Chapter 5
Learning to UNDERstand — a Training Study

In the preceding chapter, different reasons for the late understanding of UNDER were discussed from four different perspectives. With regard to studies in language acquisition, it was argued that some of the aspects like frequency and linguistic complexity cannot account exclusively for the late understanding of UNDER. Instead, context-dependent semantic factors like the motoric complexity of carrying out certain actions or the difficulty of discerning certain relations should be included in the considerations. With regard to the conceptual organization of the child's understanding, Thiel's (1985) study was presented to introduce the possibility that the meaning related to UNDER might be based on other relations. In keeping with this, it was argued that the meaning of UNDER should be regarded in a more processual way. However, at present there are hardly any studies that pursue this development of the process of understanding a spatial preposition.

In order to fill the gap, a training study about the acquisition of the Polish spatial preposition POD→ [UNDER] is presented in this chapter as a potential methodological approach to this topic. The theoretical questions addressed in this chapter concern the developmental process of children's linguistic knowledge. Two main critical points arise from the broad discussion about the acquisition of prepositions. These points will be explained in the subsections situation and linguistic input. As part of this, it will be discussed when and how the abstraction in the understanding of spatial prepositions needed for solving the **HiK**-task in the first experiment can be learned.

5.1 Method

5.1.1 Situation

In examining infants' understanding of prepositions and spatial relations, it is necessary to consider their knowledge about the objects involved. Hence, testing infants' relational knowledge requires the use of 'clear objects' and the systematic control of the information provided by context. In the design of the first study two situations were established (see section 3.3.2). The first type consisted of presenting various well-known toys to the child. The objects were chosen on the basis of their relational possibilities, i.e. the nature of these objects allowed at least two relations (e.g. an ON- and an UNDER-relation or an IN-/ UNDER-relation). The second type of situation involved confronting the child with the **HiK**-

construction. These two types of situations were adopted for the second study. The design of the training study, however, made possible that in the course of the two training sessions, various objects from the well-known situation became more and more familiar. In the final test session, in contrast to the first experiment, the well-known situation was subdivided into two further situations: a familiar one and a new one. The purpose of this was to examine children's ability to transfer their understanding to new objects. Thus, altogether, three types of instructions were used in the final study:

familiar situation	was a trained situation, in which infants received the same objects / toys every session and learned to carry out the UNDER-relation with them. As a consequence, these objects and their relational possibilities were very familiar to the infants in the final test;
transfer situation	was a transfer situation, in which infants were given new toys every session that allowed for different relational possibilities (at least ON and UNDER) and were asked to put the trajector-object UNDER the landmark-object;
HiK-situation	was a transfer situation, in which infants were confronted with the wooden construction **HiK** presented in the first study (described in section 3.3.2).

A further difference in comparison with the first experiment concerns the **HiK**-situation. All interchangeable parts of the **HiK**-construction (described in section 3.3.2) were used in this final training study. This allowed for a controlled observation of how physical properties of the objects influence the child's behavior. In the pretest, the children's performance was tested with the cube (see Figure 19). This particular part was chosen, because it implies a surface. In accordance with Clark's (1973) rules, infants should put the trajector ON the landmark for objects of this type.

Figure 19: The cube in the **HiK**-pretest

In the two training sessions, the UNDER-relation was first presented and infants then were able to practice it on the shelf (see Figure 20). This part was constructed in such a way as to suggest an IN-, ON-, and UNDER-relation because it implies both a surface as well as a hollow space.

Figure 20: The shelf in the **HiK**-training

In the final test, infants were expected to place objects in relation to the sphere (see Figure 21). As already explained in 3.3.2, the sphere was chosen as a part precisely because it does not suggest canonical relations like ON, IN, or UNDER.

Figure 21: The sphere in the **HiK**-test

In the pretest it was assumed that the situation in general would influence children's performance insofar as the objects themselves would suggest other more canonical relations than UNDER. In the final test itself, it was expected that the situation-type, i.e. familiar or new, would also play a crucial role in the children's performance. The expectation was that they would be more successful in the familiar condition, because they would have learned in the course of the training sessions (from the intercontext, i.e. the experimenter) that there are other relational possibilities with the objects. The infants were also expected to make progress in the transfer situation with new objects, because they would have the opportunity to transfer their learned knowledge to different objects. Using the terminology introduced in section 2.4, this would be an example of the activity of intracontext. The hypothesis made for the situational variable in the test, therefore, was (where NCR: number of correct responses):

H_1: NCR in the familiar situation > NCR in the transfer situation > NCR in the **HiK**-situation.

