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Titel der Masterarbeit

„The relation between syntax, semantics and cognitive representation in the spatio-temporal domain.

An intra- and interdisciplinary comparison in cognitive linguistics and computational linguistics. “

Verfasserin

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Abstract

Spatio-temporal expressions are a prominent object of study, since they form an interface between perception, cognition and language. Both are fundamental physical quantities, which have to be perceived, recognized and expressed somehow. I selected four exemplary theories concerning spatio-temporal expressions from two different disciplines for my theoretical analysis. Talmy's cognitive semantic and Jackendoff's mentalist framework are situated in the field of cognitive linguistics. They are compared with two annotation methods from computational linguistics. Since both disciplines share a common endeavor, I wondered about the possibilities and chances for fruitful interdisciplinary work in this particular domain. Thus, it is the purpose of this thesis to investigate the commonalities and differences between these frameworks, on a theoretical and methodological level. In order to achieve this goal, I compare these theories in consideration of the following questions. 1) How do they define the nature of language? 2) What is their object of study? 3) How do they perceive the interaction between language and cognition? 4) What kind of methodology is applied? My analysis reveals that all four of them agree upon the existence of certain universal elements, which they try to relate to linguistic structures. In other words, they beforehand distinguish language from cognition, thereby isolating the linguistic structure from the conceptual content, which results in a gap that they have to bridge subsequently.

Deutschsprachiges Abstract

Raum-zeitliche Ausdrücke sind ein bedeutender Untersuchungsgegenstand, da sie eine Schnittstelle zwischen Wahrnehmung, Kognition und Sprache darstellen. Sowohl der Raum als auch die Zeit sind Grundeinheiten der Physik, die in irgendeiner Weise wahrgenommen, erkannt und ausgedrückt werden müssen. Für meine theoretische Analyse, wählte ich vier exemplarischen Theorien bezüglich raum-zeitlicher Ausdrücke, die aus zwei unterschiedlichen Disziplinen stammen. Talmys kognitive Semantik sowie Jackendoffs mentalistisches System sind dem Feld der kognitiven Linguistik zuzuordnen. Diese wurden mit zwei Annotierungsmethoden aus dem Feld der Computerlinguistik verglichen. Da diese beiden Disziplinen ein gemeinsames Ziel verfolgen, stellt sich die Frage, ob und inwiefern eine fruchtbare Zusammenarbeit möglich ist. Daher ist das Ziel dieser Masterarbeit die methodischen und theoretischen Schnittstellen dieser Systeme zu untersuchen. Um diese Aufgabe zu bewältigen, habe ich die vier exemplarischen Theorien auf folgende Fragen hin analysiert. 1) Wie wird das Wesen der Sprache definiert? 2) Was ist der Untersuchungsgegenstand? 3) Wie wird die Interaktion zwischen Sprache und Kognition aufgefasst? 4) Welche Methoden werden in diesen Forschungsrichtungen angewandt? Meine Analyse hat gezeigt, dass alle vier Theorien die Existenz universaler kognitiver Strukturen annehmen, welche sie in Zusammenhang mit linguistischen Strukturen zu bringen versuchen. In anderen Worten, besteht der erste methodische Schritt in einer theoretischen Differenzierung von Denken und Sprache, wodurch eine Trennung der linguistischen Strukturen von ihrer konzeptuellen Bedeutung erfolgt. Daraus entsteht eine epistemologische Kluft, die es im Nachhinein zu überbrücken gilt.

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1 Introduction

This master thesis contributes to the interdisciplinary work between Cognitive Linguistics and Computational Linguistics theoretically, by considering its potential and its limits.

I analyse this collaboration by comparing four exemplary theories, which have the same object of research: spatial expressions in language. Two of them are situated in the field of Cognitive Linguistics, which are the mentalist framework by Jackendoff and Cognitive Semantics by Talmy. To represent the field of Computational Linguistics, I choose two projects developing an annotation method, which are GUM-Space by Bateman et al. and ISO-Space by Pustojevsky et al. The purpose of this thesis is twofold. The first aim is to show that those theories are compatible in ontologically and epistemologically terms. This is the basis to collaborate in an interdisciplinary manner. The second aim is to show concretely how this interdisciplinary work could look like.

Computational linguistic is the scientific study of language from a computational perspective.[1] It is interested in providing computational models of various kinds of language phenomena. In order to develop these models, Computational linguists needs to study the structure of language. The particular aim of the two annotation methods that are compared in the course of this thesis, is to study the domain of spatial information. Therefore, they have to extract the structures in language, which represent spatial information. Briefly, they try to relate the structure of language to the semantic domain of space.

Cognitive linguistics is a subfield in Linguistics. It interprets language in terms of a conceptual system. Cognitive linguists are interested in the relation between language and cognition. Their research is based on the fundamental assumption that meaning is central to language as well as to cognition, which enables and drives their investigation of linguistic structures. Therefore, all scientists of this field agree upon the fact that meaning is a primary subject-matter of their research. “Linguistic structures serve the function of expressing meanings and hence the mappings between meaning and form are a prime subject of linguistic analysis. Linguistic forms, in this view, are closely linked to the semantic structures they are designed to express. Semantic structures of all meaningful linguistic units can and should be investigated.”[2] In their respective frameworks, Talmy and Jackendoff assume a fundamental relation between meaning

[1] http://www.aclweb.org/archive/misc/what.html

[2] http://www.cognitivelinguistics.org/cl.shtml

and the structure of language. Based on that assumption, both have developed a theory concerning the semantics of space. Nevertheless, each one has a particular scientific background. Jackendoff comes from the field of Generative Grammar, whereas the research of Talmy is situated in the field of Cognitive Science. Thus, they differ in their understanding of the emergence of meaning from the linguistic structure, as well as in their definition of the linguistic structure itself.

Computational linguistics is per se an interdisciplinary field. In order to find out the structure of language, computer scientists and linguists collaborate intensively. The origin of this scientific tradition can be traced back to the foundation of Cognitive Science. At the research summer project on artificial intelligence at the University of Darmouth in 1956, an interdisciplinary group of scientists decided to model human intelligence in an artificial system.

"The study is to proceed on the basis of the conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it. An attempt will be made to find how to make machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves. We think that a significant advance can be made in one or more of these problems if a carefully selected group of scientists work on it together for a summer."[3]

This citation shows a strong interest of the researchers in cognition and the general processes that are underlying it. One of their main aims was to simulate the acquisition and use of natural language. They wanted to solve this problem during that summer, but modeling natural language still remains today a major problem for computational scientists.[4] This interest in cognitive processes was shared by some linguists as well. The common criticism of both fields was addressing behaviorism, which reduces the study of cognition to an input-output mechanism, whereby actual cognitive processes remains untouched (black box). The aim of this new scientific stream was to explain the mechanisms inside the black box. A famous figure of the linguistic movement is Noam Chomsky, who developed his well-known theory of syntactic structures.[5] He developed a formal theory of syntactic rules for the linguistic system. The shared aim to explain the cognitive processes underlying the linguistic faculty resulted in the beginning of a lasting collaboration and the origins of Cognitive Science.

[3]Mc Carthy et al. , 1955

[4]50 years later

[5]Chomsky, N. (2002)

Models in Computational Linguistics were based on the theory by Chomsky. Since it was primarily focused on the syntactical level of language, they failed to account for the semantic level. A current proposal to solve this shortcoming is the development of models that involves conceptual information. Both annotation methods, which I analyse, are situated in this recent field.

The aim of my thesis is to show how the semantics of spatial information could be improved through the interdisciplinary collaboration of both disciplines. To fulfill this overall goal, I treat the following aspects. On the one hand, I analyze their respective theoretical background and compare them subsequently. It reveals that, although the four frameworks exhibit intra- and interdisciplinary differences, they share basic assumptions, which is why an interdisciplinary collaboration is possible and fruitful. On the other hand, my analysis is focussed on the semantics of spatial information. My semantic comparison of the four theories in terms of spatial expressions, show the agreements and disagreements among them concerning this domain.

In order to compare the four theories on an intra- and interdisciplinary level, my analysis is guided by following points:

1) The nature of language
2) The object of study (subject-matter)
3) The concept of meaning
4) Methodology

In cognitive linguistics language is seen as a cognitive system, whereas computational linguistics defines language as isolated formal system. The aim of my analysis is to reflect on this a priori difference by questioning their assumptions. Regarding the object of study, there are intra- and interdisciplinary differences. Intradisciplinary, the structure of language that represents semantics differs in both exemplary theories from the field of cognitive linguistics. Interdisciplinary, the main difference consists in the fact that computational linguistics has to account for formal aspects of language as well. Thus, its account of linguistic structures is limited to formalizable characteristics. The concept of meaning is central for both fields, since cognitive linguistics aims to study the conceptual level and computational linguistics wants to extract semantic information. Methodologically, there are interdisciplinary differences, based

on the respective purpose and setting of these disciplines. Furthermore, the methodological analysis allows differentiating between an explanatory and a descriptive approach.

In order to address these questions, my thesis is structured in three main parts. The first part consists in a comparison of both frameworks in cognitive linguistics in terms of the four questions above, revealing their ontological assumptions.[6] In the second part, I perform an analysis of the two annotation methods ISO-Space and GUM-Space, addressing the same four questions. These two parts represent my intradisciplinary analysis. The final part is an interdisciplinary analysis taking all four theories into account. Thereby I show the possibilities and limits of their collaboration.

[6] There is a long lasting debate in Linguistics about generative grammar and other theories. One critic to generative grammar is the fact that it don´t take into consideration the brain.

2 Spatial expressions in cognitive linguistics

This part is concerned with the analysis of the Cognitive Semantic framework of Talmy and the mentalist framework developed by Jackendoff. At first, in order to situate the work of these authors in the Cognitive Linguistic framework, I briefly present the history of Cognitive Linguistics and the importance of spatial expressions in this field. Subsequently, I analyze both theories in terms of the guiding questions (see introduction). The final step of this part consists in a comparison of both theories, and constitutes a reflection on the homogeneity of them, partly due to their deep roots in Linguistics.

2.1 Introduction: situating the field of cognitive linguistics

2.1.1 History of semantics

The Greek dictionary defines the etymology of the word „semantic“ as being derived from *semantikos*, meaning “significant“, which is from *semainen*, “to signify or show by sign”. This is a first indication that semantics is the study of meaning. Many books written on the topic agree that semantics as a discipline was founded in 1883, with an article published by Bréal. He provides the first definition of semantics: „the laws governing changes in meaning, the choice of new expressions, the birth and death of idioms deserves to have a name which will be called 'semantics' ”.[7]

But the sense of this discipline in those times differs greatly from the meaning it has nowadays. Tamba showed in „la sémantique“, published in 1988, that there have been four distinct evolutions in the field of semantics since its foundation by Bréal.[8]

She terms the first branch “evolutionary period of comparative linguistics” which was dominated by a lexical-historical linguistic.[9] The linguists in this period were strongly influenced by the concept of evolution as elaborated by Spencer and Darwin (1857/1859). This research field can be characterized by the three following principles. 1) Semantics is seen

[7]L´étude ou nous invitons le lecteur a nous suivre est d’espèce si nouvelle qu’elle n’a même pas encore reçu de nom. En effet, c´est sur le corps et sur la forme des mots que la plupart des linguistes ont exercés leur sagacité: les lois qui président à la transformation du sens, au choix d’expressions nouvelles, à la naissance et à la mort des locutions ont été laissées dans l’ombre ou n´ont été indiqué qu’en passant. Comme cette étude, aussi bien que la phonétique et la morphologie, mérite d´avoir son nom, nous l´appellerons la sémantique (du verbe semainein), c’est à dire la science des significations. “ English translation: 1900, semantics , Cutch 1897, essai de sémantique

[8] Tamba, I. (2005)

[9] A lexeme is the minimal unit of language that has a semantic interpretation and embodies a distinct cultural concept.(http://www-01.sil.org/linguistics/GlossaryOflinguisticTerms/)

as the evolution of meaning in language. 2) This evolution obeys to general laws. 3) These laws can be discovered through empirical methods.

The second important stream in Semantics is called Structuralism. This approach is based on the theory developed by the Swiss linguist Ferdinand de Saussure in the beginning of the twenties century. In "Cours de linguistique générale", he differentiates between la langue (which is his object of study) and la parole (which is a usage–dependent phenomenon). In contrast to the preceding theories of meaning, language can be examined independently of its referent. Language ("le langage") is considered as a linguistic system, whose basic elements are signs. These signs are constituted by two aspects: a signifier (visible/audible part of a verbal sign) and a signified (what this visible aspect means to us). Words are not merely reflecting concepts or external objects, but are the participants of a structured system. The meaning of words arises out of the relation between the elements in this closed system.[10]

In sum, Structuralism is a synchronic and lexical study of language.

According to Tamba, the third period of semantics began in the sixties.[11]It can be seen as the implementation of semantics into generative grammar. Major characteristics of this approach are the dominance of formal grammar, the study of language on a sentence level and the consideration of language as a closed system. These characteristics root in the theory of generative grammar, which was developed by Noam Chomsky in "Syntactic Structures".[12] Generative grammar comprises of a precisely formulated set of rules whose output is always and only the sentences of a language. Furthermore, Chomsky postulates the existence of a Universal Grammar.[13] This Universal Grammar is defined as the minimal set of universal principals that underlie every language. According to Chomsky, this Universal Grammar has a psychobiological reality, since it constrains the acquisition of a language, helping children to form a potentially infinite set of correct sentences while they are confronted only with a small set of correct sentences and false sentences. This is also called the poverty of stimulus argument. Universal grammar constitutes the innate part of language.

In the seventies Talmy, Langacker and Lakoff founded cognitive linguistics in opposition to the predominant paradigm of generative grammar. Their main critic concerns the autonomous

[10] In particular through the difference

[11] Katz, Fodor, "The structure of a semantic theory" (Language, 39) in 1963 and with the introduction of a semantic component in "Aspects of the theory of Syntax" by Noam Chomsky in 1965

[12] Chomsky, N. (1954)

[13] Chomsky, N. (1952)

syntactic component of syntax in Chomsky's grammar as well as the interpretative semantic by Fodor. Furthermore, they highlight the naturalization of meaning by grounding it on the functionality of the brain. The main goal is to overcome the reduced investigation of language as a self-contained system without any relation to other cognitive faculties or external environment. The next subpart will address the assumptions of cognitive linguists in detail. In the course of this thesis, I want to address the question, if this gap has been bridged sufficiently.

The historical overview has shown that in linguistics as well as in semantics language is considered as the primary object of study. Furthermore, language is considered as a closed system with inherent laws, due to the influence of structuralism.

2.1.2 The spatial domain in cognitive linguistics

Spatial information is a specific domain of study in cognitive linguistics. Preliminary to an analysis I would like to introduce the subject-matter. The concept of spatial information in the field of cognitive linguistics is ambiguous. There exist as many different definitions as there are different approaches. A tentative definition was given by J. Zlatev: "spatial informations are spatial expressions, that is, conventional specifications of the location or change of location (i.e.translocation) of a given entity."[14]

The main reason for the interest of cognitive linguistics in spatial semantics is based on their intuition that language represents thought.

In their very general introduction, Evan and Green state that:

"Cognitive linguists, like other linguists, study language for its own sake; they attempt to describe and account for its systematicity , its structure, the functions it serves, and how these functions are realized by the language system. However, an important reason behind why cognitive linguists study language stems from the assumption that language reflects patterns of thought. Therefore, to study language from this perspective is to study patterns of conceptualization. Language offers a window into cognitive function, providing insights into the nature, structure and organization of thoughts and ideas. The most important way in which cognitive linguistics differs from other approaches to the study of language, then, is that language is assumed to reflect certain fundamental properties and design features of the human mind."[15]

This citation explains why the structure of spatial domains is a matter of particular interest for cognitive linguists. Space has a particular role for cognition. It (or the location of things in

[14] Zlatev, J. (2010)

[15] Evan V., Green M. (2006)

space) is at the interface between perception (mainly vision), cognitive processes (concepts) and language. As such it is a domain of predilection for studying the interaction of language and thought.

The universal character of space and its intersection between language, thought and experience allows furthermore shedding a light on the Sapir-Whorf hypothesis.

The second reason pertains to the assumed basic nature of space within the cognitive linguistic notion of conceptual metaphor. It refers to the fact that a conceptual domain is understood in terms of another. For example in the sentence "We are coming to the end of the year" the conceptual domain of time is understood in terms of space. Lakoff proposed that the most abstract conceptual domains are understood in terms of the most concrete ones.[16] He further postulates that the domain of space is more concrete than many others. As such, studying spatial semantics could reveal much about the mechanism of conceptualization.

2.1.3 Assumptions of cognitive linguistics

Cognitive linguists share two commitments: the Cognitive Commitment and the Generalization Commitment.[17]

The Cognitive Commitment represents the view that principles of language should reflect the general cognitive principles rather than principles that are specific to language. In this sense, the nature of cognitive linguistics is interdisciplinary: it aims to integrate results from other fields into cognitive science. Specifically, "[...] the cognitive linguistic researcher is charged with establishing convergent evidence for the cognitive reality of components of any model proposed-whether or not this research is conducted by the cognitive linguist"[18]. This commitment implicitly suggests that there is a consensus in cognitive science about the definition of a cognitive reality and the general cognitive principles. But this consensus does not exist. In fact, three paradigms co-exist in cognitive science. This implies at least three radically different points of view on the essence of cognition and the explanatory mechanisms of cognitive processes.[19] Cognitive linguistics has to be aware of this heterogeneity within the field, since there is no objective truth about cognition in cognitive science. A second implicit argument concerns

[16] Lakoff G. and Johnson M. (1980)

[17] Evans V, (2012). The two commitments are first described by Lakoff (1991). It is important to notice that they were addressed as a critic to generative grammar.

[18] Evan V. (2012)

[19] The three paradigm are the connexionism, the cognitivism and the emergentist paradigm. There cannot be found a common definition of cognition. Bridging those paradigms is still a hot topic in cognitive science.

the cognitive grounding of cognitive linguistic models. Evan assumes that by using results from cognitive science, the models would become cognitive models, and acquire a "scientific" validity. The major problem is that the interpretation of results depends on the paradigm as well (and as we have seen below there is no objective truth) and second, that scientific validity depends on the methodology and not the results. Using convergent evidence is not considered as a valid method in science.

