Published in Bulletin VALS-ASLA (Swiss association of applied linguistics) 83-2, 93-106, 2006
which should be used for any reference to this work

Popular Transfer of Scientific Knowledge – The Development of a Rhetoric of Science

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Wissenschaftliche Texte gelten außerhalb ihres jeweiligen Fachbereiches als ein "Buch mit sieben Siegeln". Dies gilt in besonderer Weise für Texte aus den Natur- und Technikwissenschaften. Die wesentliche Ursache hierfür liegt in der Art und Weise der Darstellung und Vermittlung der Wissenschaften. Wissenschaftliche Erklärungen müssen verständlich sein, sie dürfen den jeweils beschriebenen wissenschaftlichen Sachverhalt nicht verfälschen; sie müssen aber zugleich auch Vergnügen bereiten und Neugierde wecken. Diese Neugierde kann nur durch eine geeignete Wissenschaftsrhetorik geweckt und aufrechterhalten werden.
Der vorliegende Beitrag stellt ein Forschungsprojekt zur Entwicklung einer "populärwissenschaftlichen Rhetorik" vor. Anhand von umfangreichen korpuslinguistischen Untersuchungen von wissenschaftlichen und populärwissenschaftlichen Texten soll ein rhetorisches Modell entwickelt werden, das Empfehlungen und Richtlinien für die Erstellung von populären wissenschaftlichen Darstellungen enthält und die folgenden Bestandteile aufweist: terminologische Erklärungen von fachlichen Begriffswelten, rhetorische Techniken und Strategien der Vermittlung von Wissenschaft und grammatische "Konstruktionen". Ziel des Projektes ist zum einen, die sprachlichen Eigenschaften von populärwissenschaftlichen Texten und die Bedingungen eines erfolgreichen populärwissenschaftlichen Diskurses zu untersuchen; zum anderen, die terminologisch-begrifflichen, rhetorischen und grammatischen Eigenschaften von populärwissenschaftlichen Texten in einem "Konstruktionswörterbuch" zu erfassen und zu formulieren. Dieses Wörterbuch soll als praktische Anleitung dienen, um wissenschaftliche Sachverhalte zielgruppenadäquat und verständlich darzustellen. Gedacht ist an ein breites sprachliches Instrumentarium, das es erlaubt, bei bestimmten Zielgruppen ohne Expertenwissen (z.B. Kindern und Jugendlichen) gezielt und nachhaltig Neugierde für wissenschaftliche Probleme zu erzeugen.
Das Kernproblem einer Wissenschaftsrhetorik ist das Paradoxon des Strebens nach Wahrheit, Exaktheit und Effektivität auf der einen und des notwendigen Wissenstransfers auf der anderen Seite. Der vorliegende Artikel versteht sich folglich als ein Beitrag zur wissenschaftsrhetorischen Diskussion insgesamt als auch zur Verbesserung des populärwissenschaftlichen Wissenstransfers.

Schlagwörter:
Wissenschaftsrhetorik, Kinder-Universität, Populärwissenschaft, Wissenstransfer, Konstruktionsgrammatik.

1. Introduction

When I was young, my parents gave me the book *Wir entdecken das Wunderland der Musik* (Pahlen, 1968) as a birthday present. This book was written by Kurt Pahlen, a well known scientist and musician from Zurich. At the very beginning of the book, Pahlen describes how he met the children he intended to write for. To his great surprise, the children did not seem to understand the contents of the book:

> "*Sie sind doch Herr Pahlen?*" *Ich nickte, ein wenig belustigt, ein wenig verwundert. Er [der Junge, Hinzuf. vom Verf.] fuhr fort: „Sie haben ein Buch über Musik geschrieben […] Und da sind gleich am Anfang zwei schöne Bilder drin, von Kindern, die Flöte spielen und singen […], setzte das kleine Mädchen fort.* "*Und darunter steht gedruckt: 'Freude an*

> *der Musik ist allen Kindern angeboren!'", ergänzte nun wieder der Junge. "Das stimmt doch auch?" erwiderte ich vergnügt. Aber dann sah ich, dass meine beiden Besucher sehr ernste Gesichter machten […]."Wir wollten das Buch lesen", sagte der Junge fast streng. "Aber wir haben nichts davon verstanden", ergänzte das Mädchen. "Fast nichts […]", korrigierte er (Pahlen, 1968: 5 f.).*

I can remember that this statement moved me a lot when I was reading the book. I was sad and could not really understand that a book written for children could possibly be incomprehensible for them. After many years, I returned to the topic of knowledge transfer at the suggestion of Gerd Antos from Halle University. The current paper roughly outlines the concept of a rhetoric model of science that helps transfer scientific knowledge to non-experts.

