Chapter 6

Summary

The first chapter introduced some of the problems related to the question of what it means to learn a preposition. In semantics, it is generally assumed that the meaning of a spatial preposition is related to the spatial relation. But how exactly this relation is viewed depends on the connection between spatial terms and the corresponding conceptual representations of spatial alignments. It was shown that even very young infants already seem to have developed concepts for spatial relations. It is therefore justified to assume a connection between spatial terms and the conceptual representations of spatial alignments in language acquisition. This connection was then presented from four different perspectives. For each perspective, the corresponding semantic tasks were formulated that would be faced by a child acquiring language. Which semantic task is eventually taken into account by a child learning to understand spatial prepositions was the focus of the investigation in chapter 3. In discussing the problems related to the various types of connections, it was suggested that understanding language involves far more than just perceiving linguistic input. The role of symbolic knowledge in particular has to be rethought. It was shown that symbolic knowledge cannot be thought of in a traditional way, in which it is defined in the form of concepts as lists of necessary and sufficient conditions. The representation of symbolic knowledge via these lists is not flexible enough to account for variations in context. The same was also argued for meanings, which also cannot be viewed as lists of conditions that can be mapped in a one-to-one manner onto the corresponding concepts. The semantic level has to take into account the nonlinguistic social purposes, which language serves as well. For this reason, when acquiring the meaning of a spatial term, it is essential for a child to also make use of her or his knowledge from other non-linguistic sources.

The nature of non-linguistic knowledge was discussed in the second chapter. Starting from the notion non-linguistic strategies, as developed in Clark (1973), the involvement of non-linguistic factors in the process of understanding was presented from different studies with children and adults. Firstly, from the aspect of geometry, the perceptual features of the landmark-object were considered. This aspect is relevant especially for semantic views which claim a kind of abstract core meaning, which can be described by a list of geometric features.

In recent studies with adults and infants, functionality is proposed as an alternative factor. However, this proved to have a complicated profile particularly with regard to the interplay between situation and context. If the meaning of a spatial preposition is to be captured in terms of functionality, it will differ depending on the situation in which the trajector occurs. In addition, the co-occurring objects in the scene can also contribute to the meaning based on functionality.

These various dependencies are less problematic, and the meaning that arises from them appears more stable, if one views functionality as a co-product of the change of attention, as suggested in Langacker (1998) and Carstensen (2001). From this point of view, the interplay between functionality and geometry highlighted in many current studies can also be better explained. In perceiving a certain situation, the interplay between functionality and geometry is an effect, which is called up against the framework of background knowledge (Sinha, 1983) or the dominion (Langacker, 1998). This background knowledge, in turn, is called up when an initial focus of attention is created. The ability to profile was claimed to be a crucial cognitive mechanism that is indispensable for the semantics of spatial relational terms. Profiling creates a link between the inter- and intracontext as it provides the social dominion. The consequence of a theoretical view including the interplay of inter- and intracontext as a product of attentional change is that the semantics of spatial relational terms no longer involve context-independent objective features as postulated by some representatives of the two-level connection (cf. Schwarz, 1992: 24). Stability in the system is achieved due to stable cognitive processes such as profiling. The relevant semantic factors, however, are situative and dependent on other nonlinguistic aspects.

Precisely this proposal was confirmed in the results from the experimental study presented in chapter 3. The study was designed to test whether situative semantic factors could influence infants' understanding of instructions with the Polish spatial preposition NA [ON]. These situative factors were characterized as resulting from the interplay of situation and intra- and intercontext. This interplay has the advantage of also implying the nonlinguistic aspects of geometry and functionality. The quantitative results confirmed the hypothesis: when a situation is designed to motivate a certain expected relation, it is possible for infants to understand an instruction without a preposition. In this case, the understanding is supported by situational cues. Infants seem to primarily rely on their experience of what an object does or how it is used.