This commitment consists, beyond the positive attempt of grounding cognitive linguistic models in a scientific reality, in the attempt to demarcate itself from traditional linguistics and in particular from generative grammar. The major argument is that principles in Cognitive Linguistics reflect the cognitive reality, whereas principles used in traditional linguistics do not. In the light of what has been said above, it remains an open question whether this separation has really been achieved at this point.

The second commitment "is to characterize the general principles governing all aspects of human language". It constitutes the Generalization Commitment. It aims to be a scientific study of language in all its manifestations. The implicit assumption is the existence of such general principles. But this commitment's aim is to apply the generalization to all aspects of language. In contrast to traditional linguistics, which studies the diverse aspects of language separately (three subfields are syntax, semantics and pragmatics) and assume a modularity of language, cognitive linguists aim to find regularities across domains. The regularities cited are for example metaphor and polysemy. Evans states, that in practice, the domains of language are studied independently from each other. The question thereby remains open in how far this commitment can be seen as a demarcation of cognitive linguistics from generative grammar.

In addition to the two commitments above, Evans distinguishes five further assumptions.

The thesis of embodied cognition is not only an important assumption in cognitive linguistics, but plays a central role in cognitive science as well. It is a concept that stresses the importance of the mind (for example concepts and categories) /body (for example the motor system, the perceptual system) relation[20]. In particular, it assumes an influence of the body on the mind. It implicates two further sub theses. On the one hand, the perception we have of the reality cannot be the objective reality (because the experience is filtered through our senses). This sub thesis

[20] In opposition to for example, cartesian dualism which assumes a separation between both elements.

is called embodied experience. On the other hand the grounded cognition sub thesis claims that our mental representations are grounded in our embodied mental state.
The second assumption is called the encyclopaedic view. It refers to the insight of cognitive linguists that semantic representations (termed also semantic structures) in the linguistic system interfere with representations in the conceptual system. This conceptual system constitutes a vast network of structured knowledge. The implicit assumption is to understand thought through language. The third assumption is termed the symbolic thesis. It asserts that the mental grammar consists in form-meaning units and the symbolic relation that links both. In contrast to the exclusively lexical units in structuralism, the nature of these units range over all linguistic levels.[21] Larger grammatical structures emerge from the combination of single units. The fourth assumption of Cognitive Linguistic is that meaning is conceptualization. Meaning arises through the interaction between the linguistic representation and the conceptual structure. This interaction is mediated by linguistic and conceptual mechanisms and processes. The resulting meaning is non linguistic in nature.
Finally cognitive linguists assume that the mental grammar of a language user is formed by abstraction of the situated instances of language use. Language knowledge emerges from language use. This assumption is called the usage-based thesis.

To sum up, cognitive linguistics is deeply rooted in the field of linguistics. Its aim is to account for language as a cognitive process, and thereby demarcate itself from preceding linguistic approaches. Two questions remain open after this historical and theoretical overview. In how far is cognitive linguistic really cognitive and in how far does it demarcate itself from traditional linguistics?

2.2 Analysis of two frameworks in cognitive linguistics

This part deals with a detailed analysis of two theories about spatial expressions in language by Talmy and Jackendoff. I choose these authors, since their theories are situated in different linguistic frameworks and take up different points of view on the structure of spatial expressions.

[21]This postulate can be situated in the cognitivist paradigm.

The general aim of this part is to identify a common denominator underlying these two different approaches, since both authors claim to belong to the cognitive linguistic enterprise.

2.2.1 Talmy´ s theory: „The Cognitive Semantic Approach“

The first theory that will be taken into consideration is Talmy's theory of spatial expressions. Leonard Talmy was one of the pioneers in cognitive linguistics in the seventies. Since then he has published intensively in order to pursue the development and the proposal of a research program called "Cognitive Semantics". He defines the aim of research in cognitive semantics as being "the research on conceptual content and its organization in language and hence on the nature of concepts and organization in general."[22] Conceptual content consists in "something that encompasses not just ideational content but any experiential content, including affect and perception."[23]

This means he assumes that language can be studied as a separate entity that represents general conceptual content or meaning. As a result, he is committed to the idea that the study of language enables to draw conclusions about the principles underlying other cognitive processes. His research has recently been published in a two volume book "Toward a Cognitive Semantics" (2000) that will serve as basis for the subsequent analysis.

2.2.1.1 Language, a cognitive system?

Talmy never explicitly states what the ontological status of language is.[24] Nevertheless, it can be shown that he considers the nature of language as symbolic.

He states that "cognitive linguistics examines the formal properties of language from its conceptual perspective. Thus, it seeks to account for the grammatical structure in terms of the functions this serves in the representation of conceptual structure."[25] One aim of cognitive linguistics is to address the concerns of formal linguistics. The grammatical structure refers to the linguistic view of language as a system that comprises of different forms. These forms consist in the morphological, lexical and syntactical forms. The categories studied in the cognitive semantic framework are the traditional grammatical categories: verbs, nouns,

[22] Talmy L., (2000), I, p 4
[23] Talmy L. (2000), I, p.4
[24] In cognitive linguistics and in linguistics such a question seems never to be explicitly asked. One rare cognitive linguists who addresses this point is Langacker (1987), p.11
[25] Talmy L. (2000), vol.1, p.3

preposition. Furthermore those units have a semantic (meaningful) aspect, which he calls "conceptual content". This expresses the traditional semantic view of language as a symbolic system of form-meaning elements, based on the tradition of Ferdinand de Saussure. In the view of traditional semantics, language is a closed system due to the main assumption of the difference between la "langue" and la "parole" (cf. to historical approach above). This affiliation to traditional semantics is taken into account by Talmy as well. He states that "like cognitive linguistics, the tradition of semantics, after all, has its subject the pattern in which conceptual content is structured in language."[26] The main argument that differentiates cognitive linguistics from traditional semantics concerns the fact that the linguistic system is not self-enclosed but open. Talmy states that "unlike cognitive linguistics, it [semantics] has not systematically sought to relate its findings to more general cognitive categories and processes." This is the corner stone in the argument of Talmy. If he proves that this linguistic conceptual content is an integral part of the general conceptual content it would mean that language is not reduced to a linguistic system of form-meaning elements with its own organizing principles and rules. It would rather show that language is an open system, integral part of cognition. The concepts that have to be clarified are "the nature of conceptual content" and the "relation between the linguistic system and the cognitive system".

Talmy states that:

"Semantics simply pertains to the conceptual content as it is organized in language. Hence, the word 'semantic' simply refers to the specifically linguistic form of the more generic notion 'conceptual'. Thus general conception – that is, thought – includes linguistic meaning within its greater compass. And while linguistic meaning – whether that expressible by an individual language or by language in general – apparently involves a selection from or constraints on general conception, it is qualitatively a piece of with it. Thus research on cognitive semantics is research on conceptual content and its organization in language and, hence, on the nature of conceptual content and organization in general. In this formulation, conceptual content is understood to encompass not just ideational content but any experiential content, including affect and perception." [27]

It can be seen from the citation above that semantics or concepts are the result of a psychological transformation of reality. Thus, conceptual content is psychological or cognitive

[26] Talmy L. (2000), p.3

[27] Talmy L. (2000), vol. 1, p.4

in nature. The content of the concepts is not referring to an external objective world, but to a cognitive transformed meaning. The nature of the linguistic conceptual content is the same as of general conception. In his words, it is "qualitatively a piece of with it." He does not define the nature of general conception more than equating it with "thought" which is rather a puzzling definition and leaves more open questions than it answers.

What about the relation between linguistic conceptual content and general conception? Talmy characterizes it in two ways. On the one hand, he defines the content of linguistic representation in opposition to general conception. He states that the linguistic representation is constrained. But since he does not define 'thought', this assumption remains rather vague. Furthermore he does not state by which processes or mechanisms it is constrained. The relation between linguistic representation and general representation remains vague. On the other hand, he assumes that the organization of the linguistic conceptual system is the same as the structure of thought.

In sum, the main difference between traditional semantics and cognitive linguistics, which relies in the assumption that language is a cognitive system, is extremely vague. The research in cognitive linguistics is not dedicated to the relation between the cognitive system and the linguistic one but to the structure and nature of those two systems independently. This implies that the existence of this relation remains a mere assumption, which makes the whole enterprise questionable.

The second assumption is that language, as being itself a conceptual system, is structured and organized in the same way as cognition. This implies that by investigating the organization of concepts in language, the organization of the conceptualized world in general can be revealed at once. Nevertheless, he ignores the fact that this principle has two sides. All methods that qualify for studying the organization of the conceptualized world could likewise be used for investigating the conceptual organization of language. Since he considers that language can be studied in isolation from everything else, he explores its organization within the linguistic system itself. Therefore, he neglects any kind of intrinsic referential characteristic of linguistic expressions, as well as the embeddedness of language into cognition in general. In my opinion, this raises the question if Talmy actually touches the level of meaning, which is why I would rather call it a descriptive framework than an explanatory one. His theory lacks in an account of the emergence of the conceptual representations. Thus, the nature of what is conceptual is not defined as well. Furthermore, the representations are rather static than dynamic, since

language is representing one scene in time, but the contextual flexibility is not taken into account.

In summary, Talmy's assumption is that language mirrors a conceptual world, which is why studying the organization of language enables the discovery of cognitive processes.

2.2.1.2 The object of study from an epistemological point of view: the grammatical subsystem

The meaning of language (semantics) results from the complementary action of two subsystems. Those subsystems are differentiated by their function.

1.Language system consists of two subsystems

Talmy presupposes that a sentence evokes in the listener a particular kind of experiential concept, called also CR (cognitive representation).[28] The cognitive representation is defined as "emergent, compounded by various cognitive processes out of the referential meanings of the sentence elements, understanding of the present situation, general knowledge, and so on." This refers to the fact that he considers two levels of meanings (see above). The linguistic meaning results from the "referential meaning of a sentence" and the "general conception". The relationship between both is not direct.[29] The CR is determined in two ways: its structure results from the grammatical subsystem, whereas its content is determined by the lexical subsystem.[30] This reflects the categorization of traditional linguistics. Thus, the distinction between them is formal, without reference to meaning.[31] The grammatical subsystem consists in two types of linguistic forms, which are denominated in accordance with traditional linguistics "closed class". This means that the grammatical subsystem consists in a limited set of elements that cannot be augmented. This subsystem has two types of forms: an overt and an abstract or implicit. Overt forms include bounded forms like inflections, derivations, clitics and free forms such as determiners, preposition, conjunctions, and particles. Talmy calls the second type of grammatical forms abstract or implicit. These are the major lexical categories in traditional linguistics. They include the major lexical subcategories such as "nouns" and "verbs", lexical relations such as "subject" and "object" word order patterns and "zero forms". The function of the grammatical subsystem is to

[28] Talmy L. (2000), vol.1, p.93
[29] Talmy L. (2000) , vol.1, p.2
[30] Talmy L. (2000), vol.1, p.21
[31] Talmy L.(2000), vol.1, p.22

structure the system of conceptual representation. In order to fulfill this requirement, Talmy considers it necessary that these structural features have a universal nature.[32]

In contrast, the lexical subsystem determines the content of the cognitive representations, and is "open-classed".[33] Its characteristics are not universal, thus it is specific for each language. Furthermore, this set can be augmented. The classes constituting the lexical subsystem are for example: roots of nouns, verbs and adjectives, lexical complexes (collocations).

In order to illustrate the relation between grammatical and lexical forms, I would like to sketch his own example.[34]

In the two sentences "the ant crawled across my palm" and "the bus drove across the country" the English deictics "this" and "that", the English preposition "across" and the English past tense inflection "-ed" are all closed-class items. In themselves they are neutral with respect to the magnitude of space and time. They provide the topological structure of the sentence. Resolving this neutrality is the task of the lexical class items, which are the nouns "ant" and "bus" or "palm" and "country". Thus, the interaction of both subsystems is crucial for the construction of meaningful sentences.

Their main difference consists in the meaning they are referring to. The grammatical subsystem in the example above specifies only topological notions. In contrast, the lexical subsystem specifies topological as well as Euclidian notions. The grammatical subsystem is constrained on the semantic level.

In conclusion, Talmy considers language as representing cognitive representation by means of two subsystems, the lexical and the grammatical one. They are differentiated by their function for the representation as well as by semantic constraints. The former is readily augmentable and language specific, whereas the latter is universal and self-contained, which is why Talmy's theory centers on the grammatical subsystem.

2. General characterization of the grammatical subsystem

The grammatical closed-class forms are the determinants of the conceptual structure within language seen as a cognitive system. The two central notions for categorization and systematicity of the grammatical subsystem are "schematic categories" and "schematic systems".[35]

[32] Talmy L.(2000), vol.1, p.23
[33] Talmy (2000), vol.1, p.23
[34] Talmy L. (2000), vol.1, p.26
[35] Talmy L. (2000), vol.1, p.40

Schematic categories are relations among notions within certain conceptual categories for example “domain”, which contains the two member notions time and space. They are characterized as “bulk neutral” and “token neutral”, which means that they represent abstract geometric idealizations and refer to abstract types or classes, but not to any concrete and particular token thereof. They exhibit certain organizational properties like homology, intracategorial conversion and reverse convertibility. Those categories group together in larger concept structuring systems, coined schematic systems. Talmy identifies five kinds of schematic systems, which are the configurational structure (which comprises the schematic structuring or geometric delineation in space or time), the perspective, the distribution of attention, the force dynamics and causation and the cognitive state. This means that they share common principles, which is why a single closed-class item can be situated in several schematic categories.

2.2.1.3 How language structures space and motion

The main question of this section is what are the grammatical structures that confer the structure of spatial meaning as represented in language? This question corresponds to Talmys quest to identify the grammatical structures that allow the representation of spatial expressions in language, and the semantic representation in the language system.

The grammatical subsystem, as seen above, exhibits the basic function to structure the concepts of space in language. In his article “The fundamental System of Spatial Schemas in Language”[36], he summarizes the concepts that are parts of the linguistic representation. He found out that the closed-classed forms belong to larger systems with three main parts. Each part has its own function, but above all its own properties.

The first part is called “componential”, which comprises of a closed inventory of fundamental spatial elements. The inventory of those spatial elements can be found in Tab 1 (cf.annex). This conceptual representation is associates with particular surface expressions.[37]The second part is coined “compositional”, which bears the function to assemble the individual basic elements into whole schemata.

The last part of the system, the “augmentative part”, consists in the general properties that can be found across the formed schemata. One example for such general properties of the

[36] Talmy (2006)

[37] Talmy (2006), p.199

augmentative part is “magnitude neutrality”. It refers to the fact that the grammatical subsystem of language does not represent distances in Euclidean manner, which are given only in lexical terms.

A scene is a semantic linguistic representation, which results of an affect, experience or general thought. The linguistic representation is only part of the scene from a particularly point of view.

Appart from those spatial schemas Talmy studied extensively motion events. His study will be described in more detail in the third part of this thesis.

The interesting point for the comparison of the four exemplary theories is the inventory of the class of spatial elements. Since Talmy considers these semantic elements to be universal, they have to be present in every language. Therefore, these notions are compulsory if one wants to describe or tag the information about space in texts.

2.2.1.4 Methodological Considerations

In his well-known article “lexicalization patterns: semantic structure in lexical forms”, he describes the following procedural outline: “

a. Determine various semantic entities[38] in a language
b. Determine various surface entities in the language
c. Observe which (a) entities are expressed by which (b) entities-in what combinations and what interrelation-noting any patterns
d. Compare findings of this sort across languages, noting any patterns”[39]

In a first step he tests a closed-class lexical category and a spatial scene it pertains to. An example for this is the study of the preposition across in the scene “the board lay across the road”. Via introspection he was able to discover the existence of two elements, which are related by the preposition across. Furthermore, he classifies the elements as figure (the board) and ground (the road), and identifies their properties. In the context of this example the ground is defined as ribbonal, whereas the figure as linear.

After having extracted a set of spatial elements from a spatial scene, one has to check if these are really of universal nature or only specific for this sentence. The universality of the spatial schema is tested by varying the spatial scenes. If the spatial element remains consistent across

[38]Talmy defines the entities as “elements, relations and structures: both particular cases and categories of these”

[39] Talmy L. (1987)

the variation of a sentence and across languages, the universality of the properties is assumed. The following step consists in finding out if the extracted elements can be grouped in structural categories.

The method used for extracting the categories of the spatial elements is based on a deductive and introspective approach. The advantages and the limits of accessing explicit or implicit levels of conscious phenomena is an ongoing topic of debate for the scientific community.[40] Introspection is the method that consists in observing one's personal behavior and thoughts, which means that the scientist takes up a first-person perspective.

By using this methodology, Talmy identified typological and universal principles.[41]

2.2.1.5 Summary

In a nutshell, Talmy´s cognitive semantic framework is the description of the organization and structure of language as a conceptual system. This conceptual system is divided into two subsystems. A grammatical system that provides the structure and a lexical system that gives the content. By using introspection, Talmy's aim is to reveal the universal structure of the grammatical system. Thereby, he identifies universal elements and their relation in spatial scenes. Although he assumes that linguistic concepts mirror mental concepts, the subject-matter is investigated in isolation from other cognitive faculties and the external world. Nevertheless, he asserts that results regarding the linguistic organization do represent general cognitive principles.

2.2.2 Conceptual Semantics: analysis of Jackendoff's framework

Coming from a generative approach, Jackendoff in his ground-breaking book "Foundations of language: Brain, Meaning, Grammar, Evolution", tries to merge the generative program with the new developments in cognitive science.