"The Rhetoric of Science" (Gross, 1990) refers to both the rhetorical conditions of scientific texts and the rhetoric features of popular scientific texts trying to explain scientific concepts. Traditionally, the term rhetoric refers to the study of persuasive speech and writing. In this paper, rhetoric is used in the sense of a set of guidelines and rules based on a comprehensive study of scientific and popular scientific writings. Hence, rhetoric refers to the result of linguistic analyses rather than to linguistic processes like speaking or writing. The aim of the proposed research project is to develop a rhetoric model helping to make science transparent and intelligible to people without scientific background. In comparison with the title of Gross´ book, our model can be called "the rhetoric of popular science".

In the next section, I will explain the need to develop a rhetoric model for the transfer of science, and suggest three elements of this rhetoric. In the third section of this paper, I will then present these elements and explain how they fit into the suggested rhetoric model.

2. The Need for a New Rhetoric of Science

On the current book market, you can observe an increasing number of popular treatises that deal with scientific topics. Non-fiction books are flooding the market, but they are regularly praised by critics and journalists. Readers appreciate that their problems are taken seriously and feel integrated into the secret circle of science. Literary criticism of popular books on science most often refers to the language and style. These books are described as "gehaltvoll, aber leicht geschnürt" ("Sofies Welt"),"eine verständliche Einführung in die heutige Sprachsituation" ("Wörter machen Leute"),"unterhaltsam und leicht verständlich" ("Die Welt der Hieroglyphen"), "amüsant, spannend und leicht zu lesen" ("Theos Reise"),"auf vergnügliche Weise und mit vielen unterhaltsamen Beispielen" ("Wer fremde Sprachen nicht kennt") or "wissenschaftliche Darstellungen von literarischem Rang" (various publications by Hans-Martin Gauger).

There is a long list of labels you can stick on those books that describe specific scientific topics in a clear and distinct manner. In fact, this is one of the main features of non-fiction books: to present scientific knowledge to educated young people. These books are striving to make something clear that is normally beyond reach. I would deliberately use the words clear or intelligible instead of popularized because the latter clearly is a derogatory expression. I do think, however, that popularization should not be disqualified.

"Wissenschaft verstehen – wer möchte das nicht?" These are the words Jürgen Mittelstraß used to introduce one of his university speeches in Augsburg in 1996. Everybody wants to understand something, yet – and here you could intervene – nobody is able to understand everything. Science always seems to be hermetical. At least, wide areas of our modern society consider scientific research to be non-transparent and impenetrable. However, if science is meant to be hermetic, isn't popular science a kind of anti-hermetic writing? According to the rhetorician Gert Ueding (1996), there is no scientific problem that cannot be understood by a high school graduate if only he or she is curious enough.

In the Norwegian language, the word Hermetikk is spelt with two 'kk' and means tin or can. Can we imagine popular science as an attempt to drag out of a tin what the various sciences have put in before? Certainly, this is not quite correct. And yet: Mittelstraß (1996: 9) holds the view that understanding science is still like preparing for a walking tour on the moon. Such a view would provide science with a very exclusive role. However, science has not always played such an exclusive role. Benjamin Franklin´s "Experiments on Electricity", Charles Darwin´s "Origin of Species" or James Watson´s "Double Helix" aimed at everyone who was interested in a specific topic. Today, many scientists, especially from the Humanities, start to write in order to find their way in the "wood of erudition"[1]. How intelligible is, can and should science be?

This paper provides some preliminary answers to these questions, particularly with respect to young people aged about 12 to 16. Young people grow up in what we believe to be a so called society of knowledge or Wissensgesellschaft[2]. Clearly, our modern society cannot solve its problems if it misunderstands or even ignores scientific problems. Consequently, young people are the main target group of scientists and journalists. This is mirrored in the great number of non-fiction books, magazines and TV shows that are

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1 This is an expression from Jürgen Trabant (2003). Trabant comments on the reasons for his writing as follows (2003: 13): "*Der Wald der Gelehrsamkeit […] ist ebenso ehrfurchtgebietend wie undurchdringlich geworden, so dass ich versucht habe, mir selber durch das Schreiben Klarheit zu verschaffen […].*"

2 This is what Uwe Pörksen calls a Plastikwort. This is a word that conveys so many shades of meanings that it becomes almost meaningless.

targeted at young people. The great success of books on natural sciences like "Physik für die Westentasche" or "Was Einstein seinem Friseur erzählte" shows that scientific or technical topics can attract young people and make them curious to learn more about these topics.