In the qualitative analysis of infants' reactions, it was noticeable that they studied the perceptual features of objects, even the artificial objects in the **HiK**-situation, and tried to relate them to objects they knew well from everyday interactions. These findings endorse the claim that infants do not perform only on the basis of a linguistic instruction or on the basis of the preposition conveying a certain semantical core meaning — as was suggested in the semantic task that would be set from the Pomos' view on two-level semantics. The results of the study contradict, however, the task that would be set from the view of Cognitive Determinism. If infants develop a meaning as a concept consisting of necessary and sufficient conditions that are independent from context, the infants should have shown the ability to transfer this meaning into an artificial situation like **HiK**. Since infants merely showed an ability to abstract such a core meaning, it can be concluded that this view does not account for language understanding at the age studied. It is claimed instead that infants' understanding is highly influenced by context-dependent factors. This is reflected in infants' use of co-linguistic strategies.

Four strategies of this type were noticeable in observing infants playing with the set-up objects. Each of these differs on the basis of the profile of the participating objects. The analysis of the four strategies within the framework of Cognitive Grammar showed that the role of intercontext is omnipresent in the understanding of spatial prepositions. With regard to the intracontext (or in other words, the knowledge that the child brings to the task), the mechanism of profiling a participant is crucial for the understanding of spatial prepositions. This ability enables the child to create a dominion and, thus, make use of non-linguistic information derived from previous experiences. Concerning the nature of the co-strategies, it was argued that infants have the ability to perceive the trajector-landmark asymmetry and direct attention to some entity for the purpose of then establishing mental contact with another (Langacker, 1998: 7) well before they can express it in language. This ability to pay attention to the roles of objects within a scene seems to be crucial for the later development of syntactic constructions. In this sense, it appears that infants acquire certain grammatical relations preverbally.

These findings partially contradict the semantic task that would be set up from the viewpoint of Linguistic Determinism, i.e. that the process and content of early spatial semantic development is governed by the structure of the target language. Infants seems to use their knowledge from other sources in understanding linguistic instructions. These other sources, however, are already influenced by the intercontext as infants experience objects and events within social activities. In this sense, Linguistic Determinism as a cultural and social influence is present already in the so-called preverbal developmental phase.

Chapter 4 introduced the second experimental section of this thesis, which was designed to approach to the question of how the meanings of certain spatial relational terms develop. The discussion focussed in particular on the understanding of UNDER in comparison to ON and IN. Different factors were considered to explain infants' comparatively late understanding of UNDER. It was concluded that the most obvious factors, i.e. frequency and nature of the input, cannot alone provide a plausible explanation. It was argued that other non-linguistic factors such as the motoric complexity of performing an UNDER-relation in contrast to an IN-relation probably also influence the process of understanding. In order to consider cognitive factors, it was further proposed that a child's understanding is not exclusively determined by factors coming from outside like frequency but also by aspects and processes coming from inside. This led to the question of the nature of children's cognitive organization. More specifically, the idea of cognitive and / or semantic prerequisites was introduced. Particularly at issue was whether the meaning of UNDER is based on other relations (such as IN and ON), which a child first has to establish in order to understand semantically more complex relations.

In chapter 5, precisely this idea was tested in the second experiment in which the linguistic input during two training sessions with the learners was controlled. A second control variable was the situation, as was also the case for the first experiment. The evaluation of the results showed that infants displayed the best learning effects in well-known situations. This fact further supported the argument that infants learn best in concrete situations and that situational cues help them in their linguistic understanding. Situations with new objects require a different ability in understanding, as children receive only limited situational cues. In such situations, the children studied showed a better learning effect when the new relation was explained by already known relations (DO [IN] and NA [ON]). The outcome, thus, supported the theory that the meaning of UNDER may in fact be based on other more basic relations such as IN and ON.

With regard to the **HiK**-situation which required a more abstract appraisal of the landmark's geometry, the infants showed no learning effects. These results further supported the proposal of situation-dependent reasoning in infants' learning of spatial relations.