Generative or transformational grammar can be seen as the attempt to formalize natural language. In this tradition, language is seen as an abstract system governed by logical rules, since it originates from a strong mathematical and symbolic-logical background.[42] In its origins, transformational grammar aimed to describe the syntactic system of English. In order

[40] Cf. to Lyons W. (1986) for an historical critical account of introspection
[41] Talmy (2000), p. 166
[42] Tomalin M. (2006) and the review of Scholz and Pullum (2007)

to generate infinite correct sentences from a finite set of sentences[43], specific rules are applied. These rules are formation rules, transformational rules and constraints.[44] The problem in considering language as an abstract system (the analysis is purely done on language, without taking into account the external world or the mind), is that giving an explanation of the semantic level is quite impossible. In fact semantics is not inherent to language, but rather meaning arises out of the interaction between mind and world. Thus, the language system should be seen in interaction with the mind.

In the traditional understanding, meaning exclusively results from the syntactical system of language. The founder of this paradigm is Noam Chomsky, who claims that meaning arises from a deep structure of the linguistic system. Since the assumed syntactical deep structure could not be discovered Jackendoff's research aims at a new way of explaining linguistic meaning in terms of the generative principle of combinatoriality. Therefore, he develops a new "mentalist framework", which combines aspects of the generative framework with state-of-the-art developments in cognitive science.

2.2.2.1 The nature of language

Jackendoff defines language as a mental phenomenon, which means that it is a cognitive system that exists in the brain of the speaker. Furthermore, by brain he neither means the neuronal substrate nor the mind or consciousness as a self-contained entity. Since he is neither a materialist nor an idealist, he situates meaning in a new level of description between both extremes, which he calls the "functional mind" (f-mind). According to Jackendoff, the aim of linguistics is to clarify the organization of the f-mind.[45]

"The overall goal of Conceptual Semantics is to describe how humans express their understanding of the world by means of linguistic utterances. From this goal flow two theoretical commitments. First, linguistic meaning is to be described in mentalistic/ psychological terms – and eventually in neuroscientific terms. Second, the theory aspires to describe the messages that speakers intend for their utterances to convey."[46]

[43] This is also called combinatoriality

[44] Jackendoff R. (2002), chap 3: formation rules "specify how lexical items are to be combined into larger units, and how these larger units are combined into still larger units."The prototype are phrase structure rules. The transformational rules are relation between two structures, one more "underlying" and one more "superficial". When applied to the underlying structure, in changing some aspect of it, appears the more "superficial" structure. A constraint "is kind of rule that places extra conditions on structures created by formation and transformational rules."

[45] Jackendoff R. (2002)

[46] Jackendoff R. (2011), p.685

According to Jackendoff, the first commitment refers to the view that the whole linguistic system (sentence, entire language, meaning of linguistic expressions) is not to be considered as an isolated "free standing object" related to the world. In the mentalist framework these structures are embedded in cognition, and thus their nature is "mental".

In his framework, meaning is considered as a mental structure related to other cognitive structures. He assumes that "the meaning of a word is as a mental structure stored in a speaker's mind, linked in long-term memory to the structures that encode the word's pronunciation and its syntactic properties."[47]

This strong assumption is also illustrated by his definition of reference. He states that "the relation that plays the role of reference in the theory [Conceptual Semantics] is between the mental structure encoding the linguistic expression and the language user's conceptualization of the world – all inside the mind. Let us call this relation *mentalist* reference (or *m*-reference)."[48] This view is opposed to the traditional view[49] were "reference is standardly regarded as a relation between linguistic expressions (typically noun phrases) and things in the world. For convenience, let us call this *realist* reference (or *r*-reference)."[50]

The second commitment refers to the concept of meaning and more precisely to its content.[51] It consists in the five following hypothesis. The first two are issued from generative grammar and the three following can be related to the cognitive linguistics enterprise.[52]

Firstly, the meaning of an utterance is assumed to result from the compositionality of the meaning of its words and the syntax. This is not an exclusive relation: the meaning of the utterance can as well be provided by other mechanisms.[53] Another principle is his third commitment. The

[47] Jackendoff R. (2011), p.687
[48] Jackendoff R. (2011), p.690
[49] He cites for example Fodor.
[50] Jackendoff (2011), p.690
[51] Cf. Jackendoff (2011): "It [the second theoretical commitment] potentially includes everything that traditionally falls under the labels of 'pragmatics' and 'world knowledge' as well as 'semantics.' It does not specifically seek a level of representation that might be characterized as 'pure/literal linguistic meaning' or 'meaning that is relevant to grammar"
[52] The similarity of both frameworks shows that Jackendoff's framework is part of this cognitive linguistic enterprise. This relation as not been taken into account until quite recently, where for the first time he published a paper in the Cognitive Linguistic Journal (this shows the strong will of this Cognitive Linguistic enterprise to demarcate itself from generative grammar as a whole)
[53] The other ways are not clarified.

meaning of utterances reflects not only the principle of compositionality, but human categorization.[54]

The second assumption concerns the process of inference. It states that the formal basis for inference has to be the utterance meaning. It can be related to the encyclopaedic assumption of cognitive linguistics. The fourth hypothesis states that the meanings of words are not innate, but results from the learning capacity of the acquirer. This learning process has to be in accordance with empirical evidence on word learning. And the fifth hypothesis corresponds to the embodiment thesis, which states that meaning is connected to perception and action.

This mentalist framework implies the same paradox as the Cognitive Commitment of Cognitive Linguistics. On the one hand, language is seen as embedded in cognition, but on the other hand, language is still considered as an abstracted system. This paradox can be illustrated by Jackendoff's definition of English Language as "an idealization over the systems of linguistic knowledge in the minds of a community of mutually intelligible speakers. We typically presume that these systems are homogeneous, but we readily drop this assumption as soon as we need to take into account dialect differences, vocabulary differences, and stages in children's acquisition of language."[55] The answer of cognitive linguists in order to bridge that gap is the Cognitive (mentalist) Commitment. The main point here to clarify is in how far language and cognition are related, in order to show whether language is seen as a reduced system or "really" embedded into cognition.

The relation between language and cognition can be seen in Fig.1.The important point here is to consider the relation between language and "thought", in order to address if language is reduced or not, and if cognitive semantics has really overcome traditional linguistics. The mentalist commitment of the theory sets it apart from traditions of formal semantics arising from philosophical logic, which aspire to study the relation of sentences to "the world" or to "possible worlds" (where a "the/a world" is often specified in set-theoretic terms)

[54] Jackendoff R. (2011): C3 (commitment 3): "The meanings of words must conform to what is known about human categorization."

[55] Jackendoff R.(2011), p.689

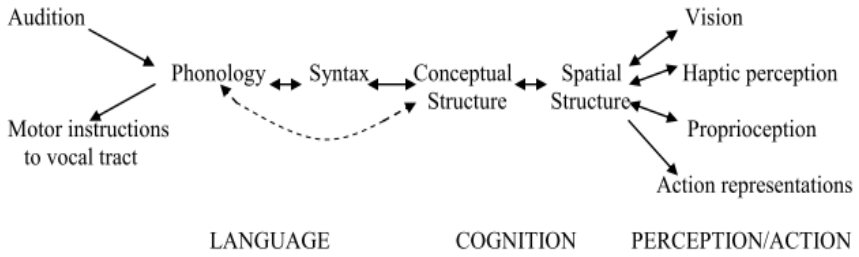

Fig1. Jackendoff's cognitive system (Jackendoff R., 2011)

"Language, as well as cognition and perception/action are considered in a mentalistic framework as generative systems with their own primitives and the arrows indicate interfaces among representations: principles that provide systematic mappings from one level to the other. On the left-hand side are the familiar linguistic levels and their interfaces to hearing and speaking. On the right-hand side are nonlinguistic connections to the world through visual, haptic, and proprioceptive perception and through the formulation of action. (One could add general-purpose audition, smell, and taste as well.)" [56]

For Jackendoff language is considered as an integral part of the cognitive system, situated on the same level as cognition and perception.

From the mentalist point of view language is a structure that allows the interpretation of the conceptual system (meaning or thought). Furthermore it can be seen that what makes language a cognitive system is its interrelation with cognition. Cognition is here reduced to the conceptual structure. The conceptual structure has three principal functions.[57] 1) It allows the formation and understanding of the representation, which is formed by incorporating pragmatic considerations and world knowledge from linguistic utterances. 2) It is as well the structure where reasoning and planning takes place. 3) And it is the theoretical counterpart of "meaning". We see here that the embeddedness of language and its relation to cognition are really difficult to prove, since cognition and its relation to language are defined to vaguely. Furthermore the semantic level is studied through linguistic structure, which is explicitly stated not to be part of language but from "cognition", which is why it cannot be studied empirically through the study of the linguistic system.

[56] Jackendoff R. (2011), p.692

[57] Jackendoff R. (2002), p.102 "Anticipating that discussion, let us say that the thoughts expressed by language are structured in terms of a cognitive organization called conceptual structure (CS). Conceptual structure is not part of language per se—it is part of thought. It is the locus for the understanding of linguistic utterances in context, incorporating pragmatic considerations and "world knowledge"; it is the cognitive structure in terms of which reasoning and planning take place. That is, the hypothesized level of conceptual structure is intended as a theoretical counterpart of what common sense calls 'meaning'".

2.2.2.2 The structure of language

Jackendoff's overall aim is to assemble different linguistic levels into a unified theory.

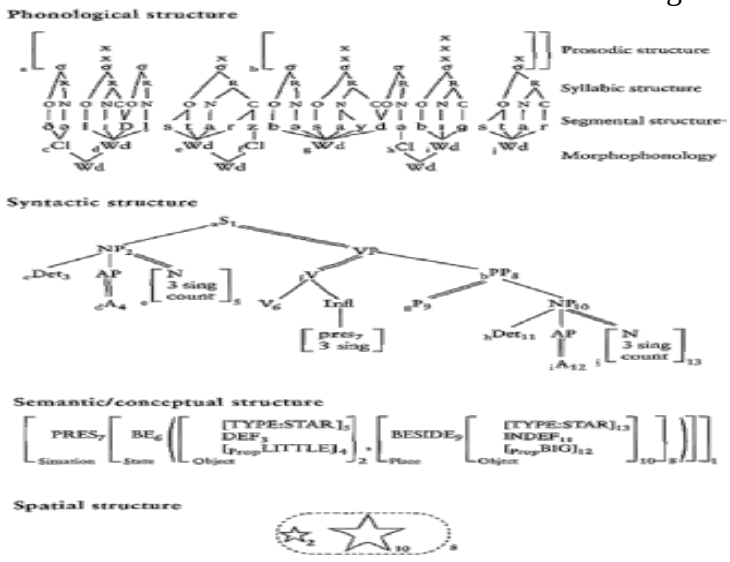

Fig.2 traditional linguistic levels (Jackendoff R., 2002)

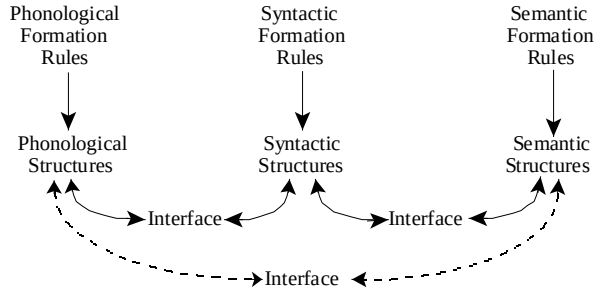

Fig 3. The parallel architecture (Jackendoff R., 2002)

His theory is based on a parallel architecture of the f-mind, consisting of three different components: the phonological (sound), the syntactical (grammar) and the conceptual (meaning).[58] (cf. Fig2) Each of these structures (and not just the syntactic one) has the capability to generate the combinatorial complexity of language. Each component is related with the others through so-called „interface components". These interfaces are the principles that play the role of constraints for the components kind of structures.[59] But (and this is the main difference to other theories) the three different levels are in several aspects completely independent from each other. These structures have their own primitives and their own principles of combination. As an example, the conceptual structure does not and cannot arise exclusively from the syntactical rule system. In contrast to the generative grammar program,

[58] Jackendoff (2012)
[59] Jackendoff (2010)

where the syntax totally determined the phonological and conceptual aspects of language, Jackendoff proclaims the independent existence of all three levels.

In short, semantics is not derived exclusively from syntax, but rather introduced as an independent generative system correlated with syntax through an interface. "It instantiates the thoughts that language expresses; syntax and phonology are the means by which thoughts are converted into overt expressions."[60]

The following examples illustrate this partial independence and relation between levels.

A sentence like "the cat died" is described in Jackendoff's framework as a tripartite structure consisting in:

Phonology: [ðə1 [kæt2]] [day3 + d4]

Syntax: [NP Det1 N2] [VP V3 + past4]

Semantics: [PAST4 [DIE3 ([CAT2; DEF1])]]

The individual words "cat" and "die" are treated as interface rules, which allow the linking of the three structures:

Phonology: [kæt2]	Phonology: [day3]
Syntax: N2	Syntax: V3 (2)
Semantics: [CAT2]	Semantics: [DIE (X)] 3

These three structures are composed in turn of different levels (cf.fig.2).The rules between the levels are not derivational.

Furthermore, the lexicon plays a different role in the theory of Jackendoff as it did in the theory of Talmy. The main function of the lexicon is to provide an interface component between the syntactical and phonological conceptual system.

According to Jackendoff, spatial representations illustrate the relation between language and vision. This is a further illustration in how far the study of the conceptual level of language is useful for theories of perception. Jackendoff argues that the task of the visual system is not only to perform object recognition, but spatial understanding as well.[61] He claims that the language system and the visual system are related, and thus that a theory of vision must take into account this relation in order to explain for example how we talk about what we see. In

[60] Jackendoff (2012), p.1135

[61] Jackendoff R. (2012)

his account he addresses the computational level of description in David Marr's metatheory.[62] In order to address this relation, he suggests a transformation of the 3Dsketch in the visual system.[63] He renames it "spatial structure" and defines it as a multimodal or amodal cognitive representation, which is not exclusively part of the visual system anymore. This spatial system is an extended version of the 3Dmodel insofar as it represents spatial understanding. Jackendoff claims that the interface between spatial structure and conceptual structure allows the information exchange between the language system and the visual system.[64] Thus he assumes a modular view of the representations. To sum up, the explanation of the relation between the language system and the visual system is based on presumed representations that he cannot prove through linguistic analysis. The question concerning what those representations are, how they can be formally characterized, what is stored in memory, how these representations are neuronal coded are all the task of a theory of vision, not of a linguistic theory.[65]

2.2.2.3 The structure of spatial expressions

What is the structure of the semantics of spatial expressions in language? He has treated this topic formerly, in "semantics of spatial expressions" a chapter of his book "Semantics and Cognition"[66]. It constitutes a taxonomic description of the spatial expressions. The units of a semantic analysis do not correspond to the units used in a syntactical one (ex. Noun, Verb etc…). But instead, the units used in the analysis are concepts. The relevant concepts for space

[62] David Marr has developed an account for the description of a system as constituted by three complementary levels: the computational level which describes the goal of the system, the algorithmic level which describes its method and the implementational level which describes its means. Considering a cognitive system, the computational system would refer to the mental representations, the algorithmic level to the cognitive processes and the implementation to the neural structures. (cf. http://www.socsci.ru.nl/~peterh/doc/marr_levels.html)

[63] David Marr applied his computational metatheory on the visual system. He assumed the existence of three levels in this system. The first level is concerned with early visual processing and is termed primal sketch. The second level concerns the viewer-centered representation of the visible surface constructed from the first stage. He calls this level 2 1/2sketch. The third stage, which is termed 3D sketch, is concerned with representing shapes for recognition. (cf. to http://brain.oxfordjournals.org/content/134/3/913.full)

[64] He states that "the new interface permits information derived through vision and encoded in spatial structure to be reformatted in terms of conceptual structure, which in turn is a suitable format for encoding into language. Conversely, understanding a heard sentence consists in developing a conceptual structure derived via phonology and syntax; this conceptual structure can then be reformatted as a spatial structure and thereby direct attention to relevant parts of the visual field." Jackendoff R. (2012), p.1136

[65] Cf. "We conclude that the visual system must deliver information on the basis of which all of these distinctions [spatial distinctions expressed by language such as manner of motion/change…] (and many more, cross-linguistically) can be made. " Jackendoff R. (2012), p. 1149

[66] Jackendoff R. (1990)

in language are: [PLACE], [PATH], [STATE], [EVENT] and the functional relations between them. [PLACE] and [PATH] are separated concepts. [PLACE] projects into a point or a region, and is normally occupied by a [THING]. The internal structure [PATH] consists of a constitutive path-function and a reference object or reference place. Jackendoff discovered the nine following taxonomic structures for [PATH]. He distinguishes between [PATH] types (bounded, direction, route) and [PATH] roles (traverses, extends over, is oriented along). Furthermore, he differentiates between sentences describing location and sentences describing motion. The analysis is restricted to sentences of the form NP V PP. He states that the relation of syntax to semantics is transparent. PP refers to a place or path, NP refers to a thing (*theme*) and the sentence as a whole refers to the situation or event in which the thing is located with respect to the place or path. The verb specifies the relation between the thing and its place or path, for example movement.

The main differences between sentences are those that express [STATE] or [EVENT] (cf.fig 4).The conceptual difference between [STATE] and [EVENT] is that the former is static, whereas the latter expresses dynamic information. Grammatically this difference is expressed by the tense of the verb: for a [STATE] the verb is always is present tense, but for an [EVENT] it has to be in another tense. According to Jackendoff, spatial information is situated on the level of a sentence (even if he considers the lexical level in his mentalistic theory).

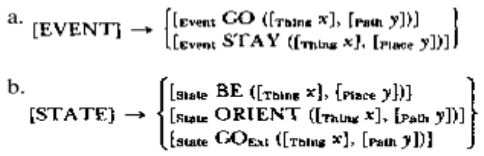

Fig 4: the semantical structure of event and state (Jackendoff R., 1990)

2.2.2.4 The methodology used

Although there are substantial differences between the theories of Jackendoff and Talmy, they both rely on the same methodological approach – introspection. "It has always been standard in linguistics to use grammatical judgments on made-up examples, as well as attestations from actual speech and text, [...]."[67] In practice this method consists in presenting a sentence or a phrase to native speakers and to ask them to judge whether the sentence or the phrase is

[67]Jackendoff R. (2007), p. 354

grammatical or not in their language or whether it has some particular meaning. Linguistic intuition is a method that gains some critics within the field of linguistic itself. An example thereof would be the lack of control examples and the variability of judgments among speakers.[68] Considering this aspect, Jackendoff's approach lacks in a comparative analysis. His judgment exclusively takes place in English, without taking other languages into account. Although the method of linguistic intuition has minor inherent difficulties, it is capable of providing interesting insights. As observed by Jackendoff, "the idea behind it is that although we can't observe the mental grammar of English itself, we *can* observe the judgments of grammaticality and meaning that are produced by using it."[69] Linguistic intuition is a descriptive method and not an explanatory one. By using grammatical judgments, we can observe something. The problem relies in the fact of what we can observe. What are "judgments of grammaticality and meaning"? This method cannot give an explanation of these concepts. As such it remains a descriptive approach, and cannot give an explanatory account.

