: How does the electron get to the (?) ?
- h. Prof: It's probably (?), I mean, how do you know that a particular electron is *Jake*, the electron that you've *been friends with* forever? I mean, once the electron, you know, sort of gets into the range where it's (?) the other electrons, then its *identity* is very uncertain.

In this excerpt, the professor tries to convey the idea that it is not possible to correctly identify and trace a particular electron once it is in a certain atomic region. In order to do so, he compares an electron with a human being. Being able to trace and identify a particular electron is seen as being friends with another person. If we are friends with someone, we are usually able to identify and detect them – and to follow their movement – in a group of people, whereas we might not be able to identify anybody else in an amorphous group of people, or notice their movement.

In the final sentence of (3h), the metaphor *identity*, which already came up in our analysis of example (3a) above, enforces the professor's use of personification for subatomic particles, which we have already witnessed in the previous parts of example (3). However, this time, the professor does not simply draw on aspects of human beings in general. Giving the electron a name and calling it a *friend* is a more individual specification of this metaphor. Whereas in the preceding parts of the lecture, the professor used general aspects of human beings in his metaphors (e.g., being *born*, the ability to *spit* and *puke* something out), he is now referring to a specific person that he calls *Jake*. In addition to being more individual than the previous metaphors, this metaphor also stands out in terms of its linguistics form. For the first time, the professor uses a metaphor in the "A = B" format ("[an] electron is Jake"), explicitly comparing

an electron to an imagined, but specific, human being. This particular form of a metaphor is given as an indicator of deliberate metaphor use by Krennmayr (2011: 154), because such a form draws the attention to the comparison between source and target domain and makes the addressee “aware of the intended metaphorical use of an expression” (ibid.). Moreover, the professor’s metaphors in (3h) probably also draw special attention to the source domain by bringing in humor. It seems to be a comical note that the professor is not only asking the students to think of an electron as a long-lasting friend, but that he is also giving it a specific name, *Jake*. According to Krennmayr (2011: 155) metaphorical units eliciting rhetorical effects such as humor, like the metaphors in (3h) are also likely to be used deliberately. Thus, the linguistic form and the rhetorical effect of “Jake metaphor” together are strong indicators for deliberateness in the professor’s metaphor use. Although the professor’s explanation does involve humor, the main function of the excerpt above, including the metaphors used by the professor, still seems to be pedagogical/explanatory.

To summarize, the metaphors discussed in the discourse reported as example (3) illustrate how the professor seems to be systematically employing personification in order to further the students’ understanding of subatomic particles and the nucleon. In each case, the metaphors focus on different aspects of human beings, for example intentional action (3d), having emotions (3e), or friendship (3h). Yet, all of these metaphors share the same source domain human being, which, since we all are human beings, is so familiar to us that it has great potential in aiding our reasoning processes about less familiar and more abstract domains (in this case, subatomic particles and the nucleon). In contrast to the metaphors discussed in example (1) and (2), the metaphors in example (3) are all indirect metaphors and mostly conventional metaphors. However, the fact that the professor uses various linguistic metaphors instantiating the same source domain, combined with the observance that he uses this coherent set of personification metaphors throughout his lecture – and at points where problems in the students’ understanding arise that require clarification – indicates that he uses those metaphors deliberately. The situations in which these personifications occur also suggest that his purpose in using metaphors is to clarify problematic issues of the topic at hand and thus to further the students’ understanding. We can thus classify these metaphors as having a mainly pedagogical function. Particularly the dialogic sequence (3a) and (3b) shows that students are indeed able to adopt the alternative

perspective on the topic offered by the metaphors and to reason from that point of view.

4.4 Deliberate metaphor in social psychology

Another interesting instance of deliberate metaphor use takes place in a social psychology class. The lecture is about aggression and the professor explains different theories of aggression. The professor has already talked several minutes about Freud's idea of *Eros*, the human sex drive. In the excerpt in example (4), he describes what Freud considered to be the instinct opposing *Eros*: *Thanatos*.

- (4) He [Freud] called this instinct *Thanatos*. And sometimes this is called the death instinct. And so, he began to change his model of human nature to one that was kind of a *battle* between these different *competing* instincts – a *battle* for which type of energy would *win out*. To use Star Wars terminology: This would be our *dark side*. This is the part of us that is aimed toward destruction.

As we can see in example (4), the professor explains Freud's model of the human nature by using several indirect metaphors that share the source domain COMPETITION, namely *battle* (twice), *competing*, and *win out*. This accumulation of coherent metaphorical expressions in one sentence already suggests that the professor is using these metaphors deliberately (cf. Krennmayr 2011: 154). Instincts, which are part of our psyche and hence not a physical phenomenon, are not perceivable with our senses. Comparing the opposing dynamics of two instincts to two opponents in a competition allows the students to understand the topic at hand by drawing on a conceptual domain they are familiar with. However, once he has set up the competition framework in order to explain the dynamics of the two instincts, the professor introduces a new comparison to elaborate on the nature of *Thanatos*. He compares the death instinct to the *dark side* in the movie series "Star Wars". Linguistically, this comparison is made explicit by using the phrase "to use... terminology". Thus, the professor explicitly instructs the students to consider the topic at hand, *Thanatos*, from the perspective of "Star Wars", which makes this an exemplar case of deliberate metaphor. Intriguingly, the dark side of the force in "Star Wars" is a very abstract and complex concept in itself. It basically represents those aspects of a mystical, invisible energy that permeates the "Star Wars" galaxy, which are considered to be evil and destructive by the "Star Wars" characters portrayed