The title of this paper sounds somehow provocative. This is because the term popular science itself is considered a contradiction. Scientific authors who write in a popular manner are said to write incorrectly. What is more, many people are prejudiced on hearing the word popularization without even knowing what it means to write popular scientific prose.

According to Eckart Klaus Roloff, journalist for the newspaper "Rheinischer Merkur", popular scientific writing includes a distinct and vivid style, the use of examples, avoiding gibberish, and using quotations (Roloff, 2001: 53).

Do scientific authors distort the original scientific idea when they try to be clear in what they say? I do not think so.

I was born in the former GDR where we used to have the URANIA, the society for the popularization of scientific knowledge. Although the ideological aspect was always visible, the various URANIA publications were meant to make science transparent to non-experts and thus legitimize it. This point of making science transparent is still a valid one, and hence should be the main objective for all scientists. Common sense, however, considers scientific texts to be obscure and non-transparent, particularly in the German-speaking scientific world. Here young scientists are asked to write complex scientific prose in order to improve their image and make them known in the scientific community. Outside this community, scientific prose is considered to be a mystery or closed book. This is true for both subjects from the natural sciences and the humanities. Scientific articles are appreciated as being highly valuable only if the scientific community understands and accepts them. The members of the community are like initiates who have been allowed to join the group and have been taught its secrets. As long as the various sciences hide from the outside world instead of trying to communicate their knowledge, the process of legitimization will not be successful. According to Paul Feyerabend (1997: 393), the separation of science and non-science is not only artificial, but also a hindrance to scientific progress as such. Hence, the scientific world and the public discourse about science are two sides of the same coin.[3]

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[3] The physicist C. P. Snow writes in his novel "Entscheidung in Barford" (1970): "*Wissenschaft wurde in der Öffentlichkeit betrieben, das war ja einer der Gründe dafür, dass sie ihre Siege errungen hatte; wenn sie sich in kleine Gruppen zurückzog, die ihre Ergebnisse voreinander verheimlichten und horteten, würden sie schließlich nichts besseres mehr sein als eine Sammlung von Kochrezepten […]*".

Linguistic research has been aiming at specific strategies of popularizing science (Niederhauser, 1999) and at the difficulties that make popularization virtually impossible (Liebert, 2002). However, no royal road to success has so far been found. Apart from numerous linguistic books advising you how to talk and write, there is still no systematic and practical rhetoric of science. A new rhetoric concept of scientific writing would have to offer a general model for popularizing and presenting scientific knowledge. A new rhetoric concept would have to offer recommendations for teachers and university lecturers how to teach science at schools and universities. And a new rhetoric concept would have to be successful in attracting many more people to deal with scientific subjects.

In German-speaking countries, a scientific rhetoric concept is still met with suspicion, although it has been practiced in many areas of our life, e.g. economy, public relations, and advertising. There is a huge contrast between the German-speaking and English-speaking scientific world with respect to their rhetorical attitudes. In the German-speaking world, the Anglo-American way of communicating scientific knowledge still has a relatively bad reputation. As a consequence, the number of graduates in the engineering sciences has decreased over the past years. In electrical and mechanical engineering, engineers are missing[4].

3. Elements of a Rhetoric Concept for Popularizing Science

In this section, I would like to briefly outline the core elements of a rhetoric concept for communicating scientific knowledge to non-experts. This concept is based on the idea to set up an interdisciplinary research project about the linguistic features of the so-called Children's University or Kinder-Uni[5].

This project assumes that transfer of scientific knowledge can only be successful if scientific understanding is accompanied by entertaining and amusing elements. If you feel entertained, you will learn voluntarily and try to satisfy your scientific curiosity. Scientific information is like medicine. It must not, however, be served like medicine. On the contrary: Scientific explanations should be served like sweets so that patients want to taste more of it.