5.1.2 Linguistic input

In previous research into the difficulties of acquiring UNDER, prepositions have generally been considered in isolation with the assumption that the meaning of prepositions is acquired autonomously for every unit. Nevertheless, the results of the first experiment described in chapter 3 suggest a processual development in which more complex relations that are acquired later develop out of early-made experiences on objects. For early experiences, the relations such as IN- and ON seem to be basic. In order to examine whether and how infants use their basic knowledge about IN- and ON-relations and thus investigate this hypothesis further, the design of the test includes instructions varying in terms of the linguistic input.

One possible way to gain insight into how children conceptualize relations is to try to systematically influence the process of building up relational knowledge. However, finding a method to do this seemed difficult. In the end, the design of the training study approached this methodologic problem via a variation of the linguistic input to the infants during the training session.

One of the crucial assumptions in this study was the claim that linguistic input can influence children's conceptualization. If children conceptualize the relation UNDER by first accessing the basic relations of IN and ON, then the children should be more responsive to training, in which these basic relations are used to explain the new UNDER-relation. This claim is based on the idea of influencing conceptualization through language understanding, and is supported by the results of a training study presented in Weigl (1977). Weigl investigated to what extent the linguistic input and / or actions of an adult communicating with a child can change or facilitate language acquisition. She concludes that the basis for language acquisition consists of a connection between the performance of an action and the linguistic comment associated with it. In this sense, an action can be linguistically present or in other words linguistically accompanied (Weigl, 1977: 74). Weigl emphasizes that this connection is especially important for young infants' development of language understanding as well as for their increasing development of language production (ibid). Ritterfeld (2000) also reports on the influence of the linguistic input on the language competence of a child. In particular, she points out different aspects in the quality of the input. Supplying additional semantical or grammatical elements belong to the excellent strategies for supporting a child's language acquisition (Ritterfeld, 2000: 416).

In the study to be presented, it was more specifically assumed that the kind of linguistic input could influence the acquisition of meaning. Children who were trained using instructions that made reference to these basic relations were expected to perform better in the test than untrained children or children who had received linguistic input which did not highlight these basic relations. Against this background, the following general hypothesis was proposed:

H_2: if during training the infants receive input which is assumed to correlate with their conceptualization, the learners are expected to show a better performance in the test than learners receiving only labels for the new relation. In other words, the nature of the adult input to the infants influences the effectiveness of their word learning significantly.

To test this hypothesis, two kinds of input were developed that were designed to influence the infants' performance positively. The first type stems from Thiel's (1985) suggestion that infants' learn UNDER by relying on the basic relation IN. In accordance with this, if in the input to the child, the UNDER-relation and -preposition is explained in terms of the IN-relation and -preposition, the learning effect should be significantly higher than with an input, which does not include the IN-relation. The other kind of linguistic input makes use of the contrasting relation of ON and is based on Clark (1993). She argues that infants learn new words by contrasting them with others, for example UP is contrasted with DOWN. Contrast is said to be one of two pragmatic assumptions children follow (Clark, 1993: 64): "[s]peakers take every difference in form to mark a difference in meaning". If this assumption does accompany children's language acquisition, children should learn more effectively when they receive input oriented towards contrasting relations.

In order to test these two assumptions (Thiel, 1985 and Clark, 1993), the input, which involved an alternation between emphasis of the IN- and ON-preposition and -relation, was varied systematically. In the two training sessions, infants were divided into four groups. Three of the training groups were given different linguistic input by the experimenter during the training session in explanations of the UNDER-relation, in instructions to carry out an UNDER-relation and in feedback on their performance. The Table 11 displays this variation in input.

The control group played with the same toys as in the training sessions, but was not given any training at all and did not receive any instructions. In the final test, infants' understanding of the preposition UNDER was tested. For this test, the form of the instructions was kept neutral in the same way as in the pretest (see section 3.3.1).