2.2.2.5 Summary

In summary, I want to highlight the four relevant points in regard to the subsequent comparison with the theory of Talmy:

- The whole framework is based on a mentalistic approach (object of study is the linguistic system in the mind/brain of the individual speaker). Language is assumed to be cognitive. As such this linguistic system can be seen as idealized, which means that all language users of one community share the same linguistic system. Language cannot be studied in isolation from other cognitive functions.
- Language represents a conceptual mental structure and not an external objective world.
- The semantic level exists independently and is related to the syntactic and the phonological level through interfaces.
- Spatial information is expressed via conceptual primitives and their interrelations.

2.3 Conclusion

"Cognitive Semantics" and "Conceptual Semantics" pertain to the cognitive linguistic

[68] Cf. Schütze C. (1996) which addresses the methodological issues of linguistic intuitions
[69] Jackendoff R. (1994), p.46-50

enterprise. They both share the commitments and assumptions of this movement. Language is seen as a cognitive/mental phenomenon, which implies that the meaning of language is based on cognitive processes. Furthermore they agree on the generalization commitment, which implies to find regularities across linguistic levels. Talmy distinguishes the lexical and the grammatical subsystem, through different functions and properties. Jackendoff's parallel architecture of linguistic levels reflects this commitment as well. Theses linguistic levels are related by an interface, which consists partially in the words that are found similarly in each level. Talmy and Jackendoff share furthermore the five main assumptions of Cognitive Linguistics. They both assume the existence of a conceptual system in the mind whose representations refer to a psychological transformation of the reality (and not to the objective world). This is what Evans termed the embodied cognition thesis. Talmy calls it cognitive representation, Jackendoff terms it conceptual structure. The encyclopedic view of language concerns the relation of the linguistic semantic level to these conceptual structures. In Talmy's framework this is incorporated by the fact that the conceptual structure is part of the cognitive representation. Jackendoff claims, that the semantic level of language is related through an interface to the conceptual structure. The third assumption refers to the combinatoriality of language. Talmy accounts for it by the formation of image schemes, which is based on the combination of elements into categories, the combination of those categories into larger schemes and so forth. Jackendoff considers that combinatoriality is the main principle that can be found in a particular linguistic system and across the different systems. The fourth assumption refers to meaning. Cognitive Linguists assume that meaning is conceptualization. As seen above, for Talmy meaning is equated with the conceptual content, and Jackendoff equates meaning with the conceptual structure. The last assumption is the usage-based thesis. Talmy as well as Jackendoff use grammaticality judgments, and therefore implicitly assume that the mental grammar of language is formed via abstraction from its use.

Talmy and Jackendoff are both concerned with the semantic level of language. The main difference between them consists in the linguistic units (forms) they analyze. Talmy addresses mostly the level of single words (preposition, verb, nouns). Jackendoff starts from the analysis of a sentence.

The analysis of both authors has shown that in their framework the cognitive embeddedness of the linguistic system remains on assumptions. In other words, the relation between the linguistic system and the cognitive system cannot be proven through their merely descriptive analysis.

But this cognitive commitment was the main fact that demarcated them from traditional approaches. Thus, the question remains open, if they are really more “cognitive” than traditional approaches. It seems to me that the traditional paradigm has not been overcome for good, which is why language is still considered as an isolated system in those frameworks. This does not mean that language is not a cognitive system, but only that its relation to cognition has not been proved in the “cognitive linguistic” enterprise.

3 Computational linguistics on spatial information

3.1 Introduction: overview of the field of computational linguistics and its main assumptions

3.1.1 Definition of computational linguistics

Computational linguistics, is defined by the ACL (Association for Computational Linguistics) as the "scientific study of language from a computational perspective".[70] Computational linguists are interested in providing computational models of various kinds of linguistic phenomena.

This part of the thesis is concerned with the phenomenon of semantics in computational linguistics. The practical challenge that computational linguistics faces nowadays, is the ever increasing amount of data that exists on the internet. Information extraction is concerned with the development of tools, in order to classify and extract specific information from this quantity of multifarious data.[71]A major theoretical issue concerns Natural Language Understanding. It refers to the kind of semantic representation that is suitable for capturing the meaning of natural language.[72] This issue is shared with the field of Artificial Intelligence and can be traced back to its origins. There has been a lot of progress made since the conference at Dartmouth in 1956, where the pioneers in artificial intelligence have met in order to set the foundations of artificial intelligence. But until the 1990, there has been the continuous problem of the semantics. Even if systems like ELISA where created in order to copy language use in humans those programs have their limits. They cannot reproduce the complexity of natural language. The problem the scientists are confronted with is the fact that these artificial languages lack something that is quite different from natural language. The main solution for them was that it lacks the semantics, or the meaning of natural language. In fact, how can semantics be taken into account in order to approach and resemble that of natural language. This question was the starting point of a new discipline called computational semantics.[73] Results from this discipline are also crucial for the sub discipline of natural language extraction, since the content or the meaning of the information you want to extract is extremely important.

[70] http://www.aclweb.org/archive/misc/what.html
[71] http://en.wikipedia.org/wiki/Information_extraction
[72] Blackburn P. and Bos J. (2003)
[73] Blackburn and Bos (2003), p.27 "The aim of computational semantics is to find techniques for automatically constructing semantic representations for expressions of human language, representations that can be used to perform inference. "

Accurate annotation methods and tools are extremely important for extracting specific linguistic content in text. They are fundamental for natural language processing, since they allow a lot of applications.[74] The better the linguistic information extracted, the better will be the processing afterwards.

3.1.2 Assumptions of computational linguistics about text meaning

Hirst addresses in his paper about the views of text-meaning in computational linguistics the issue of implicit assumptions of meaning in the history of this discipline.[75] He establishes a parallel between the different views and the changes of method and their applications in computational linguistics. He defines the three following kinds of meaning and knowledge that computational linguistics aims to model[76]:

- Meaning is "in" the reader (subjective text-meaning): This roughly corresponds to the period 1975-1985. This view considers that the meaning of texts relies on the reader and mostly on his interpretation. Thus, this view implies that meaning depends on the reader's knowledge or believes. In computational linguistics it corresponds to the application-independent language-understanding research, which is based on the "intelligent agent paradigm" in artificial intelligence. The aim of this paradigm is to create independent intelligent agents, which interpret linguistic utterances in the world, increasing their knowledge and planning their actions accordingly.
- Meaning is "in" the writer (authorial intend): This roughly refers to the period of 1985-1995. The corresponding paradigm in computational linguistics is the "computer-as-servant paradigm". It states that humans command the computer by means of natural language. The according applications are mainly interactive-dialogue systems, in which the computer has to interpret literal sentences of the user's. A text means whatever the user thinks it means or intends it to mean.
- Meaning is in the text (objective text meaning): This corresponds historically to the period from 1995 to 2005. During that period, research in computational linguistics was dominated by the application of statistical and machine-learning methods to large, non-interactive texts. The implicit assumption is that the meaning of texts is determined

[74] an application is for example the semantic web
[75] Hirst G. (2007)
[76] "text" is defined as "any complete utterance long or short".

solely by the combination of words. “Meaning is extracted from the text by processing it”. The world view of computational linguists is that human use the computer to shift the information into natural language. The computer’s task is to find information in texts. Applications are statistically based lexical methods. “If the user asks for articles about raptor migration in Colorado, then the statistical relationship of the words in the text to those in the query is determined, and the text is ranked accordingly for the degree of relevance of its meaning.”[77]

According to Hirst, these views will begin to be combined in actual research. The analysis of Hirst will serve as guideline for the following analysis of the two theories.

3.2 The ISO-SPACE annotation framework

In common language, annotating a text consists in adding some commentary or explanation to existing linguistic data. In the scientific community, this term is used in a similar way. An annotation has to be differentiated from a representation. In computational linguistics, the concept of representation refers to the format in which the annotation is rendered (XML, LISP,) independently of its content.

The linguistic data of interest can be of various kinds, such as speech databases, written texts or ethnographic materials. During the last decade, a variety of different annotation schemata has been developed, which is why a standard framework for the annotation of linguistic data is developed. It is determined by the following requirements: expressive adequacy, meta-independence, semantic adequacy, incrementiality, uniformity, openness, extensibility, human readability, explicitness and consistency.[78] As a linguistic annotation method, ISO-Space follows the guidelines of this standard.

3.2.1 The goal of the ISOSPACE project

This annotation method has been established rather recently and is still developed further.[79] ISO-Space aims at the extraction of two kinds of information – spatial information and spatio-temporal information. Therefore, it consists of two components.[80] The first one, based

[77] Hirst G. (2007), p.5
[78] Ide N., Romary L. and al. (2004)
[79] Some content of the meetings and development of ISO-Space can be found on the internet at: https://sites.google.com/site/wikiisospace/
[80] Pustojewsky J. (2011)

on SpatialML, is dedicated to the annotation of spatial information with an emphasis on properties, locations and places. The second component is concerned with the annotation of spatio-temporal information. It is based on TimeML and STML with an emphasis on locating events in space.

Every annotation scheme consists of two different parts: the representation (which is the format used) and the annotation. In order to compare the theories of cognitive linguistics above, with the annotation schemata, it is necessary to find out the underlying annotation. This has to be done bearing in mind that the representational part of the system has to be taken into account as well, since it determines the limits in which the annotation can be used. A more detailed analysis will be presented in the subchapter concerning the methodology of ISO-SPACE After those preliminary remarks concerning the annotation scheme in general, the rest of the chapter will be use to describe its structure in detail.

The aim of ISO-Space is to serve as an interface between natural language as expressed in text and formal language that can be used computationally. A limit has been reached in computational linguistics concerning the annotation of semantics in natural language. Partially, this is based on the fact that the entire information is not contained in a word or expression, but rather a great part of the meaning depends on the context.

The goal of ISO-SPACE is to establish schemata that allow the most accurate translation of natural language into formal language. Concrete applications for such a specification are for example the creation and visualization of objects from a verbal description of a scene, the identification of the spatial relations associated with a sequence of processes and events from news articles, the determination of the object location or the translation of a viewer centric verbal description into another relative description.

The following excerpt of a news article is one example of the kind of spatial information ISO-Space aims to capture:

"NYT: July 15, 2011

CAIRO-A Libyan ship that tried to break Israel's blockade of Gaza docked in the Egyptian port of El Arish on Thursday afternoon as the ship's sponsor […] said that the boat had shifted course because the Israeli government agreed to allow Libya to support building and reconstruction in Gaza."[81]

[81] The example is issued from Pustojevsky J. et al. (2010)

The information that ISO-Space aims to capture in this text, is the movement of the ship from a region (identified as part of the blockade near Gaza) to a location (identified as a port in Egypt).
On a more abstract level the annotation scheme aims to capture the motion, the moving objects and the paths along which the motion occurs.[82]

3.2.2 The structure of the ISO-Space annotation scheme

In order to account for spatial and spatio-temporal information, the ISO-Space framework combines two existing annotation schemes.[83] The first one is SpatialML which emphasis is on marking up places in natural language.[84] This scheme has been used for the automatic extraction of static information.[85] The second component is TIMEML and STML, with an emphasis on locating events in space. TIMEML allows the extraction of spatio-temporal information and the STML (Spatio-Temporal Markup Language) annotates motion.[86]
This implies that the ISO-Space framework decomposes spatial information into two subcategories – static (spatial) information and dynamic (spatio-temporal) information. ISO-space incorporates this two existing resources and extends their scope. In fact its goal is to capture implicit spatial information and to deal with the full range of verbal descriptions of spatial relations.
Concerning the structure of ISO-Space, the annotation consists of two kinds of syntax: a concrete syntax which is the STML syntax and an abstract syntax which defines the model and the structures constituting the information about space. This abstract syntax consists of a conceptual inventory and a set of rules, defining the combination of these elements. Therefore, it represents the level that qualifies for analyzing this model and comparing it subsequently with the cognitive linguistic theories from the first part.

[82] Pustejovsky J. and al.(2010) for more examples of applications
[83] Pustejovsky J. and al. (2011)
[84] SpatialML extracts information about places, including explicit information (ex. the name of a town) and implicit information (ex. three miles from NY). It aim is to ground the references to precise positions that can be characterized in terms of geocoordinates. (Mani and al., 2008)
[85] Mani and al. (2008)
[86] "It deals with the time stamping of events (identifying a event and anchoring it in time), ordering events with respect to one another, reasoning with contextually underspecified temporal expressions and finally, reasoning about the persistence of events." (cf. http://www.timeml.org/site/index.html)

3.2.3 The nature of language

The question addressing the nature of language is never explicitly asked in any paper published about ISO-Space. One reason thereof is that it is not of uppermost importance to ask this question if you are developing a scientific tool. But I think it is necessary and valuable to pose this question, since this annotation framework aims to be an interface between natural language and a formal language, underlying the computation. Being an interface, it's important to define both types of linguistic systems.

"A major research question in the interpretation of textual data is the lack of a clear separation of information that can be derived directly from linguistic interpretations and further information that requires contextual interpretation."87Considering the historical part above it refers to two different kinds of historical assumptions about meaning. The first level of meaning is in the text and can be identified directly by the syntax. It refers to the objective-meaning. The second assumption concerns meaning as interpretation. In this case, it corresponds to the subjective meaning of the text. Here, the question is how to relate both. As such natural language is considered as written data plus the associated (two) levels of meaning. Further "the goal of ISO-SPACE is not to provide a formalism that fully represents the complexity of natural language, but rather to capture these complex constructions in text to provide an inventory of how spatial information is presented in natural language."88 This shows furthermore that it is assumed that there is an abstracted kind of generalized spatial meaning (which arises from the two different levels of meaning above). The computer's task is to capture those two kinds of meaning. From this citation can be inferred that language is a system which conveys meaning in a twofold manner. On the one hand it can be explicitly derived from the structure of language itself, and on the other hand it can be implicitly inferred from the contextual framework. Furthermore, Pustojevsky states that this context dependent meaning cannot be captured in computational terms, which is why it has to be set apart from the linguistic structure that can be computationally captured. Thus, the informational value of natural language has to be reduced to a closed system, in order to be compatible with the formal language (which is the language that can be used by machines). Then the meaning exclusively arises from the components constituting the system and the relations between these elements. In other words, the

[87] Pustejovsky and al. (2011)
[88] Pustejovsky and al. (2011)

pivotal assumption underlying the ISO-space project is that the context-independent part of natural language represents explicit meaning directly. By this context-independent part, Pustejovsky refers to lexical and syntactical structures.

In conclusion, it is assumed that language is constituted in form-meaning pairs. The form refers to the lexical or syntactical level. The meaning is of two kinds: explicit meaning, which is seen as the meaning that can directly be inferred from the form, and implicit information, which corresponds to the interpretation of the reader (subjective meaning). The task of the annotation scheme is to extract both kinds of spatial and spatio-temporal information.

3.2.4 Semantics of spatial expressions in ISO-SPACE

The goal of this section is to identify the different subcategories which constitute the conceptual inventory of spatial and spatio-temporal information in the ISO-Space framework. The following main concepts have been identified by the researchers for the ISO-Space framework:[89]

- "Locations (regions, spatial objects): Geographic, Geopolitical Places, Functional Locations
- Entities viewed as Spatial Objects.
- Paths as Objects: routes, lines, turns, arcs
- Topological relations: *inside, connected, disconnected*
- Direction and Orientation: *North, downstream*
- Time and space measurements: units and quantities for spatial and temporal concepts
- Object properties: intrinsic orientation, dimensionality, size, shape
- Frames of reference: absolute, intrinsic, relative.
- Spatial Functions: *behind the building, twenty miles from Boulder*
- Motion: tracking moving objects over time"

Furthermore they defined the semantic requirements concerning the relations between those spatial entities as spatial expressions. These employ a combination of five parameters of meaning:

- "Topological: in, inside, touching, outside
- Orientational (with frame of reference*): behind, left of, in front of*
- Topo-metric: *near, close, by*
- Topological-orientational: *on, over, below,*
- Metric: *20 miles away"*

[89] The two following classifications are issued from Pustojevsky J., Yocum Z. (2013)

These are the important concepts identified, in order to capture spatial and spatio-temporal information in language. The innovative approach applied here, is that the development of the formal language is based on the annotation and not on the text itself. In other words, the formal language in ISO-Space represents the semantics of the text but not its syntactical and lexical structure. Although this is a rather recent approach, it seems to have promising future.[90]

The important point to retain here is, that in contrast to other spatial frameworks the annotation in this project is based on a semantic metalanguage. The annotation does not concern the structure of the word, but rather its semantics.