The main objective of the research project presented in the current paper is to develop a kind of rhetoric dictionary that can be used for transferring science

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4 This is why transferring of science and technology and recruiting new students were the most important aims in the year of technology, which was initiated by the Federal Ministry for Education and Research (BMBF) in 2004.

5 This is a general term covering university lectures for children and teenagers on various scientific topics. The idea to offer lectures for children was born in Tübingen.

to the public. Such a dictionary must be based on empirical data that can be gathered using the following procedures:

- We can analyze scientific lectures that have already been taken place. The empirical data for such analyses should be provided by sessions of the Children's University, TV programs like *Sendung mit der Maus* and youth magazines like *GEOlino*.
- We can give young people an incentive to create their own rhetoric concept. The musician Kurt Pahlen who I mentioned at the very beginning of this paper strongly suggests that children write their own rhetoric of science (Pahlen, 1968: 7).

Independent of the decision where the empirical data comes from, we need to solve the question of which linguistic elements should be included in a rhetoric concept for the transfer of science. What we are looking for are new strategies and techniques for the transfer of knowledge that are highly effective und meet the needs of young people. Transferring scientific knowledge to non-experts is neither a repetition of every scientific detail, nor does it mean to simplify and falsify scientific topics. Ueding (1996) emphasizes that the main objective of a rhetoric project should be to simplify complex scientific structures and create a model that can be easily understood without detailed scientific background knowledge. This model should, however, contain those details that are absolutely necessary from a scientific point of view. Ueding does not say, however, which linguistic elements are suitable for creating his rhetoric model. Niederhauser´s book on conductivity describes linguistic strategies and techniques that are used in several articles about this topic. Niederhauser, however, does not succeed in creating a general rhetoric model for the transfer of scientific knowledge. In my opinion, the following elements should be part of a rhetoric model of science: the classical figures of speech (e.g., schemes and tropes), the patterns of linguistic organization in popular scientific discourse, and terminological and grammatical elements. Consequently, a new rhetoric of science should consist of at least three parts:

- Terminology of knowledge transfer
- Rhetorical strategies and techniques
- Grammatical constructions, including syntactic and semantic patterns of popular scientific discourse

3.1 Terminology of Knowledge Transfer

In his book Wissenschaftliche Plaudereien, the author and satirist Karl Valentin makes fun of the scientific jargon. Using neologisms and nonsense

words, he describes rain as "eine primöse Zersetzung luftähnlicher Mibrollen und Vibromen, deren Ursache bis heute noch nicht stixiert wurde".[6]

These and many other nonsense examples seem to demonstrate that any text can be made difficult by including a number of technical words. If this was true, it would be relatively easy to popularize a scientific text. You would only have to eliminate the technical expressions and foreign words. The reason for calling a text scientific is its specialized or technical terminology. To study a scientific subject means to study its terminology[7]. This includes identifying your target audience because a terminology in the sense of "collection of concepts and terms" should always be user-oriented. In other words, "die sozialen Zumutungen einer wissenschaftlichen Sprache [liegen] in den Begriffen" (*cf.* Kieserling, 2001: 20). Scientific terms[8] express scientific concepts or notions instead of single words, e.g., foreign words and neologisms. Terms cover the name for a scientific concept, the relevant features, and the scientific object itself. Languages for specific purposes always depend on the subjects they describe. Manfred Bierwisch (2001: 14) comments: "Was Polymerisation ist, kann man erklären, verzichten kann man auf die Wortbildung nicht". Bierwisch aims at the rational understanding of science and society. Popular science must explain how special terms function in the scientific realm they come from, and why they function in a specific way.

This approach takes two tendencies into account that have been heavily criticized at the international conference on the occasion of the 40th anniversary of the IGN[9] in Hamburg. In one of the conference lectures, Willi Schmidt complained about two features of popular scientific writing: the attempts to describe instead of explaining things, and about the fact that scientific research increasingly focuses on the economic benefit instead of intending to augment the knowledge that is valuable to everyone (cf. Wolfschmidt 2003).

There is yet another aspect: Scientific answers and explanations come from controversial discourses. Those who want to analyze scientific thinking will have to analyze scientific controversies. This, however, has so far been completely ignored in all attempts to transfer scientific knowledge. Scientific results are always presented as being final und unchangeable. Controversies and disputes among scientific competitors are not considered at all. Consequently, the first part of our research program will be dedicated to the

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6 Valentin, K. (1992): Sämtliche Werke, 8 Bde. u. Erg.-Bd. München (Piper).