Table 11: Different input in the training sessions

	Group UNDER	Group UNDER-ON	Group UNDER-IN
Input during training sessions	only UNDER	contrasting UNDER with ON	explaining UNDER with IN
EXPRESSIONS	Popatrzcie, piesek jest POD stołem!	Popatzcie, piesek jest POD stołem, nie NA stole!	Popatzcie, piesek jest W tej dziurze* POD stołem!
	[Look, the dog is UNDER the table!]	[Look, the dog is UNDER the table, not ON!]	[Look, the dog is IN the hole UNDER the table!]
	A teraz jestem POD stołem	Teraz jestem POD stołem - a teraz NA stole	A teraz jestem W tej dziurze POD stołem
	[I am now UNDER the table]	[I am now UNDER the table - and now I am ON the table]	[I am now IN the hole, UNDER the table]
INSTRUCTIONS	Daj kotka POD most!	Daj kotka POD most!	Daj kotka POD most!
	[Put the cat UNDER the bridge!]	[Put the cat UNDER the bridge!]	[Put the cat UNDER the bridge!]
FEEDBACK (positive)	Tak, kotek jest POD mostem	Tak, kotek jest POD mostem	Tak, kotek jest POD mostem
	[Yes, the cat is UNDER the bridge]	[Yes, the cat is UNDER the bridge]	[Yes, the cat is UNDER the bridge]
FEEDBACK (negative) with a final demonstration of a correct relation	Nie! Popatrz, daj go POD...	Nie NA, daj go POD...	Nie! Daj go DO tej dziury, POD...
	[No! Look, put it UNDER...]	[Not ON, put it UNDER...]	[No! Put it IN the hole, UNDER...]

* dziura was checked in the CHILDES database: it is a common word in the input to the infants

5.1.3 Semantic hypothesis

The results of the first experiment (see section 3.4) suggested that infants do not necessarily make use of lexical knowledge in order to understand instructions containing a spatial preposition. For the second experiment, therefore, it was of interest to consider whether the infants could transfer their learned understanding of UNDER to the abstract **HiK**-situation and how their performance would differ depending on the training group they participated in.

The prediction of a learning effect after the training sessions, raises the question about the nature of meaning the infants will have learned. It is assumed that:

H_3: if infants perform well in the **HiK**-situation, this means that they are able to transfer the meaning of UNDER to an artificial situation. This presumes that they have acquired an abstract core-meaning consisting of the geometry of the acquired relation, because this aspect of meaning is needed for correct performance in this situation (see section 1.5.2).

Another interesting question concerns the link between the semantic and cognitive level. In chapter 3 (see section 3.8), it was discussed whether the understanding of UNDER represents transcontextualized understanding, i.e. whether it challenges the abstract and linguistic abilities more than the understanding of IN and ON. The semantics of UNDER require that the child discerns other relational possibilities due to the preposition and resists the influence of situated information.

Behavior of this type was indeed observable in an older child who participated in a pilot study conducted to test this idea. This boy (aged 32 months old) received a toy-engine and a tunnel (see Figure 22). He was then asked to put the engine the tunnel (a syntactically incorrect instruction). In this case, he formed a canonical relation: the engine IN the tunnel. In the next step, the toys were moved apart and the child was instructed to put the engine ON the tunnel. The child performed correctly in accordance with the preposition used in the instruction. These observations suggest that this child who was six months older than infants studied in this thesis possessed a higher level of semantic competence and was thus able to mobilize his more abstract knowledge to understand instructions. Of course, it could be argued that this advanced competence may be merely the result of individual differences. However, Parisi and Antinucci (1970: 204) also report that there is an increasing approximation to adult performance with age in experimental tasks designed to test lexical and semantical competence in spatial locatives.

Daj	lokomotywę	tunel!	
[Give	the engine-AKK	tunnel!]	
Daj	lokomotywę	NA	tunel!
[Give	the engine-AKK	ON	tunnel!]