3.2.5 The annotation language of ISO-Space

On a more detailed level and based on the observations above, the researchers chose to mark-up the following elements:[91]

"1. The entities:

- Location: this is represented by the inherently grounded entity. It can be a place or a path.
- A spatial entity: that is not a location but which is identified as participating in a spatial relation (ex; building, John)
- A motion: inherently spatial event, involving a change of location
- An event: is a situation that does not involve a change of location, but one which is identified as participating in a spatial relation
- A spatial signal: relation word that supplies information to the spatial relations
- A measure tag: capturing distances and dimensions
- Adjunct tag: captures information about event-path or manner of motion information that is not contributed directly by a motion verb

2. The spatial relations:

- Qualitative spatial link: a topological relation between location, spatial entities, events and motion
- Orientation link: describe a non-topological relation between two elements
- Movement link: relation word, that locates a state or motion in a particular region or path, adds information to an existing event path, or provides information on the relation type of a spatial relation
- Metric Link: captures measurement relation between spatial objects or the dimension of a spatial entity"

These concepts are tagged in the text based on the semantic level. Grammatically they can be

[90] Bunt H. (2007)

[91] Pustejovsky J. et Yocum Z. (2013). It corresponds to the specification 1.5 of ISO-space

nouns, adjectives, adverbs and verbs. Furthermore, spatial relations are based on the property of compositionality. In this framework, spatial information results from the relation between two entities or from a relation word. The entities and the relation word are grammatically situated on a lexical level, which means in this case that the majority of entities are nouns, whereas the majority of relation words belong to the class of adverbs. This annotation assumes that the spatial and the temporal domains are separable from other semantic domains. The question remains, if these three spatial relations (qualitative link, distance link, spatial signal) are sufficient to capture the entire sphere of spatial information? In order words, it is questionable if the level of granularity is accurate, since it is provided by the human annotator.

3.2.6 Methodological considerations

The first step was to create an initial specification, which was based on the Qualitative Spatial Reasoning literature. But, due to the idiosyncratic nature of linguistic expressions, and the immense possibilities of different spatial configurations, this initial specification had to be modified. The next step involved the application of this initial specification to diverse genres of text. The initial genres were written directions, standard news articles, location descriptions, interior descriptions and travel blogs.

The ISO-Space specification is developed by following the MATTER cycle.[92] This is a cycle that involves an iteration over the following sequences: (1) Model, (2) Annotate, (3) Train, (4) Test, (5) Evaluate, (6) Revise. The Model Testing phase, also called MAMA methodology, is an iterative cyclic process as well, which is originally used for the development of software.

This methodology is task specific, which means that the model and annotate phases are not an automatic processes, but rather rely on interventions by human annotators.[93]

In contrast to other researchers, which apply a predefined set of qualitative spatial relations, the MATTER cycle iterative process aims to capture the full meaning of spatial relations, remaining as close as possible to natural language. In order to illustrate this particular approach, I will present the example from the paper, which is supposed to provide an accurate list of different sense a spatial preposition can have in context. This methodology was applied to refine the Q-link (qualitative spatial link) which captures the topological relation between spatial elements. To achieve this goal, they first prepared the data in constructing a set of

[92] Pustejovsky J. et al. (2011)

[93] In this case, they used the Amazon Mechanical Turk Service.

spatial prepositions. This set resulted from two subsequent steps. First they established a list of all English prepositions, and selected those which had a potential for being spatial. In a second step, they selected among those prepositions the most frequently used and associated them with their different spatial meanings. Having this set, the next goal was to disambiguate the sentences to identify spatial uses. Sentences in which the prepositions were highlighted were presented to the annotators, who had to judge whether the sentence is spatial or not. Given the results, the next round of annotation involved spatial preposition sense disambiguation. In this round consisted of randomly selected sentences with a given spatial use of a specific preposition. The annotators were asked to compare the sentence with a set of sentences that use the same preposition and judge if the sense of the preposition in each sentence in the set matches with the target sentence. After several rounds, signature features of each sense can be identified. The next round involved the annotation of the figure and the ground entity in the spatial relation. As a result, the semantic field of the preposition in question is supposed to be as close as possible to natural language. This methodology has a strong similarity with Talmy's methodology. (cf.2.2.1.4)

ISO-Space aims to be a universal framework, but the MATTER cycle was exclusively performed in English. Thus, it is questionable to conclude that these prepositions (or spatial relations) are expressed in the same way in other languages.

3.2.7 The corpus used for the annotation framework

This section deals with the importance of the corpus used for the annotation framework. In the initial phase of the development of ISO-Space researchers were divided into groups according to the different genres of texts. The initial genres were: travel blogs and newspaper articles. It turned out that each category of texts expresses spatial meaning specifically. This means that natural language is not a homogenous class, but depends strongly on contextual circumstances. Any system that claims universality has to account for such inhomogeneities in the expression of meaning within natural language.

3.2.8 Summary

To sum up, Iso-Space is an annotation scheme for the extraction of spatial (static) as well as spatio-temporal (dynamic) information from texts. Language is considered as system of elements. These elements are form-meaning pairs. The form refers to the lexical forms

(prepositions, verbs, nouns) and is associated to concepts. These concepts in this analysis correspond to at least two different kinds of meaning. From a computational point of view, the formal language is based on the semantic meaning that results from the annotation, but not from the words themselves. Furthermore, the annotation is not automatic, which is why the choice of relevant spatial information is decided a priori by the human annotators. What defines the content of spatial semantics depends on the choice of the corpus.

The major problem underlying the conception of spatial domain in ISO-Space, is the definition of the subject-matter. Annotation concerns merely the conceptual part of language, which seems impossible to rend automatic without the intervention by a human annotator. Furthermore, this annotation scheme is related to the underlying assumptions of Computational Linguistics in general. The information is seen as well as "objective meaning" which can be extracted directly from the text without any interpretative step. Such spatial information is for example the "place tag" and "measure tag". The spatial information that is aimed to be captured is seen as the subjective–meaning of the writer. As such, it tries to capture the conceptual part of linguistic structure, which needs an interpretative step. Information that is contextually dependent in the sentence is for example the movement link, the relation between two entities, etc. And the final meaning which aims to be captured is the reader's meaning, which consists in the attributes of the links (figure, ground and frame of reference). This information, using the concepts of figure and ground, needs a further "processing" step by the annotators. As such, the annotation method in this step has to consider the knowledge of the reader (in this case the knowledge of what is in the mind of the human annotator). On the other hand, since it is a computational theory, it also aims to capture information that is relevant for the applications. Thus, the meaning is defined a priori with respect to the requirements of the applications.

The underlying problem is that these kinds of meaning are combined indifferently. The question that remains open is how to take into account those three types of meaning in the annotation.

3.3 GUM-Space: the generalised upper model extension for space

In the field of Computational Linguistics exists various ontologies concerning spatial information.[94] One reason thereof is that spatial information has become very important for numerous kinds of applications. One of these ontologies is the Generalized Upper Model

[94] Kordjamshidi P. et al.(2010). They cite: ACE, GML, KML, TRML...

(GUM) extension for space, which will be the subject of analyze during this section.

3.3.1 Introduction

The analyzed annotation scheme for spatial information, is based on an extension of an already existing ontology, called the GUM Model (Generalized Upper Model). In the field of computational science, the term ontology refers to a representational system of knowledge.[95] It is a conceptual system, which models experiences of the world. Although there are differences between ontologically based models, general agreement exists between ontologies on the following issues:

"• There are *objects* in the world.
• Objects have *properties or attributes* that can take *values*.
• Objects can exist in various r*elations* with each other.
• Properties and relations can change over *time.*
• There are *events* that occur at different *time instants.*
• There are *processes* in which objects participate and that occur over time.
• The world and its objects can be in dif*ferent states.*
• Events can *cause* other events or *states* as effects.
• Objects can have *parts."*[96]

The GUM-Space ontology is a domain specific model that represents knowledge and experience of space. Precisely, it represents the knowledge that language provides for the representation of space, since it is based on linguistic structures. GUM-Space as such is a specification of the GUM ontology, "that aims to cover language with space, actions in space and spatial relationships and develop an ontological organization that relates such expressions to general classes of fixed semantic import".[97] It is used for diverse concrete applications in the field of Natural Language Processing and is used as an annotation scheme.

3.3.2 Nature of language in this ontology

Language is considered as "a system that imposes particular constructions of space, of spatially-anchored events, and of spatial configurations that relate in complex ways to the spatial situations in which they are used."[98] As such, the nature of language is a functional system

[95] Chandrasekaran B. and Josephson J. (1999)
[96] Chandrasekaran B. and Josephson J. (1999), p.22
[97] Bateman J. et al. (2010), p. 1027
[98] Id., p.1027

that, like other systems (e.g. perception), filters, schematizes and structures one's experience of the world. In other words, language has a particular way to represent our awareness of space. It does not represent the totality of a spatial scene but rather focuses on specific aspects of it. The extension of GUM for space models only takes into account this specific spatial information that language represents. Thus, GUM extension for space is a linguistically motivated ontology.

"We propose for this a linguistically-motivated ontology, or 'linguistic ontology' for short, that provides a specification of an encapsulated layer of ontological information motivated solely by the requirements of linguistically-expressed spatial meanings. This provides a new layer of organization for capturing the contribution of language to spatial interpretation that is free of non-linguistic, contextually-dependent additions. We thereby decompose and modularize the problem of interpreting and producing spatial language by 'stratifying' three ways: (i) lexicogrammatically, (ii) according to a shallow semantics, and (iii) by contextualized specifications—all three of which are formally distinct. The application of ontological engineering methods then offers considerable benefits for teasing apart the respective contributions made by these essentially distinct knowledge sources."[99]

A main assumption of this author is that particular grammatical forms can convey this linguistic meaning, as an isolated and self-contained system. He assumes that contextually-dependent meaning, which results from the use of language in particular situations, can be neglected. He further defines this level of meaning as intermediate between linguistic form and contextualized meaning. By linguistic form he means the grammar or closed-class forms. In order to model these particular kind of meaning, strong linguistically evidence has to be taken into account. Bateman and al. used for this evidence the results of empirical analyses in linguistics on spatial semantics, and their own research of situated spatial discourse. An example of the Gum representation of the sentence "to the left of the computer is a USB drive" and its correspondence with the linguistic form can be found in fig.5.

[99]Bateman et al.(2010), p.1029

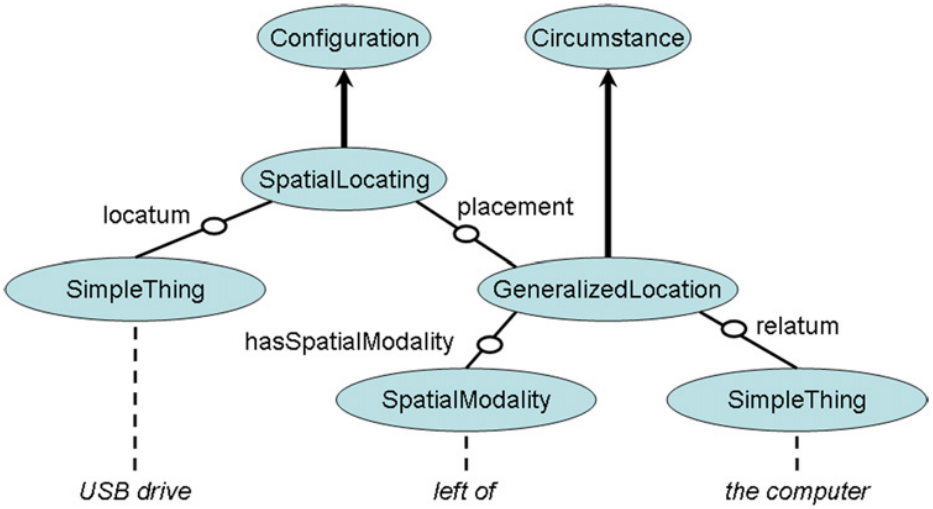

Fig 5.The Gum representation and the relation to the linguistic form (Bateman et al. (2010), p.1038)

This sentence has a contextual dependent meaning. “Left of the computer” is ambiguous and could as well mean the point of view of the hearer or of the speaker. This kind of meaning cannot be resolved by the linguistic structure. The utterance itself “locates” a figure with respect to a ground. This distinction is done semantically: the figure (movable entity) is asymmetric in contrast to the ground (more static). And this asymmetry is reflected as grammatical syndrome within the linguistic structure. For example: subject/indirect object, main and subordinate clauses. Those distinctions can be found by alternations (replacing one word by another in the sentence), resulting in structures that do not allow that meaning. Those constraints indicate that the meaning is structured specifically, which is used by the researchers to construct the ontology. This precise meaning was used to define a semantic entity in GUM-Space called a Configuration. Configurations correlate with grammatical clause or other grammatical units that express events or relationships. The particular type expressed in the sentence here is a SpatialLocation. This type of semantic configuration has the function to relate some entity (figure) to a specification of some place (ground). Secondly, the figure ground asymmetry motivates the attribution of distinct roles in the configuration: the USB fills the position of a locatum relation, and the place fills a placement relation. Thirdly, the entity being placed and the place itself can be distinguished by virtue of distinct grammatical behavior. They are assigned to distinct linguistic-ontological categories in the GUM hierarchy. These are the concepts of SimpleThing and Circumstance, which reflect the distinction between identity and location of entities. “USB drive” is a SimpleThing and “to the left of the computer” is a Circumstance, specified in a grammatically motivated sub-concept of GeneralisedLocation.

The concept GeneralizedLocation provides a common semantics for any linguistic expression of a "place" – including prepositional phrases, adverbials, nominals and other spatially-relevant constituents. Furthermore, GeneralizedLocation does not construct directly a place on the basis of specified entities, but through distinct kinds of "modes of anchoring and locating". These are grouped together in GUM-Space under the concept of SpatialModality.

As shown by the example above, the establishment of this linguistic ontology relies upon the use of hand-crafted annotated sentences and expressions. The establishment of categories is based on a linguistic theory, adopted from different linguistics theories.[100]

To sum up, language is considered as a functional system consisting of form-meaning elements. The form comprises mainly of closed-class elements. Furthermore this ontology is based on a syntactic analysis and not only on words. The linguistic structure is assumed to have an inherent meaning that constitutes an intermediate layer between the linguistic form and the contextualized meaning. It is assumed that this layer can be modelled separately and the association with the contextualised meaning will be done in further research.

3.3.3 Methodology used for the establishment of the annotation scheme

The researchers used seven different spatial language corpora in German and English. All of these corpora are collections of task-oriented dialogues in the spatial domain. Thus, they include a large variety of localizing expressions, spatial action descriptions, and route descriptions.

The process for establishing the GUM extension for spatial expressions is the following:

1) Pre-processing of the utterances

The first step is a selection of sentences that carry spatial information. Idiomatic or metaphorical sentences were neglected in the selection, in order to account only for direct spatial information. Subsequently, they isolate the pure linguistic structures, in order to achieve context-independent spatial information.

2) Manual annotation of the utterances

In a next step they used the findings described above, in order to annotate larger corpora, in terms of spatial information. Thereby, they improved their annotation system for spatial

[100]They cite for example among others Bierwitsch, Levinson, Talmy and Vandeloise

information significantly. Of course, this is an open-ending process, which means that the analysis of different or larger corpora would result in a further improvement of this annotation scheme.

3) Interannotator agreement

Finally, the established annotation scheme was evaluated by a so-called interannotator agreement.[101] This step had two aims. On the one hand it aimed to evaluate the reproducibility of this linguistic ontology by comparing the annotation of two novice annotators, with respect to the accuracy of categories and relations, to a golden standard, which was established by the researchers themselves. On the other hand it was used in order to see whether this annotation method can be used. Since this annotation relies on the specification of the ontology of GUM-Space, units are annotated as complex structures. A sentence is defined by a construction that consists of different categories and relations for each spatially –relate unit in the sentence. In a first step, the annotators were asked to clean up the sentences (remove the non-spatial information) and in a second step to annotate the sentences according to the annotation scheme.[102] The results showed an inter-annotator agreement. Interestingly there were differences in the cleaning up of the sentences, which is the process of discriminating between spatial and non-spatial information.

3.3.4 The structure of the linguistic ontology

Using the methodology above, the researchers have selected the following categorization. The selected categories rely on linguistic structures. Since GUM-Space is an extension of the GUM ontology, they consist of similar hierarchical and conceptual levels. Hierarchically, GUM comprises of three conceptual levels of complexity.

1. *Element*: subsumes single objects or conceptual items, which participate as constituent parts in configurations.
2. *Configuration:* subsumes activities or states of affairs, i.e., representations of experience, which are expressed at the level of the clause.
3. *MutliConfiguration*: describes a sequence of configurations, as expressed by a clause complex that reflects dependencies between single clauses.[103]

[101] Hois J. (2010)

[102] The specific guidelines can be found at : http://www.ontospace.uni-bremen.de/ontology/evaluation/gum-evaluation.html

[103] Bateman et al. (2010), p.1042

Specifically for spatial information, there are three possible configurations:

1. The description of a spatial position of an entity and tells you where something is located (STATIC): SpatialLocating (sub-concept of BeingANDHaving)

2. The description of a spatial action of an entity in terms of moving, turning or orienting (DYNAMIC): NonAffectingSpatialDoing

3. The description of an entity that is moving, turning or orienting another entity (DYNAMIC): AffectingSpatialDoing

These configurations are realized through the following elements:

1. GeneralizedLocation: describes the location of an entity.

2. SpatialModality: describes the spatial modality between two or more entities.

3. Process: states the type of a spatial activity.

4. Conceptual roles of the units in a configuration: locatum, relatum etc…

Additional information about spatial configurations can be expressed by using attributes, which define modifications or refinements occurring in spatial expressions. An example for an attribute is SpatialPerspective.