Following this, various potential explanatory factors for the later acquisition of UNDER in comparison to ON and IN were considered. One of these was a semantic explanation based on the semantic terminology proposed in Nüse (1999). In according to this, it was noted that English UNDER, German UNTER and Polish POD refers to two everyday concepts: INSIDE and UNDERSIDE. The concretion of these concepts is, moreover, object-specific.In terms of children's conceptual organization the argument was formulated as follows: if children conceptualize the meaning of UNDER in terms of everyday concepts, and it depends on the particular object as to where its SURFACE, SIDE, INSIDE and UNDERSIDE are, then a child has to have had experiences with a particular object in order to decide where these regions of the object are. The more difficult it is to discern these, the longer it will take to acquire the spatial relation concerned.

An important factor contributing to the late understanding of UNDER is therefore emerging when processes of perception are considered. In shedding light into the question of what makes the relation ON more basic than UNDER it was proposed that it is easier to perceive something that is physically and (through its canonical orientation) socially constrained. Against this background, it was assumed that the interplay between functionality and the geometry is also central to the meaning of a spatial relational term. An important feature of ON, for example, is how a trajector object will behave on a given landmark object. This predictable reaction to gravity highlights that the surface of the landmark object is physically constrained (through gravity). This perceptual feature is, in turn, related to the function of support. Such relations are less salient for UNDER. Furthermore, a SURFACE is perceptually more prominent than the UNDERSIDE of an object, and it is more likely that children when examining a new object will pay attention to its SURFACE initially. For these reasons, it was argued that UNDER often plays a secondary role in an object's function and 'competes' with other relations like IN, ON and BEHIND.

A further issue that was considered was the nature of the development of understanding of more complex spatial relational terms like UNDER. The results did not suggest, however, that the understanding of more complex spatial terms is accompanied by a qualitative change in the kind of reasoning that children use to understand spatial prepositions.

Putting these results and the findings obtained in chapter 3 together, it was concluded that the development of understanding spatial relational terms is not accompanied by the development of a core meaning based on geometric aspects as formulated in the Momos' semantic task or that of Cognitive Determinism. Instead, learning to understand a linguistic unit requires the use of situative information and experiences with the particular linguistic unit in different situations with different objects. Transferring the meaning of a relation to an artificial situation like **HiK** seems to require different cognitive abilities than the skills used during everyday communication about objects belonging to our daily routine. These skills did not yet appear to be present to any great degree in the children studied. Being able to elaborate the geometric core of a relation can nevertheless help us to understand and act in new situations, where functional cues are less noticeable. Precisely this ability is reported in adult studies (cf. Coventry, Prat-Sala & Richards, 2001). For this reason, it was argued that the modularity of language or linguistic symbols seems to be a product of development (Thomas & Karmiloff-Smith, 1998; Weinert, 2000) rather than its starting point.

Situated meaning

In the two experiments described here, it was shown that the situation plays a crucial role in the understanding of linguistic input. The situated view of semantics was thus claimed to be best able to account for these findings and was described in more detail in chapters 2 and 3. In this view, the semantic level, i.e. the construction of meaning is the load that is partially shifted from the inner processes of the child to the child's environment, i.e. the outer world. There, the semantics coincide with the pragmatics as all adult actions (handling objects, causing events) are influenced by cultural values and conventions. The perception and behavior of the child are in this way necessarily influenced by the culture and language. "In this sense, cognition can extend beyond an agent's brain to be distributed over a system of people and objects within an environment" (Beer, 2000: 97). However, the knowledge the child applies to solve problems is, nevertheless, grounded in her or his cognitive abilities and cognitive processes such as profiling (see section 2.5).

From this perspective, a rigid boundary between linguistic and extralinguistic knowledge is rejected (cf. Langacker, 1997). Linguistic meanings are viewed as "acts" (Sinha, 1999a: 232) that are intrasubjectively constructed as an attempt to make sense of an intersubjectively shared universe of discourse. The discourse is continuous with the material world, in which other human activities are carried out. Against this background, learning linguistic communication is nothing more than a manifestation and extension of children's already existing skills of joint attentional interaction and cultural learning (cf. Tomasello, 1999: 131).