Figure 22: The situation for a non-canonical request

As the pilot child showed, this ability can be triggered later. In order to examine whether there is a correspondence between infants' understanding of UNDER and the ability to desituate and transcontextualize knowledge, infants' response to a non-canonical request (to put a toy-engine ON a tunnel) was tested at the end of the pretest and the test session. More specifically – as in the pilot study – two instructions were given to every child of the type used in the first experiment (see section 3.3.3). In the case of the first instruction, infants were expected to put the engine IN the tunnel as suggested by the situational cues. In the second case, infants were required to resist the canonical relation and put the trajector ON the tunnel based on the linguistic information only.

The semantic goal for this experiment was to investigate how infants learn the ability to desituate and decontextualize, i.e. to respond explicitly to a linguistic information. It should be noted here that this goal contrasts with what was already argued for in the previous chapters (e.g. 1.3). Research on cognitive development was reported on in supporting the objection against a possible abrupt transition from understanding on the basis of pragmatic cues to understanding due to semantic knowledge.

The following hypothesis summarizes the rationale behind the following investigation:

H_4: If differentiated semantic knowledge is required for understanding UNDER then there should be a correlation between infants' understanding of UNDER and their ability to correctly perform an instruction with a non-canonical relational request.

5.1.4 Design and procedure

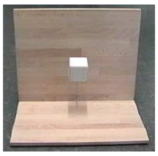
The training study was conducted on four successive days and comprised of a pretest, two training sessions and a test session which will be described in detail below.

Pretest session

In the pretest, infants' performance on an instruction containing an UNDER-preposition was alternated with an instruction requesting an ON-relation. The pretest session lasted about 15 minutes depending on the infant's confidence in the experimental situation. Six sets with different toys were presented to the children, and they were instructed eight times (six times to put X under Y, and two times to put X on Y). Finally, infants were confronted with the **HiK**-situation containing the cube-part and were instructed to put the ball under the cube (see Table 12).

Often, the child gave the impression of not paying attention to the instruction. In such cases, the instruction was repeated once again. If the child responded to the instruction with the requested UNDER relation for the two objects presented, it was scored as a correct answer. If the child performed another relation, e.g. ON, it was scored as incorrect. In case the child did not respond to the instruction at all, the response was excluded from the scoring altogether.

Table 12: Sets and instructions in the pretest

SETS	INSTRUCTIONS
	Daj pieska POD stół! [Give the dog UNDER the table!] Daj kotka POD materac! [Give the cat UNDER the mattress!] Daj pieska POD dach! [Give the dog UNDER the roof!] Daj pieska NA materac! [Give the dog ON the mattress!]
	Daj wiadro POD drabinę! [Give the bucket UNDER the ladder!] Daj ptaszka POD umywalkę! [Give the bird UNDER the washbasin!] Daj pieniążek POD talerzyk! [Give the coin UNDER the plate!] Daj pieniążek NA talerzyk! [Give the coin ON the plate!]
	Daj piłkę POD kostkę! [Give the ball UNDER the cube!]
	Daj lokomotywę tunel! [Give the engine-AKK tunnel!] Daj lokomotywę NA tunel! [Give the engine-AKK ON tunnel!]

Training sessions

For the training, infants were divided into four groups and learned the preposition UNDER in two sessions. The results from a pilot study suggested that two sessions are sufficient for a significant learning effect. In the pilot study, two groups (of two boys aged 23 months) were compared. While the first group received only two training sessions, the other group was trained three times. The difference in the training was not significant for the performance in the test.

Each session lasted about 15 minutes and took place on the second and third day of the study. Organizational considerations necessitated that each training session was carried out with two infants simultaneously. Nevertheless, it turned out that there were not only organizational advantages to this solution. In this training situation, learning was more natural as one child could learn by observing the other, and the focus of the experimenter's attention was not on one child all the time. Concerning the interaction between the two children, especially in the first session, some ‘fights’ over the toys arose initially, and it could often be observed that one child took a more active role in the training situation than the other. The active child played more with the toys while the other observed more. However, in the second session, the roles were often less strictly divided, and there was no direct correlation found between the active-passive role and child’s performance in the test. Overall, the naturalness of the training situation with two children was counterbalanced by disadvantages related to the social variables: it was difficult to control whether both of the children received sufficient input, i.e. whether one of them may have suffered from her or his observer-role.