7 Terminology is understood as a structured set of concepts and the terms used to represent them in a specific subject field.

8 Terms are linguistic representations of scientific concepts, characterized by special reference within a discipline.

9 IGN stands for "*Institute for exploring into the history of natural and technical sciences*".

analysis of how scientific authors deal with special terms in popular scientific prose. Here we would like to give recommendations to optimize natural language for the description of scientific purposes. Even today, some scientists hold the view that it is impossible to use natural language patterns for a description of natural sciences:

> *Die Umgangssprache ist nicht notwendigerweise vage, schillernd oder ungenau; das ist lediglich die ohne Könnerschaft gehandhabte Umgangssprache. Der Möglichkeit nach ist die Umgangssprache in der Darstellung der Wirklichkeit von beliebiger Präzision* (Hassenstein, 1979: 238).

To analyze scientific and popular terminology, we will have to describe which kinds of definitions or explanations are suitable for popular scientific prose. I would prefer to use the term definition[10] only with respect to terms from natural and technical sciences, and use the term explanation with terms from the humanities. This differentiation is based on structural differences between these sciences, some of which are listed below:

- established canon vs. large field of scientific knowledge
- vertically vs. horizontally organized knowledge
- analytical vs. hermeneutical understanding
- little vs. a lot of interference during translation

Taking these structural differences into account, terminological analyses aim at explaining which terms you need to transfer scientific knowledge, and which terms can be used to express scientific concepts.

When exactly are specific terms introduced in scientific texts and in popular scientific prose? How are they explained? And which types of definitions[11] are used to explain scientific concepts? Finally, the question remains which verbal and non-verbal designations are recommended to be used to express scientific concepts. When analyzing the terminology of knowledge transfer, the following difficulties are encountered:

- Definitions may vary due to different authors and target groups.
- If there is no proper content system, other kinds of knowledge have to be used, such as people's experience and examples, which again can vary.

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10 Definitions are linguistic descriptions of a concept, based on the listing of a number of characteristics.

11 Generally, the following types of definitions can be distinguished: content- or analytical definition (definitions according to *genus proximum* and *differentia specifica*), extensional definitions (definitions with reference to the parts of a concept), genetic and operational definitions (all processes in their order are named), definitions by context, and nominal definitions (e.g., using synonyms).

- If examples, pictures, formulas, etc. are used as definitions, they require extra effort of presentation; especially if they are not word-based.

3.2 Rhetorical Strategies and Techniques

The precise definition and designation of scientific concepts is only just the first step towards a successful transfer of scientific knowledge. Terminological definitions or explanations of concepts must be adequate for your target audience. Different target groups require different rhetoric approaches. If you want to transfer knowledge in a clear and concise manner, you need marked rhetoric abilities. Despite the increasing influence of the Internet, despite the increasing use of pictures and images, and despite experimental museums, language is still an essential element of knowledge transfer. However, the relevance of linguistic elements still needs to be further analyzed and applied to the realm of science. Definitions of terms frequently occur in controversial discourses whereas rhetorical figures play an important role in the transfer process itself. Analyzing stylistic inventories, however, is not a mechanical task. It also includes reflecting on the role of these figures in the sense of a – scientific or popular – text. Therefore, scientists must be able to handle a great variety of rhetorical devices in order to make non-experts curious to know more about scientific topics. In my view, any scientific fundamentals can be explained to non-experts. It is often underestimated that transferring knowledge from experts to non-experts happens every day. In fact, this is the standard procedure of knowledge transfer.

Incomprehensibility is caused by the presentation of science, not by the scientific content itself. No concept, however simple it may seem, can be made clear if you do not succeed in finding the right expressions or metaphors. You might reply, however, that making something clear is not simply a question of choosing the adequate expressions. It involves far more than the special effects of language production. Our rhetorical analyses should, therefore, include the theory and practice of techniques of argumentation, involving listeners/readers as well as speakers/writers. In addition, making something clear is a question of how we can change the way we look at our world. As soon as science contradicts our common way of thinking, human language reaches its limits[12].