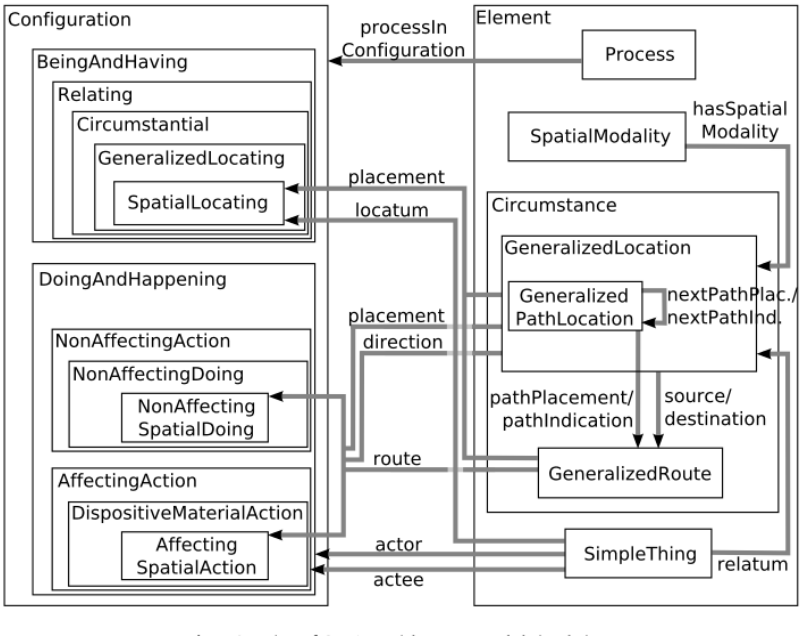

Fig. 5: the concepts and their relation in GUM-Space (Bateman et al. (2010) ,p.1044)

An example of an annotated sentence in the GUM extension for Space framework is the following:

“The chair is next to the table”

SpatialLocating *sl1*:

locatum:*chair*

processInConfiguration:*is*
placement:GeneralizedLocation*gl1*:

hasSpatialModality:RelativeNonProjectionAxial*rnp a1*

relatum: *table*"[104]

3.4 Comparison of both annotation frameworks

This chapter presents the results of the comparison between the spatial extension of GUM and ISO-Space. It consisted in a theoretical analysis of the two frameworks, by comparing the annotation schemes. The aim is to reveal general problems and find some preliminary solutions to them. Furthermore it goes far beyond the goal of this master thesis to analyse extensively the two annotation schemes, therefore it just highlights some selected examples. The last point is that it is impossible for me to look at the formalism behind the annotation schemes, and therefore I will remain on the semantic level, assuming that the relation between linguistic structures and "linguistic meaning" as well as the relation of formal structures to annotation methods are precisely formulated and can be translated into formal language in both annotation methods.
For this analysis it is assumed that there exist at least two kinds of meaning: one that is intrinsic to the linguistic structure, and one that is contextualized. This difference in meaning exists in whole sentences and as well as in single units (of meaning), which is specific to linguistic meaning. Linguistic meaning can be analysed separately from the contextualized meaning. It does not necessarily require a reference to the external world, but only to so-called "conceptualizations". The other kind of meaning refers to concrete objects in the world, it is not conceptualized.

A clause complex consists of a multitude of subunits with their own spatial meaning. The meaning of the whole complex is more than the meaning of its subparts. Consider for example the sentence: "He walked out of the house, across the field, to the train station". This sentence

[104] Hois J. et al. (2009)/ the complete organization of this annotation method as well as the hierarchical structure can be found in the technical report of Hois J. et al. (2009)

consists in a sequence of spatial motions: he walked out of the house, then cross the field and finally arrived at the train station. In GUM-Space, this complex configuration is treated as a conjunct of simple configurations. On the level of a clause complex, ISO-SPACE has no specification that allows the decomposition of many related states of affairs into separate configurations. It seems assumed that the only sequences possible are conjuncts, that are enhanced by signal words such as: "then", "and then". Language seems to differentiate conjunct sequences from disjunct ones, and from states of experience that are only loosely related spatially. Disjunct sequences are for example: "Go from Elmira to Coming but not back to Bath." They combine sentences with "or" and "but not". There are units with no or loose spatial connection between the two sequences such as "Peter is from Paris and he lives in London". They can be distinguished lexically by "and".[105] ISO-Space only captures the spatial information of conjunct sequences in a complex clause.

A further point concerns the meaning of the subunits themselves, as single states of experience. GUM-Space differentiates between a static spatial scene and a dynamic spatial scene. Furthermore it makes a distinction between two kinds of dynamic spatial configurations. A NonAffectingMotion describes a "dynamic spatial motion, movement, or reorientation of an entity"[106] and an AffectingMotion, which describes a "dynamic spatial motion, movement, or re-orientation, in which something/someone (actor) is moving another entity (actee)".[107] An example of the last configuration is "He moves it". ISO-Space captures motion by way of the MOTION_TAG and the movement link. Neither the MOTION_TAG, which captures mainly verbs, nor the movement link can capture the "AffectingMotion" configuration. A solution to this problem would be to attribute a spatial_entity tag to the actee in such a configuration, and to add an attribute consisting in the id of the actee in the MOTION_TAG attributes set.

ISO-Space captures two kinds of information concerning a static scene. What he calls the spatially inherent information such as place, path and measure (and the corresponding measure link). And the spatial relation between entities which capture their relative topological position (QLINK) or their orientation (OLINK). Considering the linguistic structure, ISO-SPACE mixes up two kinds of elements. Those are the open-class elements and the closed-class elements. These can be differentiated according to their function, and they allow for different kinds of

[105] GUM-SPACE Annotation Manual found in http://www.ontospace.uni-bremen.de/ontology/evaluation/GUM-Annotation-Manual.pdf
[106] Id., p.14
[107] Ibid, p.15

spatial information. Open-class elements have a contextualized meaning, whereas the closed-class elements are said to relate to the linguistic meaning (meaning that can be abstracted from the specific representations)[108]. In ISO-Space those direct tags are essentially the place, the path and the measure tag. There seems to be a problem in the granularity of the annotation scheme. Place and path tag are elements of the "location category", in opposition to spatial_entities which are part of "non-location category". But the linguistic meaning lacks this difference. Spatial_entities are functional entities, since they are defined as playing spatial roles in a spatial relation. As such, the place Tag is also part of the spatial_entity category. In ISO-Space, a place is considered as an external object and likewise as a conceptual role. Place is only defined as a concrete place with coordinates. This does not correspond to a linguistic meaning. As such, meaning of the lexicon is too narrow for the annotation of spatial information. The level of meaning captured by the ISO-Space place tag refers to the "knowledge" of the computer, and not to a "conceptualized linguistic meaning". This difference in function and identity is clearly marked in GUM -space, which captures the identity of a place by the "SimpleThing" category, whereas its function in a spatial relation is captured by a "domain". The result of this reflection is that the content/meaning of a place is defined subjectively by the annotators, but is not linguistically determined. This is shown by the comparison with the path tag in ISO-Space, which is defined "as a location where the focus is on the potential for traversal or function as a boundary".[109] A place element in ISO-Space is for example a river .But there is no "objective" reason why river could not be tagged as a path, since it could have a focus on traversal and could function as a boundary as well. Therefore the meaning is not determined by the function of the word, but rather from the context.

A spatial relation between two entities refers to the kind of spatial relation between two entities. In ISO-SPACE, these relations capture topological relations between entities (QSLINK), orientation relations (OLINK) and metric relations (MLINK). In GUM-Space the different kinds of relations refer to the SpatialModality in the hierarchy, which consists of three types: 1) relations that express the distance between two entities; 2) relations that express the direction between the entities; and 3) relations that express the relative position of one entity to another.[110] Distance information can be found for example in a sentence like "The house is by the river"

[108] Talmy (2000), vol1
[109] Pustejovsky et al. (2013), p.26
[110] Bateman et al. (2010)

and would be expressed via "by". The direction information is for example expressed by "behind" in "the hot dog stand behind the Macy's". In this specific case, it reflects a back projection. A relative position (or functional information) is for example "on" in "the pen is on the table". "On" refers to a "support" relation, where "table" physically supports "pen".[111]

From a global point of view, there are different kinds of granularity of meaning captured by the relations in ISO-Space. This can be related to the analysis of the elements.

An example is the metric link, which is triggered by the measure tag and reflects the precise position of an entity in terms of metric distance, height, etc. When comparing to the GUM extension of space (which is assumed to reflect only the linguistic meaning), this contextualised meaning is not captured. The same holds true for the topological relations. The origin of the topological meaning is not a linguistic conceptualized one, but a mathematical one. The features of this relation are based on the RCC8 (Region Connection Calculus) and the addition of the IN[112]. The question here is if this mathematical representation of the relation between entities, which refers to a Euclidian space, reflects the "linguistic meaning". In other words, can those relations be captured by linguistic structures?[113] According to the scheme of GUM-Space it seems that those relations are too specific and belong to the contextualized kind of meaning. In GUM- Space, qualitative links only capture information if it is distal or proximal. Proximal is a superconcept of spatial modalities involved with lateral and frontal projections. "The characterization of the sentence 'Bill is waiting at the post office' as expressing the spatial modality Proximal then makes the commitments to a functional connection between the person waiting and the post office without (wrongly) committing to a spatial contextualization involving containment; both inside and outside the post office are still compatible with descriptions with 'at'."[114]

In ISO-Space, "at" in the example "Bill is waiting at the post office", would be difficult to annotate in ways of topological relations.

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[111] Id.

[112] The RCC calculus is an abstracted description of the relations between regions in a Euclidean or topological space. There are 8 basic relations: DC (disconnected) means that the two regions do not share any point at all; EC (externally connected) means that they only share borders; PO (partially overlapping) means that the two regions share interior points; EQ (equal) means that they are in the same region; TPP (tangential proper part) means that one region is a subset of the other sharing some points on the borders; NTPP (non-tangential proper part) similar to TPP, but without sharing any bordering points etc…cf. to http://en.wikipedia.org/wiki/Region_connection_calculus. ISO-Space furthermore add IN (which is a disjunction of TTP and NTTP)

[113] It can be seen as a problem of reference in the annotation scheme. What kind of information is aimed to be captured? Reference to the contextualized meaning or it is the reference to an "objective knowledge"?

[114] Bateman et al. (2010), p.1028

Concerning the orientation link, there is a problem of granularity in the attributes. For example, the frame of reference concept does not correspond to a linguistic meaning. It needs a further step of interpretation and consists in a reflection about the linguistic meaning itself, for which reason it is not part of the linguistic meaning. As such, it cannot be characterized by way of linguistic structure, but rather by the interpretation of the whole spatial information captured. This holds equivalently for the attribute goal_reached (which can be filled by “true” or “false”), since it needs a further step of interpretation of the linguistic meaning in order to be answered. The exemplary sentence “The dog is in front of the couch” is only interpreted as an intrinsic point of view, due to the fact that as human spectator one can situate the entire sentence.

Considering the orientation link, a further paradox arises. The only sentences that can be captured express static locations. This is the case, since in ISO-Space this relation is triggered by a spatial_signal. Furthermore, it highlights the implicit separation between motion events and static events. It is per se problematic, since motion events also reflect spatial relations between the entities that can be oriented.

3.5 Conclusion

ISO-Space and GUM- Space are both annotation schemes that aim to capture the spatial information in text. Spatial information refers to the linguistic meaning of the text. Spatial information corresponds in both schemes to the meaning that results from the linguistic structures. It is assumed that there are two levels of meaning. The first level is the linguistic meaning, which is conveyed by linguistic structures and can be modelled as an ontology, since it consists in a finite set of elements. The second level is a contextualized meaning, which does not arise from the linguistic structures, but rather needs an interpretation based on contextual information (which is not present in the text).It is constituted by an infinite number of elements. The linguistic meaning refers to what cognitive linguistics would call the conceptualization. The analysis showed that ISO-Space does not only capture this kind of information, but also captures meaning referring to the outside world. This results in problems in the granularity of the annotation scheme. The nature of language is in both schemes reduced, because it is assumed that both levels of meaning are distinct. As such language is seen as a structure of intrinsic form-meaning pairs.

Concerning the methodology, both annotation schemes apply the same method in order to test their scheme based on the interannotator agreement. The last common point concerns the assumptions of both frameworks regarding the meaning in text. Both assume that this meaning is in the reader (and as such capture the conceptualized knowledge), but furthermore, ISO-Space assumes that some aspects of meaning can also be extracted from the text itself (extraction of elements in the world).

4 Interdisciplinary comparison of both disciplines

This chapter has two different aims. To show that the theoretical background of the four theories is comparable. And a summary of the common elements and relations between the elements represented by language in a spatial scene.

4.1 The common elements and relations in a spatio-temporal scene

All four frameworks agree on the existence of a conceptualized meaning, which is reflected by linguistic structures. These linguistic structures construct spatial meaning in a specific way. Firstly, language distinguishes between static and dynamic configurations. Precisely, a spatio-temporal scene shows the following three meanings.

1. The description of a spatial position of an entity and tells you where something is located (STATIC)

2. The description of a spatial action of an entity in terms of moving, turning or orienting (DYNAMIC)

3. The description of an entity that is moving, turning or orienting another entity. (DYNAMIC)[115]

Secondly, on a conceptual level language makes a distinction between the elements or entities constituting a spatial scene. A classification of the common elements is resumed in figure 6.

	Talmy's "cognitive Semantics"	Jackendoff's "Conceptual Semantic"	ISO-Space	GUM -Space
PRIMARY OBJECT	THE PRIMARY OBJECT (FIGURE) "movable or conceptually movable entity whose site, path, or orientation is conceived as a variable the particular value of which is the relevant issue"	FIGURE "object to be located"	FIGURE "identifier of the place, path, spatial entity that is being related"	LOCATUM "role of which location or position is described"

[115] Bateman J. (2010)

LANDMARK	THE SECONDARY OBJECT (GROUND) "Is the reference entity, one that has a stationary setting relative to a reference frame, with respect to which the Figure' site, path or orientation is characterized.")	LANDMARK	GROUND "Identifier of the place, path, spatial named entity, or event that is being related to."	RELATUM "The relatum specifies the reference object that is referred to in a spatial locating configuration and holds between a place and a spatial object. Similar to locatum, this term is directly taken from linguistic classification of entities in spatial expressions."
OTHER OBJECT	THE SECONDARY REFERENCE OBJECT (EXTERNAL OR ENCOMPASSIVE)			ACTEE
FRAME OF REFERENCE	Frame of reference with the secondary reference object		For motion only	
LOCATION		REGION	PLACE	GROUND
PATH/ROUTE			PATH	PATH/ROUTE
ORIENTATION			QUALITATIVE SPATIAL LINK	
MOTION	MOTION EVENT		MOVE LINK/ MOTION TAG	

Fig.6: summary of the common elements

4.1.1 The Figure/ Trajector

Considering a spatial scene, the figure is the semantic role attributed to the entity that is located, moving or oriented. Grammatically, it often corresponds to a nominal. In the sentence "The cat is on the sofa." "the cat" corresponds to the figure.

4.1.2 The ground/landmark/relatum

All four theories attribute a semantic role to the entity that the figure is related to. It seems to be expressed grammatically by a nominal as well. In the sentence: "the lamp is next to the table.", "table" corresponds to the ground.

Language assigns particular characteristics to the figure and the ground object, such as its dimension, its number, the state of boundedness or its motive state. They are not characterized by specific metric spaces such as a particular size, length, distance or orientation.[116] A further

[116] Those characteristics are paralleled with the figure/ground contrast in psychology and in particular the Gestalt theory. Furthermore this contrast is found equally in the semantics of two events related to each other in a

property of these elements is that they are reduced in a spatial scene to geometric points in order to be located. A further remark concerns the attribution of these roles. According to Talmy, these semantic roles are provided by the scheme of distribution of attention**,** which allows specifying the focus on a referent scene from an indicated perspective. The semantic of language is particular, which is why language does not allow every possible meaning. The example sentence "The house is near the bike" sounds semantically odd in comparison with the sentence "The bike is near the house", although both have the same structure. This comparison shows that figure and ground have asymmetric properties. They have different definitional properties and associated properties. The definitional property of the figure is that it has unknown (spatial or temporal) properties to be determined. By contrast, the ground acts as a reference entity with known properties that characterizes the unknown properties of the figure. The additional properties are for example the fact that the figure is more movable, smaller, geometrically simpler, more recently on scene, more dependent etc…[117] The additional properties refer to the perspective taken on the scene.

4.1.3 The secondary reference object/further element

The secondary reference object is used by Talmy in order to account for the location and orientation of the figure-ground spatial schema. It can be traced back to the concept of region by Jackendoff, which is why it is treated below in the paragraph concerning the framework of reference and region. GUM-Space defines as further element the actee which corresponds to "the entity that is being moved oriented or turned in a dynamic setting".[118] ISO-Space does not use a secondary reference object in its annotation frame. This implies that it cannot capture dynamic information that refers to this element, as in the sentence: "I put the bag there."

4.1.4 The spatial disposition of the figure (or the primary object) with reference to the ground

The spatial disposition of the figure refers either to the site, when the object is stationary, or its path, when moving, and its orientation in both states. According to Talmy, a static scene needs

temporal situation. The corresponding linguistic structures are the main and subordinate clause of a complex sentence. Talmy L. (2000), vol 1, chap.5

[117] Talmy L.(2000), vol1, chapter 5: Figure and Ground in language,pp 315-316

[118] Bateman et al., annotation manual,p.17

a figure-ground, path, placement and frame of reference. In this case, it is indicated in terms of distance from or relation to the geometry of the second object. In the example sentence “The bike stands near the church”, the figure (bike) can be characterized as being situated in “proximal” distance (by the preposition “near”) from the ground (the church). This meaning is captured by the ISO-Space framework through the orientation link and partially by the distance link. In the GUM spatial extension for space the distance between two entities is captured via the distance spatial modality, which can be expressed by a preposition, a verb or an adjective. This relation can be quantitative (metric distance) or qualitative (proximal/distal). Jackendoff defines this notion in the following manner:

[STATE]→ { [state BE ([THING], [PLACE])] [state ORIENT ([THING], [PATH])] [state EXT ([THING],[PATH])] }

This means that he defines a static spatial scene by means of a STATE function. The first kind specifies the location of the object (as in “Mary stands next to the house”), the second kind specifies the orientation of objects (as in “The sign points toward New York”) and the third function specifies the spatial extension of linear objects along a path (as in “The railroad goes from Vienna to Berlin”). It can be seen that in contrast to Talmy, Jackendoff treats the path as a static entity. Furthermore, the location is defined less specifically than in the other theories, since he is concerned with the syntactic structure.

4.1.5 Frame of reference and perspective point

The frame of reference is not defined as a semantic role like figure and ground. Thus, it is not represented directly by the linguistic structure. But it is an important concept, in order to situate entities in space. It is present in each theory, except the one of Bateman, since it extracts spatial semantics that purely rely on linguistic structures.

The frame of reference in ISO-Space is based on the research of Levinson.[119] According to Levinson’s theory, the functionality of a frame of reference consists in labeling different kinds of coordinate systems. He describes three of those systems in linguistics: the intrinsic, the absolute, and the relative.