As far as the setting is concerned, the preposition UNDER was presented to the infants in three situations (a familiar, a new and the **HiK**-situation) whereby the experimenter differed her linguistic input to every group. The training sessions consisted of five phases. The aim of having various phases was to offer different actions to infants, since it was not the goal to investigate infants’ understanding of a preposition based on passive observation alone. According to the training study by Borkowki, Levers and Gruenenfelder (1976), children learn prepositions more effectively, if they can act on the objects involved (ibid: 782). It seemed likely that less infants would be addressed with a passive observation than if they were offered different kinds of action (see also Hasselhorn, 1987 for a systematic overview of experimental training research on improving children’s learning ability).

Phase I. The procedure started with a small warm-up phase, in which a picture-book was shown to the infants. This book was composed from pages out of two books by Lucy Cousins[1] and included four pictures, in which a mouse is hiding UNDER an object (bed, table, wash-basin, blanket). The four pictures were accompanied by a story read by the experimenter (see Appendix A). In every picture, Mausi is looking for his friends and one of the depicted objects could be ‘opened’. For example, one could take a look under the table (see Figure 23).

Figure 23: The picture-book

From the beginning, this book was presented with different linguistic input:

1 Cousins, Lucy (1999): Wo ist Mausi? Sauerländer, Ffm.
and Cousins, Lucy (1999): Wo steckt Mausis Panda? Sauerländer, Ffm.

Table 13: An example of different input in reading the picture book

	Group UNDER	Group UNDER-ON	Group UNDER-IN
Input during training sessions	only UNDER	contrasting UNDER with ON	explaining UNDER with IN
EXPRESSIONS	Look, Kuno is UNDER the bed!	Look, Kuno is UNDER the bed, not ON!	Look, Kuno is IN the hole UNDER the bed!

Phase 2. In the second phase, a roof and a dog were presented to the infants. The dog was placed under the roof (see Figure 21). Then, the experimenter told the children that she was a dog and that the table was a roof, and demonstrated UNDER again. The advantage of the self-action in this phase is that infants only have to concentrate on the person opposite them. This is in contrast to the next phase, where the UNDER-preposition was related to an action between two toy-objects and the infants then had to share the attention between what the experimenter was saying and how the objects were composed.

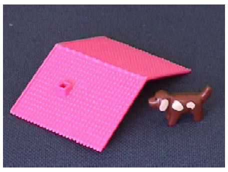


Figure 24: The dog and the roof

Phase 3. In the third phase, other toy-animals, a toy-bed with a mattress, a toy table and a toy chair were presented to the infants (see Figure 25).

Figure 25: The familiar situation

Then the animal was placed UNDER each of the three objects one after the other. At the end of this phase, each of the children was asked to put the animal UNDER one of the objects. Each child was given a single instruction and she or he received different feedback on her or his performance depending on the group (see Table 11). Together with the objects from the second phase, these objects and relations constituted the familiar situation for the test (since they were already known to the children).

Phase 4. Next, the infants were confronted with the **HiK**-construction including the shelf-part (see Figure 23). The relation UNDER was presented on this construction with different linguistic input. Every child was asked to put the ball UNDER the shelf at the end of this phase and received different feedback on her or his performance depending on the group.

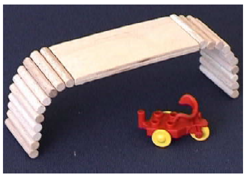
Instruction:

Daj piłkę POD półkę!
[Put the ball UNDER the shelf!]

Figure 26: The shelf in the **HiK**-situation

Phase 5. Finally, new toy-objects were introduced to the participants (see Table 13). With these at least two relations were possible (IN or/and ON, UNDER). Each child was requested to put the new objects in an UNDER-relation together.

Table 13: New objects in the training sessions

	NEW OBJECTS	
first training session	 Daj dzbanek POD czapkę! [Put the pot UNDER the cap!]	 Daj młotek POD stół! [Put the hammer UNDER the table!]
second training session	 Daj rowerek POD most [Put the bike UNDER the bridge!]	 Daj filiżankę POD ławkę! [Put the cup UNDER the bench!]

Test session

In the test session on the fourth day, every child was tested – as in the pretest – without other infants being present. This session took about ten minutes, and the procedure was similar to the pretest. Three conditions were designed for the test. In the Table 14, (*) stands for number of correct performances in accordance with the instructions (NCR).