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[12] *Cf.* the theory of relativity that you can only understand if you ignore our human idea of space and time. In his book *Das ABC der Relativitätstheorie* (1995), Bertrand Russell invents an imaginary story to explain why it is so hard for us to understand the fundamentals of this theory. Just imagine being high above the ground in the skies and losing consciousness. If you regain consciousness, you have completely forgotten who you are and where you come from but you are still able to understand what is happening around you. Then, it would be much easier for you than for anyone on earth to understand what relativity is all about.

No matter what you are describing, verbal or non-verbal utterances: If you develop a rhetoric model of science, you have to do a great deal of research into the field of applied rhetoric. You need to analyze the rhetoric and stylistic requirements that make an obscure scientific topic as transparent as possible. This process resembles the different kinds of scientific presentation in text books and non-fiction books.

3.3 Grammatical Constructions

Current linguistic development shows an increasing interest in surface phenomena of texts. Before that, the pragmatic tradition of discourse analysis had been trying to play off the communicative function of a text against its linguistic form. The communicative activity (meaning or function of words) was more important than the systemic approach (analysis of forms). Currently, both linguistic perspectives are being exchanged again. The systemic approach dominates whereas the communicative approach is thrust into the background. This means that a textual understanding not only depends on textual functions and meanings, but also on various phenomena on the surface of texts.

The concept of Textoberfläche refers to different linguistic phenomena, for instance contextual hints, topic elements of the sentence structure, collocations, text design, and linguistic expressions as form and results of speech acts.

The concept of a rhetoric model of science is dedicated to the linguistic expressions. These are lexicalized expressions in a specific scientific area. Every communicative act is realized by means of typical linguistic expressions with certain syntactic features. In discourse analysis, speech acts are assigned to text types. Both speech acts and textual functions can be recognized and understood only by the usage of typical lexical expressions. These expressions are only just lexicalized communicative acts. The main linguistic features of specific text types are neither their contents nor the text functions. The main features are the lexical surfaces of texts. The lexical elements create communicative acts and thus are responsible for the functioning and the understanding of texts.

What you can learn from a text largely depends on how the content is presented on the surface level. This presentation can be very different according to the scientific or popular character of the text. This is why a rhetoric model of science must provide some advice about the presentation of the text surface (linguistic expressions and text design) to make the transfer of knowledge successful.

The construction grammar model is being increasingly used for the explanation of surface phenomena. Construction grammar is the name for a grammatical theory that was developed in the 80ies in the Center for the Study

of Language and Information in Berkeley (USA). Within this theoretical framework, linguistic expressions are called constructs[13]:

> *What is perhaps unique about construction grammar is (1) that it aims at describing the grammar of a language directly in terms of a collection of grammatical constructions each of which represents a pairing of a syntactic pattern with a meaning structure, and (2) that it gives serious attention to the structure of complex grammatical patterns instead of limiting its attention to the most simple and universal structures (Fillmore/Kay, 1987).*

Construction grammar tries to answer the question of what kind of grammatical knowledge people possess, and what they have to do in order to be linguistically successful, or, in other words, to successfully transfer scientific knowledge.

Grammatical constructions are fundamental units that sentences and meanings consist of. The following example (*cf.* Fig. 1) shows a typical sentence structure with a number of constituents, word classes, and syntactical relations:

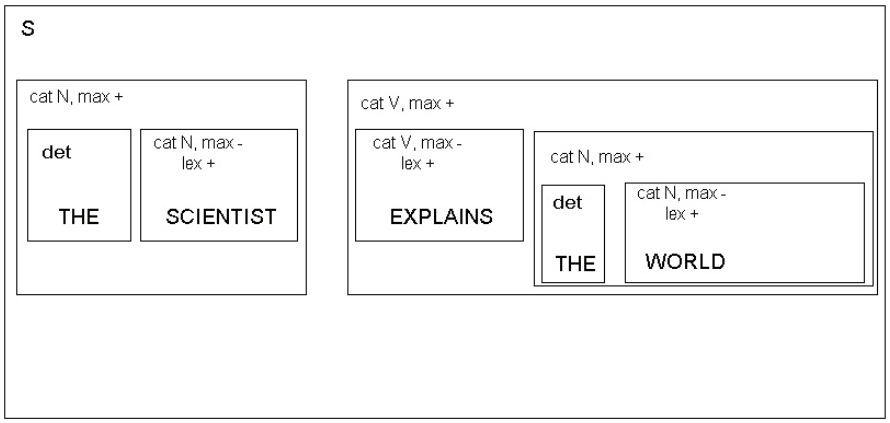

Fig. 1. Construction grammar analysis of a sentence

Because constructions are conventionalized routines that involve a pairing of form and meaning, they can exist independently from the words of a sentence. Constructions belong to a kind of superior category consisting of traditional grammatical elements that are rather schematic or formal (e.g., relative and interrogative clauses), as well as simple lexical items (e.g., words or lexemes). Our project will put special emphasis on less schematic constructions and more on substantive ones, such as idioms[14].