Consequently, the development of meaning profits from this “dual grounding” (Sinha, 1999a: 237): for the intracontext, the “situated information” (Strohner, 1995a: 56) is provided by not only an experience in the world but by an (intercontextual) experience within a social group.

A conclusion that can be drawn for the nature of meaning is formulated as follows: the development of meaning consists of an internal process of construction and an external process of internalization (Sinha, personal communication, 1.11.2001). For the internal process, the experienced situation is crucial. It provides situated information to be processed by and integrated into the intracontext of the child. For the external process of internalization, the system of language as it is presented in approaches by, for example, Bowerman and Choi (2001) or Tomasello (2000a) is crucial.

Issues claimed for the modelling

At the beginning of this thesis it was mentioned that developing a meaning is not only discussed in the research area of language acquisition but also in areas that will provide insights into mental processes. In order to make the situated view of semantics more explicit for approaches in cognitive science, this thesis ends with a formulation of various crucial issues in the form of criteria for modelling a situative process of understanding spatial relational terms. For readers, who are familiar with modelling, different systems as examples are referred to.

Generally, in modelling meaning, the interplay of perception and conception needs to be taken into account. The relevance of this issue was already considered in the model presented in Regier (1996). His model highlights the involvement of the perceptual system in understanding spatial relational terms and shows that the perceptual system restricts the potential ways that spatial relations can be conceptualized in. In this system, however, the understanding of spatial terms is displayed solely by the activity of the output nodes and the linguistic signals are disregarded. Moreover, there is also no distinction between conceptual and perceptual categorization, and language understanding is limited to an analysis of perceptual features. With regard to these insufficiencies, not only the connection to the here-and-now is important in modelling the situated view. A model has to demonstrate a redescription of given information to register the roles of objects in these events. This redescription or conceptual categorization (cf. Mandler, 1992; 2000) is responsible for the development of a stable, transcontextualized, semantic representation as part of the intracontext. The stability of meaning formation achieved in the intracontext is important for the psychological reality (see Mandler, 1993: 145).

How the conceptual stage could be potentially modelled is shown in Rehm (2001). This model makes a distinction between percepts and concepts, even though this distinction is made in a different way than Mandler (1992; 1998) suggests. Instead, this perspective on concept formation bears similarity to the approach presented by Madole and Oakes (1999), who place emphasis on a process-oriented, constructivist approach of conceptualization and deny a strict separation of conceptual from perceptual structures (cf. Madole & Oakes, 1999: 291). The development of concepts is permanently linked to the perceptual world and is therefore dynamic and task-dependent. In contrast to other perceptual theories (e.g. Jones & Smith,1993), however, conceptualization “is a flexible, but relatively developmentally stable process” on the perceptual level (Madole & Oakes, 1999: 308), since conceptual processing is not dependent only on the here-and-now. Instead, it merely cooperates with perception. In such a dynamic approach to the development of conceptualization, the focus is more on the processes involved than on the content of concepts. These stable processes guarantee relatively stable concept formation.

Beside the stability of processes, an important issue for conceptualization remains the issue of task-dependency. From a developmental perspective, concepts should incorporate the potential to evolve at any time due to modifications in different situations. This issue is also taken into account in the LOKATOR-system by Rehm (2001). This system demonstrates how situated information can change the content of concepts due to the different experiences of different agents, while the process of understanding still remains successful.