The intrinsic frame of reference “involves an object-centered coordinate system, where the coordinates are determined by the 'inherent features' sidedness or facets of the objects to be

[119] Levinson S.(2003)

used as a ground or a relatum."[120] But it relies on the properties of the object: its shape, canonical orientation, characteristic motion, etc… In other words, the intrinsic features of the entity determine the frame of reference.

In an absolute frame of reference, the perspective is given by ubiquitous orientation system such as compass directions or environmental features. This means that it is characterized by metric and objective features.

Finally, he distinguishes the relative frame of reference, which locates entities based on their interrelations.

GUM-Space does not account for this information at all, since this reference frame is not a notion that can be derived from the linguistic structure. Talmy developed a reference system based on the secondary reference object, which he associates with the finding by Levinson.[121] He associates the localization of the figure by the primary object of reference only by means of an intrinsic frame of reference. The localization is "ground-based", as for example in the sentence "The bike stands near the church". Furthermore, Talmy introduces a secondary reference object. In most cases it is not explicitly named in the sentence, but rather arises implicitly out of a spatial term. It can encompass the primary reference object or be external to it. An encompassive secondary reference object is for example a queue. It is implicitly contained in the spatial expression "ahead of" in the example sentence "John is ahead of Mary". In this sentence, the figure (John) is localized by the ground (Mary) but as well by the directionality of a second object which is distinct from the ground. This directionality refers here to a queue, which is the secondary reference object. Another encompassive type, apart from the queue, is the directed space set up by the earth (such as in the sentence "The bike stands west of the house"). Talmy parallels this field-based location with Levinson's absolute frame of reference. The external secondary reference object is wholly outside the primary reference object, exhibits a range of non-asymmetric geometries and is expressed in the sentence by a nominal. In the sentence "The bike is on the side of the church toward the cemetery" the secondary object is the cemetery side. It refers to an externally characterized ground part. In the preceding sentence the location of the figure (the bike) is characterized by the primary reference object (the church) and more precisely by the secondary reference

[120] Levinson S. (1996), p.140
[121] Talmy L.(2000), vol 1, p.213

object(the cemetery side).This type of external secondary reference object is said to be non-projective and refers to a guidepost based localization. The second type of external reference frame is projective. It has an asymmetric geometry that projects out of it to form a reference frame. The source of the projection is frequently the speaker or some previously defined viewpoint. In the sentence "The bike is on the right of the house", the figure (the bike) is localized by the primary reference object (the house) and by the secondary reference object (on the right). The source of projection in this sentence corresponds to the speaker. The corresponding frame of reference is called by Talmy projector-based. Talmy relates the linguistic use of a projective secondary reference object to Levinson's relative frame of reference.

Jackendoff, comes up with an independent reference system, which consists of eight different frames of reference. These are categorized into two major classes: intrinsic frames of reference and environmental frames of reference. The geometric frame uses the geometry of the figure itself to determine the axes.[122] As an example, it allows to determine the length of the figure by using the dimension of greatest extension. The motion frame of reference indicates that "the front of a moving object is determined by the direction of motion".[123] The two following frames of reference depend on the functional properties of the object. The canonical orientation frame "designates the top (or the bottom) of an object the part which in the object's normal orientation is uppermost (or lowermost)".[124] The canonical encounter picks up the intrinsic part of the object based on how it is encountered. As an example "the part of the house where the public enters" functions as the front of the house. Furthermore, Jackendoff describes four environmental frames. The gravitational frame "determines the object by the direction of gravity, regardless of its orientation".[125]The geographical frame is "the horizontal counterpart of the gravity frame, imposing axes on the object based on the cardinal directions north, south, east, west."[126]The contextual frame is "available when the object is viewed in relation to another object, whose own axes are imposed on the first object."[127] And finally the observer frame

[122] Jackendoff R.(1996), p.18
[123] Id.
[124] Ibid
[125] Jackendoff R.(1996),p.19
[126] Jackendoff R.(1996), p.19
[127] Jackendoff R.(1996),p.19

which “may be projected onto the object from a real or hypothetical observer.”[128]
The frame of reference system by Levinson was criticized by Thenbrick, due to the fact that it applies only to static spatial scenes. She developed another reference system, which enables the possibility to locate dynamic scenarios as well.[129]
Each of these frames of reference is associated with a respective point of view, which means that the spatial scene crucially depends on an observer. For the intrinsic case, which positions the locatum with respect to the relatum, the perspective point is the relatum. It is a first-person perspective, in which the viewer is situated in terms of the viewed. In contrast, the absolute case does not require a relatum, since it is a third-person perspective. Furthermore, the positions of the entities involved are described in objective terms, such as cardinal directions or a coordinate system. The relative frame of reference is based on a third-person perspective as well, but in the case the observer is situated in a concrete point of view.
Every author agree that a spatial scene has limited ways to be perceived, and that there are a limited number of possible ways of localizing the figure. Nevertheless the four theories have different ways of characterizing it.

4.1.6 Path/route role

GUM-Space uses the semantic concept of path/route in dynamic spatial scenes as well as in static ones. In both cases, it is defined by the following attributes:
-a Source: starting position of a motion, placement or orientation
-a Pathplacement: intermediate position which is a place area/region)
-a PathIndication: intermediate position which is a landmark (point)
-a Destination: end position
Furthermore, ISO-Space attributes the notion of path to a path-tag. It captures the location where the focus is on the potential for traversal or function as boundary. This notion is linguistically expressed via prepositions. In contrary to the path of a motion event, this path-tag does not capture intermediate points. The path in a static setting is considered as a subset of place elements, defined by a beginning and an end point.
Jackendoff defines the path (or trajectory) “as one of five functions that map a reference

[128] Jackendoff R.(1996),p.19
[129] Tenbrick T.(2011)

thing or place into a related trajectory."[130] The five functions are TO, FROM, TOWARD, AWAY–FROM and VIA.

Talmy considers that the path is a universal semantic category that "refers to the variety of paths followed or sites occupied by the Figure Object in a Motion event."[131] This concept is conferred by the verb root in Romance, Semitic and Polynesian and by the satellites of most Indo-European languages, as in English with forms like "in", "out" etc…The concept of path is treated in the same way in static and in dynamic spatial scenes. In fact, a universal property of the semantic organization is that "the state of locatedness is conceived and subdivided into components in the same way as an event of translational movement."[132] This refers to the phenomenon of fictive motion. It can be illustrated by the comparison of the two following sentences. "That mountain range lies between Canada and Mexico" and "That mountain range goes from Canada to Mexico." The first sentence directly expresses a static spatial relationship, whereas the other one evokes something in motion (from north to south), but is in fact static.[133]

According to Talmy the conceptualization of a path in language appears in three major types.[134]The orientation path refers to the "linguistic conceptualization of a continuous linear intangible entity emerging from the front of some object and moving steadily away from it."[135] An example sentence which illustrates this kind of path is "She crossed in front of the TV." The verb cross can be used when walking transversely in front of an object with a front. The second type of paths is the radiation path, which are linguistically conceptualized as a "radiation emanating continuously from an energy source and moving steadily away from it."[136] These category of paths is illustrated by sentences such as "The light is shining into the cave", where shine involves a radiation from the sun. The last kind of paths is shadow paths, which are linguistically conceptualized as "the shadow of some object visible on some surface has fictively moved from that object to that surface."[137] A sentence such as "The tree threw its shadow down/into the valley" is

[130] Jackendoff R.(1990), p.44
[131] Talmy L.(2000),vol 2, p.154
[132] Talmy L.(2000), vol2, p.167
[133] Talmy L. (2000), chap.2 for a detailed description of fictive motion and the different categories of path.
[134] Talmy (2000), vol1, pp.106-116
[135] Talmy L.(2000), vol1, p.106
[136] Talmy L.(2000),vol 1, p.111
[137] Talmy L.(2000), vol 1, p.114

an illustration of this type. These three categories of path have the same principle. The trajectory of a scene is characterized by an object that has a source role, and the object that is the goal of the emanation.[138] Talmy, in contrast to the other theories does not consider an intermediate point of the trajectory.

Thirdly, the relation between figure and ground are specific in a spatial scene. Specifically, the relation can be characterized via its dependence on static or dynamic spatial settings. Further specifications differ between the four frameworks, due to the different levels of granularity of the information they want to extract. Generally speaking, the relation between figure and ground allows to situate an object in a frame of reference or to follow the trajectory of a moving object. Nevertheless there can be found differences in the way how the relations are treated. The GUM-Space framework for example considers also functional relationships between figure and ground. It is more specific regarding the characterization of these relations than ISO-Space. All four theories agree on the fact that the type of relation between two spatial entities is mainly represented by a preposition on the linguistic level. The GUM-Space annotation method identifies majorly three relations: 1) a distance relation, which refers to the qualitative or quantitative distance between the two entities; 2) a functional relation, which represents functional dependencies between two entities; 3) a relative distance relation, which refers to the type of positions between entities relative to each other. ISO-Space distinguishes internally between four relations: 1) a qualitative link, which extracts the distance between entities; 2) an orientational link, which specifies the orientation of an entity; 3) metric link, which aims to extract the exact distance between entities; 4) movement link, which precisely describes the motion of a figure in relation to another one. Talmy characterize relations between entities as those relations are less specific than they are in GUM-Space, since ISO-Space cannot extract functional dependencies between two entities. Furthermore, its inherent structure differs from GUM-Space, the location of a figure is not exclusively captured through relations, but rather relies on other attributes of the figure.

4.1.7 Motion

The expression of motion needs several semantic components: the figure, the ground, the path of motion, the manner of motion and the cause of motion. According to Talmy, three of these

[138] Talmy L.(2000), vol 1, p.117

semantic components are central across languages: the ground, the manner and the path.

These three semantic components are not expressed in the same way linguistically. Talmy makes a separation between two groups of languages. The verb framed languages (Romance, Semitic) convey path-meaning by lexicalisation of the verb root (ex.: sortir). The second group of languages (Germanic, Slavic), which Talmy calls satellite framed languages. They encode path-meaning in satellites (particles, prefixes and prepositions), which are associated to the verb root (ex.: walk into). Therefore the verb root allows encoding other dimensions of motion events, such as manner. An example would be the sentence "John walks by foot". Movement is expressed by the verb (walk), whereas the manner is expressed through the preposition (by foot). In ISO-SPACE, this information about motion is captured in two ways. Via a motion-tag, allowing a differentiation between the manner of motion and the path of motion. This annotation is based on the preceding findings of Talmy. Secondly, motion is captured by means of a movement link, which specifies the path a particular motion takes. For Jackendoff, motion is constructed via GO, which is an event function. The arguments of GO, which denotes the motion along a path (such as in the sentence "I traveled to New York") are the THING in motion and the PATH it traverses.[139]

As seen above motion is described in the GUM-space annotation under two distinct concepts: the NonAffectingMotion (which "describes the dynamic spatial actions of an entity (actor) that does not affect other entities), and the AffectingSpatialAction (which describes "a spatial action that affects an entity the actee").[140] The first kind of motion is subdivided into three further types of motions. A NonAffecting directed motion defines a spatial action in which the direction or the path of motion is given (such as in the sentence "the man walked forward"). It can be captured via a motionDirection (depending on the actor), a direction (in case of reorientation of the motion) and by a route (see above). The second kind of NonAffectingMotion specifies the change in orientation of the actor (such as in the sentence "Turn from the kitchen 90 degrees to the left to the office." It is captured via an orientation direction or a route.[141] Finally the last concept captured specifies an action without information about the location of the motion. This configuration is illustrated by sentences such as "He is dancing".[142]

[139] Jackendoff R. (1990), p.44
[140] Hois J. (2009), p.16
[141] Hois J. (2009), p.18
[142] Hois J. (2009), p.20

4.2 The relation between semantic categories and structure elements

This part concerns the relation between the conceptual framework discussed above to the concrete linguistic forms, like syntax and lexicon.

All authors agree upon the existence of a conceptual level, which is represented by language. In the preceding section, I have introduced the concepts that are relevant for the description of a spatial setting. Furthermore, the four theories agree on the fact that the structure of language represents this level through particular syntactical and lexical constructions. But they disagree about the particular form of these linguistic structures and their relation to the conceptual system.

The cognitive semantics framework (Talmy) separates between open-class and closed-class forms. The open-class (lexicon) provides the content, whereas the closed-class forms offer the structure for the conceptual level. The theory is exclusively interested in the closed-class forms, due to the finite amount of entities it consists of. An important characteristic of these forms is their universality. These universal entities are represented lexically in the linguistic structure. Since Talmy's theory is based on lexicalisation, the meaning arises from prepositions, verb roots, etc.

The approach of Jackendoff is slightly different, since he considers conceptual content as the result of the composition of different kinds of conceptual notions. He is interested in the generative rules, which connect basic elements to meaningful structures. He makes a distinction between surface arguments and conceptual arguments, which is why his theory mainly concerns structures of higher-order. He discovered that there is no one-to-one correspondence between these levels. Therefore he remains rather evasive regarding the concrete relation between the linguistic and the conceptual level. In other words, his analysis is of unidirectional nature. He applies linguistic rules to investigate the conceptual level, without taking into account the possible significance for the linguistic level.

In order to capture the spatially relevant concepts, ISO-Space takes a two-fold approach, which means that it accounts for structural as well as lexical elements. It does not separate between two different semantic levels. On the one hand, it considers that nouns and proper nouns represent spatial entities directly. For example, concrete names for cities or geographical places can stand for places and locations. On the other hand it uses semantic concepts like

ground or figure, in order to capture higher-level concepts, such as the trajectory of an entity, or the distance of two entities. Beside the mere conceptual description, it accounts for spatial relations by the application of concrete concepts, like metric distances. The distinction between the two levels of meanings is not always clear.

The framework of GUM-Space relies heavily on a grammatical background. It captures only the semantic concepts that are expressed linguistically and is concerned with the grammatical forms. It only takes into account the closed-class forms. The conceptual level of this linguistic annotation method is situated between the linguistic forms and the contextualized interpretation. [143] As such, the conceptual level is defined in contrast to the two other levels. In particular it has to avoid overcommitment, that is, "the description captures formally just the degrees of flexibility, or underspecification that the linguistic utterance leaves open."[144] Furthermore, this conceptual level serves as a basis for the contextual meaning. The last property is that this conceptual level is universal across languages.

In conclusion, the examined theories agree upon the importance of the conceptual level, but they differ in terms of its content. The content of the conceptual level in the theories by Talmy, Jackendoff and Bateman et al., is separated from the contextualized meaning. In contrast, ISO-Space incorporates contextualized meaning as well. Furthermore, they do not fully agree upon the relation between the syntactical/grammatical and structural surfaces.

4.3 Examples

4.3.1 Metric distance

The metric distance between entities, according to Talmy and Jackendoff, is not adequately represented by linguistic structures, since language does not account for a Euclidean view. In contrast to the view by cognitive linguistic, the ISO-Space annotation, which shows a considerable lexical account, makes a lexical distinction for each of such physical objects (cf. ISO-Space, basic ISO-Space elements). For example, a figure can be a particular city or a concrete geographical place. Their attributes are not semantic attributes, like dimension or number, but rather concrete identifications of their location. As such, the ISO-Space annotation method extracts spatial information from different kinds of linguistic structures (open-class

[143] Bateman J. et al. (2010), p. 1042
[144] Bateman J. et al. (2010), p. 1042

elements and closed-class elements).This example illustrates the fundamental difference between computational linguistics and cognitive linguistics. The former aims primarily to be applicable, which is why it incorporates open- and closed-class elements of language, since this is necessary to successfully extract all kinds of spatial information. On the other hand the latter aims for a comprehensive theory to explain the representation of spatial information in language, which is why its approach is restricted to the closed-class elements. Thus, there are intrinsic boundaries to the transformation of concepts in cognitive linguistics into the realm of computational linguistics, such as the metric distance illustrates.

4.3.2 Characteristics of the figure

Another example for the limited adoption of theoretical concepts in the concrete application concerns the characteristics of figure. The crucial problem is that the theoretical concepts identified by cognitive linguists rely on an interpretative step, in order to be of universal nature. Thus, these intrinsic characteristics are not directly present in language itself, which is why they cannot be directly applied for an annotation method. Talmy asserts that the content of the conceptual system arises from the open-class elements, which are lexical elements and cannot be systematized. But every annotation method depends on this type of meaning as well, since this is what they try to extract. It implies that the conceptual system underlying an annotation method has to be based on closed-class as well as open-class elements, in order to fulfill its goal. Therefore, computational linguists can profit from theories by cognitive linguists regarding the closed-class elements, but not in terms of the open-class elements.

4.3.3 Spatio-temporal Information

The realm of spatio-temporal information is one example that demonstrates a positive aspect of interdisciplinary work between cognitive linguistics and computational linguistics. Specifically,between ISO-Space and Talmy's cognitive semantic framework. Talmy identifies ten universal structures in language addressing motion events, which he terms "motion-aspect formulas".[145] Grammatically, they rely on verbs. In ISO-Space, motion events are captured by the move-tag, which can be filled by ten verbs describing motion. The ISO-Space annotation does not cover the entire semantic concepts by Talmy. Specifically, it does not account for motion

[145] Talmy L. (2000), vol1, p.245-252

events involving duration ("bounded extent of time"). ISO-Space merely considers the change of location by the moving entity without accounting for the time this process requires. In the ISO-Space framework, the meaning of time is reduced to a time-point, lacking in the concept of a period. For example ISO-Space cannot capture the temporal information contained in the following sentence (motion event). "I walked along the path for twenty minutes". ISO-Space captures information that is spatial or temporal, but fails to capture spatio-temporal information. This shortcoming derives from the combination of SpatialML and TimeML, without further integration into a higher-level system.