as “good”. It is probably precisely this ability to mentally assign a certain group of characters (the antagonists) to the dark side, which makes the source domain less abstract than the target domain. However, throughout the movies, the use of *the dark side* seems to reflect exactly what *Thanatos* and *Eros* seem to be: competing internal forces that lead us to “evil” or “good” behavior. This would make the primary function of the “Star Wars metaphor” a pedagogical or explanatory one. It is questionable, though, if the entire student audience is in fact familiar enough with the source domain to appreciate the metaphor’s explanatory value. On the one hand, a rich knowledge of the “Star Wars” movies probably allows the students to map a wide set of aspects from the source domain DARK SIDE to the target domain THANATOS. On the other hand, the exact mappings highly depend on the understanding of the source domain, which is not only rather difficult in this case (as opposed to the personification in the chemistry excerpt above, for example) but probably also very individual. Yet, a crude understanding of the basic plot should at least allow the students to assign the “bad guys” to the dark side, which facilitates a basic understanding of the concept THANATOS. The fact that not all students may be familiar with “Star Wars” in the first place might have led the professor to clarify that Thanatos is the instinct which is aimed toward destruction in the last sentence of example (4).

Apart from its explanatory function, the metaphorical comparison of Thanatos with the dark side in “Star Wars” possibly also serves other functions in the professor’s teaching. Presumably, “Star Wars” is seen as a series of cult movies among at least a group of students. Mentioning “Star Wars” and displaying knowledge about the series on the professor’s side may facilitate a certain degree of social bonding between the professor and some students. The professor may have chosen this metaphor to reduce the distance between him and part of his audience in terms of age and superiority. Thus, an additional function of this metaphor might be to indirectly deliver a statement along the lines “I am just like one of you – I am interested in similar things like you”. Yet another possible function of this particular deliberate metaphor, apart from its explanatory and social value, might be to rouse interest in the topic at hand. Deliberate metaphors like *dark side* in example (4), *Frankenstein* in example (1) and even the humorous *Jake* metaphor in example (3) may not only be employed for their (possible) cognitive value, but also to keep the students interested in the scientific concepts at hand – and maybe even in order to entertain them to a

certain degree. This would also explain why the professor in example (4) used the *dark side* metaphor after he had already begun to explain the concept at hand by means of metaphors from the source domain COMPETITION. The particular competition involved in the movie series “Star Wars” might be more interesting and entertaining than just referring to competitions in general.

5. Conclusion

My corpus-based analyses of authentic excerpts of US-American college lectures showed that *deliberate* metaphors are indeed used in order to communicate abstract scientific concepts in biology, chemistry and psychology. In my detailed discussion of each example, I pointed out the linguistic and contextual clues for deliberateness in the professors’ use of metaphors. This demonstrated that deliberate metaphors can be multifaceted and thus come in quite different forms – reaching from rather obvious cases of direct and novel metaphors to those that are novel but indirect. Example (3) even illustrated cases of indirect and conventional metaphors that seemed to be used deliberately as a teaching tool. Hence, the clues for deliberateness range from linguistic signals, as the “*like*” particle in example (2) or the phrase “to use Star Wars terminology” in example (4), and cognitive signals, as the novelty in the mapping between *Frankenstein* and *transcription factors* in example (1) or between *Thanatos* and the *dark side* of “Star Wars” in example (4), to contextual clues like the accumulation of metaphors from the same source domain in example (3).

Moreover, my analyses have demonstrated the different functions of deliberate metaphors in teaching scientific concepts. The dominant function of the professors’ metaphor use seems indeed to be a pedagogical or explanatory function. In all lectures, metaphors were used deliberately in order to offer the students a presumably more familiar source domain at points when abstract concepts needed explanation. Hence, deliberate metaphors are used as a teaching tool in science education at university level. However, the success of this teaching tool is not always clear. Several problems possibly arise from the professors’ use of deliberate metaphors. They range from potentially wrong mappings suggested by a metaphorical model, as we have seen in the *Frankenstein* metaphor in example (1) and the *pile driver* metaphor in example (2), to the possibility that some students are not familiar enough with the source

domain, demonstrated by the *dark side* metaphor in example (4). On the other hand, the personifications in example (3) have illustrated a case of a presumably successful use of deliberate metaphors as an explanatory tool. In this excerpt we have even found evidence that students take up the professor's metaphors and use them in order to reason about the topic at hand.

Although the explanatory or pedagogical function of deliberate metaphors seems to play a central role in the excerpts of the college lectures presented here, we have also found other functions of deliberate metaphor use. In example (3), for instance, combining a deliberate metaphor with humor seemed to have the additional function of arousing the students' interest in the topic. Furthermore, this particular deliberate metaphor may even have an entertaining function for the student audience. Yet another potential function of deliberate metaphor in teaching scientific concepts could be detected in one of the psychology lectures. The reference to the concept *dark side* of the movie series "Star Wars" in example (4) indicates that the (social) function of this metaphor is, apart from its cognitive value, to lessen the power differences between professor and students, an imbalance between speaker and audience which is generated by the overall discourse setting of college lectures.

Despite the few problematical issues that some specific deliberate metaphors may cause (as, for instance, unintended mappings), deliberate metaphors not only "stand out" from the mass of non-deliberate metaphors, but also seem to be a valuable tool for teaching scientific concepts. As the examples have demonstrated, they are intended to fulfill various functions in college lectures and we have even seen evidence that the pedagogical function was carried out successfully, since a student used the metaphors to reason about the topic at hand. However, it would also be interesting to know if the use of deliberate metaphor actually also results in greater learning success. In order to find that out, studies investigating and testing the learning outcome would be interesting directions for future research.

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