As was shown in the experiments presented in this thesis, infants are guided in their understanding by their knowledge about objects and events. When modelling the understanding of language, this object and event knowledge has to be integrated into linguistic knowledge. With regard to spatial relations, the roles that objects play in events are of particular concern for conceptual knowledge (cf. Mandler, 2000; Nelson, 1996: 110). These roles must be considered as a product of attention, because only an attentional shift makes a relation explicit. This issue is successfully dealt with in the system presented by Gasser, Colunga and Smith (1999). PLAYPEN presents a model of how roles for objects could develop from object categories. In this process of development they demonstrate how perceptual knowledge, i.e. perceptual features of objects, could become redescribed as conceptual knowledge in the form of relational categories. The point worth noting with regard to conceptual knowledge is that it remains task-oriented and can, thus, be continually modified. A disadvantage of this model is the central role that the perceptual features of objects play for spatial relational categories. As was shown in the discussion of co-linguistic strategies, children do not only rely on perceptual information. Instead, the interplay of perceptual and functional features is crucial in creating a dominion for spatial relations.

From a situated point of view, the information contained in object and event knowledge is not limited to the physical world. Instead, it provides shared intersubjective social experiences. At the center of the learning process, a situation is created intersubjectively, and already the child’s perception is influenced by the intercontext. Based on the assumptions of Linguistic Determinism, LOKATOR (Rehm, 2001) demonstrates how the content of the concepts developed for spatial relational terms can differ depending on perceptual and linguistic experiences. Moreover, the type of input provides patterns for the interpretation of perceptual input and affects the action of the system.

Another possibility for modelling the involvement of intercontext in the process of understanding is to make use of connectionism. Social information is provided via the learning typical for connectionist models as the experimenter / teacher determines the coding patterns. A simple connectionist model for learning spatial relational terms is presented by Zlatev (1997). The teacher also determines the semantic categories that are relevant for understanding spatial relational terms. The relevant semantic categories are an attempt to adopt current research about spatial relational terms. The distinction between trajector and landmark points to the role of attention (Carstensen, 2001). The specification of a reference system suggests the influence of cultural preferences (Pederson et al., 1998). The specification of the region indicates a geometric description in the form of topological terms (Herweg, 1989). However, there is a lack of semantic aspects related to the functionality of objects. A grave disadvantage of this model is that it concentrates on the acquisition of understanding due to linguistic input. Consequently, a situation is decomposed into abstract aspects (by the assumptions of the model) and delivered to the system in parts. In Zlatev's network, no perceptual grounding is given, and the categorization of the linguistic input is not connected to the conceptual system.

The issues claimed for modelling endorse the view that understanding spatial relational terms is a complex process once again involving situative processes of human reasoning.

Outlook

In this thesis, just two of many possible approaches to studying the development of meaning in the situated understanding process were presented. The weaving together of different strands of the topic have made it clear, however, that more research is necessary to gain detached insights into the connection between spatial concepts and spatial meanings. In particular, further studies with infants would be of interest as a greater variety of studies about adult understanding of spatial relational terms already exists. More concretely, additional studies about the understanding of older children in the **HiK** situation would shed more light on how the ability to rely on geometric information develops when functional cues are not given.

Concerning the semantic complexity of certain spatial relational terms, it would be worthy studying parental input to infants, when they explain the UNDER-relation to them without the use of gestures or prior demonstration of this relation directly. Since parental input is said to be adjusted to the level of background knowledge of infants, it would be interesting to analyze exactly which background and communicative knowledge is assumed by caregivers and which linguistic terms are used in explaining the 'foreign' relation. From some of the accidental interventions made by parents during the first study it is clear that caregivers typically use a variety of additional linguistic cues (verbs, nouns, etc.) in their explanations. It would also be of interest to investigate whether this strategy of using different cues leads to faster learning effects.

A greater understanding of the factors contributing to the development of spatial meaning could be approached directly through further training studies. In order to investigate how successful the use of a certain linguistic cue is, this cue could be highlighted in the training of UNDER. One possibility would be to vary the verbs in the linguistic input to the learners. Verbs relate to different functions. Explaining UNDER in terms of an action of ‘hiding’ or ‘catching’ might increase the learning effects of this relation. This idea of training re-emphasizes the functionality of objects embedded in cultural doing that facilitate the profiling of a linguistic unit. This highlights once again that the meaning of spatial relational terms can only be determined as a product of the interplay of inter- and intracontext.