Generally, the representation of grammatical knowledge including syntactic and lexical items is called syntax-lexicon continuum (Langacker, 1987; Croft,

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13 For detailed information about construction grammar, *cf.* Goldberg (1995), which is the most influential book on this grammatical theory to date.

14 Fillmore, Kay, O'Connor (1988) distinguish a number of construction types by their degree of schematicity. A typical example of a rather schematic construction is the Declarative Passive construction, which can be represented as [*SBJ be-TNS VERB-en by OBL*].

2001). The syntax-lexicon continuum is a salient distinguishing feature of construction grammar in contrast to syntactic theories in the generative tradition. Formal and functional structures of grammatical units must not be separated. This means that the functional component (semantics and information structure) is an inherent part of the syntactic configuration. Each construction specifies the semantic roles of different syntactic positions in a sentence. In addition, encyclopedic information is also included with a description in construction terms, e.g. media-specific information, stylistic and social registers (scientific, religious, formal), recommended target groups, or even dialectal features.

I would like to put forward the following thesis: The transfer of science is based on grammatical constructions und their use in specific situations. To provide evidence for his, the following questions should be answered:

Which constructions and construction types are typical of the scientific communication and in the popular discourse about science? How do the structural differences between natural sciences and humanities influence the way science is presented in public? And finally: Which rhetoric strategies and presentation techniques can be recommended to be used in communication with specific target groups?

There are many different ways to present the final results of terminological, rhetorical and grammatical research. In this paper, I suggest using the so-called constructicon, which is an encyclopedic dictionary for all kinds of constructions. Whether we intend to have our research results included in a major terminology database (constructicon) or not, the information we will collect should be presented in structured terminological records. The constructicon will be used for storing the information relevant to each entry. From a terminological point of view, the constructicon will contain terms and definitions. From a rhetorical point of view, it will contain figures of speech, rhetoric strategies and techniques. And finally, from a grammatical point of view, it will contain syntactic constructions and categories (e.g., the passive construction, relative clauses, prepositions), as well as substantive constructions (e.g., words from the lexicon) and idioms (keep/lose your cool).

4. Summary

The aim of science is to determine the principles governing the physical universe. This process largely depends on the use of language. According to David Crystal (1991: 381), however, the gap between scientific and everyday language is still a large one. Scientists are often unable to express themselves in terms the lay person can understand, and there is a widespread mistrust of scientific language as such. As a consequence, there is no collection of

rhetoric methods and strategies that can be used for transferring scientific knowledge, especially from the natural and technical sciences.

The proposed "rhetoric of popular science" aims at bridging the gap between unintelligible scientific and everyday language. Scientists are obliged to sufficiently explain non-experts what they are doing in their research laboratories, and what public money is spent for. If scientists or scientific authors do not succeed in explaining research procedures and scientific results, we will return to a kind of mythic state, in which "keine Götter mehr herrschen", sondern "ein finsterer Verstand, der sich der wissenschaftliche nennt und sein Delphi in den Laboren geschaffen hat" (Mittelstraß, 1996: 13). To avoid this and justify the scientific research in almost all areas of modern life, both scientists and scientific authors should strive for a popular presentation of science.

The rhetoric model proposed in this study helps improve the transfer of scientific knowledge, using three basic components that have been explained in the preceding sections: scientific and non-scientific terms and definitions, rhetorical figures, strategies and techniques, and grammatical constructions. We claim that, using these components, it will be possible to create popularizations of science that maintain intelligibility while avoiding oversimplification.

To successfully create the proposed rhetoric model, we need to carry out the following tasks: First, we will have to isolate and identify the linguistic features that constitute the style of popular scientific prose (as opposed to scientific articles). Second, we will have to find out which components are appropriate for the various public target groups (e.g., children with no scientific background).

The result will be a comprehensive model that allows transferring scientific knowledge to non-experts more easily and intelligibly than ever before.

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