4.3.4 Overspecification of "across"

This example issued from the article of Bateman et al. shows how cognitive linguistics can also benefit from collaboration with computational linguists.[146] It takes the case from the interpretation of "across" by Talmy in the sentence "the board lay across the road". Bateman criticises the fact that the analysis is centred too narrowly on the individual items, rather than on what the grammatical construction as a whole commits to. Talmy makes the claim that "across" involves the ground (here the road) to be ribbonal in nature. But in fact it is not always the case, as Bateman et al. show. In a counterexample such as "the bridge across the lake", which shows the same configuration as the preceding sentence, "across" does not imply that the lake has to be ribbonal. In fact, the association of "across" to a ground with ribbonal form seems more likely to arise from a conceptualized knowledge of the world, rather than from the "pure" linguistic semantic information.[147]

4.4 A priori comparison of the two disciplines

The preceding analysis reveals the following points. All theories agree on the existence of specific conceptual notions for the domain of space (figure, ground, secondary reference object, etc.). They furthermore agree on the existence of this conceptual level that is separated from the contextualized meaning, and is related to the linguistic forms. But they differ in their notions of the content of the conceptual notions. Thus, any collaboration between the two disciplines has to be aware of these differences. The next comparison concerns the ontological level, and is interested in finding out if the four theories have a compatible framework.

[146] Bateman J. et al. (2010), p.1040
[147] Bateman J. et al. (2010), p.1040

In the field of computational linguistics exists papers that present successful collaborations with cognitive linguistic, but comparable papers are missing in the field of cognitive linguistics.[148] Computational linguistics poses the following questions to the field of cognitive linguistics:

- How do formal models of semantics (for example, the semantic web) become meaningful to humans?
- Do space and time play a special role in explaining and representing meaning?
- What is special about spatio-temporal ontologies from a cognitive semantic perspective?
- What kind of formalism captures best what ideas from cognitive semantics?

In a first step, I compare the four frameworks in terms of the following points: 1) nature of language; 2) object of study; 3) methodology and 4) meaning. A summary of the result in each framework could be seen in figure 7. The purpose of this comparison is twofold. On the one hand, it reveals the commonalities and differences between the four frameworks. On the other hand, I try to answer the questions of Kuhn in the course of this analysis.

	Talmy	**Jackendoff**	**ISO-Space project**	**GUM Project**
What is the nature of language?	**Not explicitly stated. Language is a cognitive system that represents in its own way conceptual representations**	**Language as a mental phenomenon Language makes the relation between two kinds of knowledge (mental representations and the perception we have of our world)**	**Language as a closed system transferring meaning**	**Language as a functional system that has the role of filtering experience**
What is the primary object of study?	**The semantic level of language**	**The conceptual level of language**	**Spatial informations that are linguistically expressed in text.**	**Spatial configurations which are linguistically based**
What is the linguistic structure?	**It is composed of two kinds of classed: open-class (variable and no universal) which confer the content of the conceptual level and closed-classes (innate and universal) which confer its structure.**	**Language as a system composed of a parallel architecture. The forms are phonological, lexical and syntactical and semantic level. Study of the syntactical level and the**	**Lexical level**	**The grammatical structure**

[148] Kuhn et al. (2007)

		interaction with the conceptual level		
What is the methodology ?	**Introspection**	**Introspection**	**The Matter cycle**	**Empirical and corpus driven method**
Particular question of interest for researcher	• **Find out the particular fine grained structure of language that expresses spatial relations** • **The general character of conceptual structure in human cognition**	**Interest in the structure of language itself (3 levels with characteristic formal structure): phonological, syntactic and semantic/ conceptual and spatial structure).**	**The goal of ISO-Space is not to provide a formalism that fully represents the complexity of spatial language, but rather to capture these complex constructions in text to provide an inventory of how spatial information is presented in natural language**	**How much space gets into language? Constructing an ontology that reflects the semantic level (mediated by linguistic forms) and that is separated from the contextualized meaning**
What is the relation between language and cognition?	**The nature of the conceptual structure includes the linguistic meaning**	**Language is related to cognition via an interface**	**Meaning is inherent to language**	**Language reflects thought**

Figure 7: summary of results from the interdisciplinary comparison

4.4.1 Nature of language

I would like to begin with a short summary of the first and second part concerning the nature of language in the four theories. For Talmy, language is a cognitive phenomenon that represents conceptual representations. Jackendoff considers language to be a mental phenomenon that represents conceptual representations. In ISO-Space, language is seen as a closed system transferring meaning, whereas GUM-Space defines language as a functionally closed system that has the role of filtering experience. It can be seen, that Jackendoff and Talmy see the nature of language similarly, namely as a cognitive phenomenon. In contrast, computational linguistics reduces language to a closed system, playing a functional role.

At first sight, it seems that these two systems do not share the same ontology, which is why a fruitful collaboration may be difficult. But, I demonstrated above that cognitive linguistics actually consider language to be a self-contained system as well. Briefly, they assume the existence of a fundamental conceptual system, underlying various kinds of cognitive capacities, including language. Thus, language is supposed to represent this conceptual system. Nevertheless, their theories lack in prove of the conceptual system, which results in the study of language in isolation from cognition. As a result, language is ontologically equivalent in the

four frameworks, namely a self-contained system. In conclusion, cognitive semanticists cannot answer the question by Kuhn, “how do formal models of semantics become meaningful to humans?” since their linguistic system remains unrelated to cognition.

4.4.2 The object of study (primary subject matter)

Talmy and Jackendoff, try to identify universal structures underlying language. These structures are situated on a conceptual level, which manifest in language as grammatical patterns. Due to their universality, these structures are a finite set and they are fundamental for all natural languages as well as cognitive processes. Talmy investigates these structures merely on the lexical level, whereas Jackendoff's research includes the syntactical level as well. ISO-Space and GUM-Space are as well interested in the relation between the linguistic structures and the conceptual level. The main differences between the four frameworks are their definitions of linguistic forms (study of the lexical, syntactical or grammatical forms) and the content of the conceptual system. As such, a fruitful collaboration has to take into account those inter- and intra-disciplinary differences.

4.4.3 Meaning and the relation between language and the cognitive system

Meaning or semantics is a central implicit notion in all those frameworks. What is meaning, is another way to ask what are spatial representations? Where do spatial expressions get their meaning from? In each of the four frameworks this question addresses something differently.

In Talmy's framework meaning is situated on the conceptual level. The content of this conceptual system is provided by open-class elements in language. As such, spatial expressions receive their meaning from open-class elements. Since Talmy does not study these open-class elements, his theory lacks in a precise definition of meaning.

For Jackendoff, meaning lies in the semantic level. In the mentalist framework, language is considered as a system that comprises of three parallel levels (syntax, phonology and semantics). Meaning is the content of the semantic level. It arises from the interrelation of the three other levels. Nevertheless, he remains rather evasive about a deeper investigation of this level.

In the ISO-Space framework language directly captures two kinds of meaningful spatial content. On the one hand it captures meaning from the conceptual level (figure and ground),

and on the other hand from the external world (metric distance, location, etc.). Both sources provide spatial and spatio-temporal information.

The final system, GUM-Space, extracts only spatial information that is grammatically substantiated. It models the semantic level.

In summary, the two annotation methods extract information from the conceptual realm and from the objective world. Since the conceptual level is based on an interpretative step of knowledge abstraction, it is problematic to automatize its annotation. In contrast, information about the objective world can be directly extracted from the text corpora.

Cognitive Semantics, clearly states that language represents only the conceptual system. This assumption arises from the historical criticism of traditional linguistics. Traditional linguistics is characterized by the fact that language is seen as an isolated system, which primarily represents objective meaning based on the external world. The point of critic is that the grammatical approach cannot access the level of meaning.[149]

All four theories agree that language is a system that represents spatial information as conceptual content. Furthermore, this content has its reality in the mind. Thus, the question of meaning concerns the relation of these two systems. To give an answer to this question means to answer the question how language and thought are interrelated. The answers of the four analyzed theories remain rather evasive.

Cognitive Semantics describes the structure of the conceptual system, rather than explaining the conceptual content. They assume the existence of a conceptual system, and their aim is to describe this system. Therefore, they are not able to explain how the conceptual system comes about, and how it conveys meaning.

On the first sight, both domain could be compatible and could be fruitful to each other. We have seen in the first part, that the research in cognitive linguistics, in contrary and in opposition to formal linguistics, allowed a development of really specific typologies of the domain of space and spatial expressions in the structure of language. Those findings could be used in computational linguistics as well, in order to improve the categorization of entities in ontologies and annotation schemes.

Returning to the questions by Kuhn, this is the place to answer if “space and time play a special

role in explaining and representing meaning?"[150] My analysis has revealed that Talmy and Jackendoff would answer affirmatively but they could not properly explain why. Space and time play a central role, since those concepts are at the interface of perception, cognition and language. Nevertheless, the level of meaning is omitted.

4.4.4 Methodological Comparison

All four theories basically rely on the introspective method, and are rather subjective. The detail of each method could be seen in the preceding parts.

For cognitive semanticists, introspection is used to define more precisely the conceptual level. They take one noun, adjective or verb, and then try to find out the conceptual aspects of language which it represents. The comparison is furthermore done across languages, and is careful.

Computational linguists, use mainly in the first step of the creation of an annotation or an ontology a kind of brain storming in order to find out, what concepts are relevant to be annotated and how they could be annotated. It is in this first step of the procedure, that computational linguists could use the results and data from cognitive semanticists, which analysis is more precise and carefully done across languages.

Computational linguists are interested and presuppose a universality of the structures, and want furthermore an application through language, because of the translation. The fact that cognitive semanticist systematically also use the comparison across language they extract concepts that can be found across languages.

Cognitive linguists on the other hand could use the results of Computational linguists in order to test the systematicity of their conclusion. They could test their hypothesis on a wide range of sentences across languages.

[150] Kuhn W. et al. (2006)

5 Conclusion

To sum up, the analysis of the four theories were made in two different directions. On the one hand, this thesis considers the interdisciplinary work between cognitive linguistics and computational linguistics. It compares their different frameworks concerning the nature of language, their object of study and the applied methodology.

It revealed that all four frameworks place an emphasis on linking language and cognition, but assume that language represents cognition in general, through mental images.

On the other hand, since the aim and assumptions of the analyzed theories were quite similar, it was possible to compare a particular conceptual domain, namely that of space-time expressions, in detail. It turned out that spatio-temporal expressions share common features among all four theories. In other words, a spatio-temporal scene can be described with characteristics that seem to be universal across languages. The main difference of the description of a spatio-temporal scene in the four frameworks relies on what linguistic structure is paralleled with those notions. In this respect, the levels of granularity have to be distinguished, and the authors seem to disagree on the nature of those structures (lexically, syntactically, semantically…).

Therefore, the main result is that an interdisciplinary work is possible between computational linguistics and cognitive linguistics, since they share a common ontology. But on the epistemological level, certain differences have to be clarified.

A further important aspect addressed in this thesis, is the source of meaning of linguistic expressions. Each framework seems to be based on a particular account for the origin of meaning, each associated with a particular Weltanschauung. They assume that this origin is to be found in cognition, and therefore their common goal is to relate their results about linguistic structures to general cognition. As shown in this thesis, the theories have no empirical prove of this relation, and assume that cognition is based on mental representations, which is adopted from other disciplines. Above all, the scientific discipline that is concerned most with identifying the mechanism of human cognition is cognitive science. Taking a closer look reveals that it is in itself not a homogenous discipline, and there can be found at least three different paradigms which define cognition differently. Those definitions have a strong influence on the conceptualization of the source of meaning. The further paragraphs will sketch these inconsistent definitions and reflect on the problems of representationalism. Finally, it tries to show some alternatives in order to bridge the gap between language and cognition. It situates the results of this thesis in the larger framework of cognitive science, drawing parallels with it

and showing the limits of the four analyzed theories concerning their theoretical assumptions.

According to Varela, the origin of cognitive science can be traced back to the beginning of cybernetics.[151] During the forties and until end of the fifties, researchers began to be interested in the scientific mechanisms underlying the processes of thought and recognition. Having a strong mathematical and logical background, they saw the processes as explicit mechanisms and mathematical formulas. They made the assumption, that the human cognitive functioning could be explained via mathematical logic.

This idea is according to Varela, the ground for the first paradigm in cognitive science: cognitivism.[152] In 1956, two major conferences toke place in Darmouth and Cambridge. During the summer of 1956, the Darmouth research project regrouped researchers, who will become the founders of Artificial Intelligence. Organized by J. McCarthy and with the participation of M. Minsky, N. Rochester and C. Shannon (among others), its goal was to "find how to make machines use language, form abstraction and concepts, solve kinds of problems now reserved for humans, and improve themselves."[153] The second conference at the MIT regrouped researchers from diverse fields such as linguistics, psychology and computer science. N. Chomsky, J. Bruner and G. Miller (among others), aimed to overcome the behaviorist movement, which has been predominant for decades in their respective fields. They were interested in relating their respective object of study to a scientific view of mechanism underlying cognition, refuting to see the mind as a "black box".

The main outcome of both meetings was that cognition could be defined as an operating system of symbols. This assumption is based on the precedent idea of cybernetics, which assumes a strong analogy between the computer and the brain. The processes obey mathematical (logical) rules, which remain to be discovered. The symbols are the mental elements which represent particular aspects of the reality (external world). Thereby, they create a new level of interpretation, which is the symbolic level. For cognitivists, the main question to be resolved is how to relate the symbolic level to the physical one. Under such a paradigm, language as cognitive phenomena has to bear those two levels. The physical level corresponds to the structure of the linguistic system, whereas the content, or what is called in generative grammar deep structure, has to be found out by derivation. This corresponds to the symbolic level. The

[151] Varela F. (1988), p.32
[152] Varela F. (1988), p.30-36
[153] Mc Carthy et al. (1955)

laws of derivation obey to logic and are sequential. Since the two levels cannot be reduced, linguistics tends to separate language from the physical world.

The second paradigm, connectionism, is issued from two critics of cognitivism. It refutes the fact that the basic elements in the operative system are meaningful per se. The second point of critic concerns the sequentiality of the logical operations. As a solution to the first problem, connectionism takes meaningless elements as basis for its framework, organizing themselves without a guiding unit and forming complex patterns. With respect to the neuronal architecture, these units obey to rules which represent their level of interaction.[154] In opposition to the cognitivist paradigm, which define rules for meaningful elements in order to have access to deeper elements (top-down), connectionism starts from meaningless units to arrive at the level of meaning (bottom-up). Meaning emerges from the interaction between these basic elements. In response to the second problem of cognitivism, the meaningless elements are organized as a network, implying a simultaneous information processing. The rules in this system are the different operations that can be applied to a single element and those which transform the connectivity between elements. A system is said to be functional, if its emergent properties correspond to a specific cognitive capacity.[155] Meaning results from the activity patterns that result from the simultaneous interaction between units of equal value. In short, this theory accounts for the reality of the brain, and tries to model neuronal networks. This paradigm can explain phenomena like the plasticity of the brain. Connectionism is said to describe a sub-symbolic level.

Subsequent researchers in cognitive science combine both paradigms. For example, they use connectionism to describe how the brain works at a deep level, and cognitivism to explain higher cognitive phenomena. But such an approach has gained some critics as well. In the early 90s, a new paradigm emerged. It started from the view, that the two preceding paradigms did not take into account that humans are constantly interacting with the world, which leads to constant real-time feedback loops, transforming both realms alike. In cognitivism and connectionism the inputs to the cognitive systems were artificially created. Both paradigms postulated that cognition corresponds to the resolution of predefined problems that are provided by an external source. The third paradigm, called situated cognition[156], does not agree with the

[154] A famous rule is the hebbian learning algorithm. It is based on Hebb's postulate. Considering that there are two cells A and B and A fires continuously at B, it states that the efficiency of A will be augmented.

[155] Varela F. (1988),p.77

[156] Also called embodied cognition, or embodied dynamicism

idea that the cognitive system extracts information from a pre-given world. The problem of the two preceding paradigms lies in the use of static representations, to mirror the external world as singular and unrelated objects in the spectator's mind. But several researchers have shown that perception and cognition aren't passive processes, where the external reality is represented one-to-one in the mind, but cognitive states are actively created and changed in an ongoing manner. To illustrate we can take the example of memories, which are reconstruction from an internal state of the brain. The recall of memories affects the current cognitive state and transforms it. The result is a new state, combining both patterns of activation. The last point of critic is that neither cognitivism nor connectionism can bridge the explanatory gap between the material functioning of the brain and the conscious level of cognitive phenomena. The third paradigm makes the claim that instead of representing a world, cognitive processes result in the emergence of a conception that is inseparable from the structures in which the cognitive system is embodied.

One of the famous theories within the third paradigm is the enactive theory by F. Varela. In his theory the cognitive system is self-organizing and interactions with its environment simultaneously. It is inspired by the phenomenon of autopoiesis in biology. His example to illustrate this theory is a mobile bacterium that swims in an aquatic environment to ascend to a gradient of sugar. This bacterium will swim per hazard until it finds the gradient of sugar thanks to its receptors. Then it will follow this gradient until reaching the source of sugar. This simple example illustrates a dynamic sensor-motor circle. The movement of the bacterium (first per hazard and then towards the source of sugar) depends on what it is perceives, and its perception depends how it moves in return. Concerning autopoiesis, every observable characteristic of the environment reflects or "enacts" the perspective of the bacterium. The important point is the significance of the sugar. Sugar exists in the environment as a chemical molecule, but its significance as aliment is not an intrinsic characteristic. It is a relational characteristic that only exists in terms of the bacterium's metabolism. The meaning of sugar as nutritional resource arises within the bacterium's cognition. In contrast to the former paradigms, the meaning is not an intrinsic feature of objects per se.

The analysis of the first part has shown that the frameworks of Jackendoff and Talmy are considering language as representing cognition in structural terms. Furthermore, the two presented theories in computational linguistics share this assumption. Starting from the study of the linguistic system, they aim to describe the structure of cognition in general. All these

theories are clearly to be situated in the first paradigm, namely cognitivism. They assume the existence of a symbolic level that is represented by language. Moreover they assume that it is this level that gives rise to semantics. As it is typical for cognitivism, they are only concerned with the symbolic level, without accounting for its physical embodiment. It does not take into account that those concepts are only meaningful in the subjective world that is created by the speaker or user of language. In short, language is not only an autonomous linguistic system, but is strongly interrelated with cognition. Concepts are only meaningful in this interaction. Referring to the simple example above, language is to cognition like the bacterium's metabolism to the sugar molecule.

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