Table 14: Design of the test session

		LINGUISTIC INPUT (Groups)			
		UNDER	UNDER-ON	UNDER-IN	control
	familiar situation	*	*	*	*
SITUATION	transfer situation	*	*	*	*
	HiK-situation	*	*	*	*

The following table depicts the objects used in the test-setting:

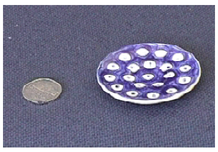
Table 15: Sets and instructions in the test

SETS	INSTRUCTIONS
	Daj pieska POD stół! [Put the dog UNDER the table!] Daj kotka POD materac! [Put the cat UNDER the mattress!] Daj pieska POD dach! [Put the dog UNDER the roof!] Daj pieska NA materac! [Put the dog ON the mattress!]
	Daj konika POD most! [Put the horse UNDER the bridge!] Daj książkę POD szafkę! [Put the book UNDER the cupboard!] Daj szmatkę POD dzbanek! [Put the flannel UNDER the pot!] Daj szmatkę NA dzbanek! [Put the flannel ON the pot!]
	Daj piłkę POD kulę! [Put the ball UNDER the sphere!]
	Daj lokomotywę tunel! [Give the engine-AKK tunnel!] Daj lokomotywę NA tunel! [Give the engine-AKK ON tunnel!]

As described above, for the familiar situation, well-known objects were used. Three new sets (see Table 15) constituted the transfer situation, in which infants were expected to transfer their understanding of POD→ [UNDER] to the new objects. The choice of the new objects for the test is explained below. In the **HiK**-situation, the sphere was used as a new landmark. Finally, the semantic hypothesis (H_4) posed in 5.1.3 that there should be a correlation between infants' ability to understand UNDER and perform non-canonical relational requests was tested with a set consisting of an engine and a tunnel.

Testing infants' performance for the transfer condition seems insofar more difficult as for the familiar situation as the sets from the pretest- and the later test-session are purposely not the same and one can thus object that they are not directly comparable.

Table 16: The settings in the transfer situation

PRETEST	TEST
 bucket / ladder	 horse / bridge
 bird / washbasin	 book / cupboard
 coin / plate	 flannel / pot

It should be noted, however, that the goal in the design of the sets for the transfer situation was to integrate the different requirements[2] for understanding UNDER for different objects

[2] Halpern, Corrigan and Aviezer (1983: 155) differentiate between two types of spatial understanding connected with UNDER: The first type of UNDER exists because of the structure of one of the objects, e.g. a ball UNDER a table, where a hollow space is given. The second type involves creating space relations between two objects, e.g. a block UNDER another block and is motorically more complex, because the child has to lift one object in order to put another UNDER it — see section 4.3.

and to vary them in both the pretest and the test. In accordance with this (see Table 16), two of the three tests in the transfer situation involved the ‘easier type’ (cf. Halpern et al., 1983: 164) of understanding UNDER: in the pretest these were the sets bucket / ladder and bird / washbasin; in the test, horse / bridge and book / cupboard. These objects all create a hollow space and suggest not only the UNDER- but also IN-[DO][3] and ON-relations. In the third set, a motorically more difficult understanding of UNDER was required as the objects did not involve a hollow space and the child had to lift one of them if she or he wanted to put the other one UNDER it: in the pretest, this was the set coin / plate, and in the test the set flannel / pot.

In general, the sets share the similarity of suggesting alternative relations: while the sets bucket / ladder from the pretest and horse / bridge from the test suggest only NA [ON]-relations additionally or canonically, the sets bird / washbasin in the pretest and book / cupboard in the test allow not only the relation POD [UNDER]. Furthermore, since it seemed possible that infants might have different expectations about animate and inanimate objects as far as movement was concerned (Meints at al., to appear) the objects were additionally varied on the basis of animacy. However, no difference in performance was observed when inanimate objects were involved as compared with animate stimuli. In preferential looking tasks made with 15-, 18- and 24-month olds, Meints et al. (to appear) also found no overall difference in children looking patterns between inanimate or animate objects. In their study, the infants were exposed to ON- or UNDER-relations.

Participants

Twenty-six infants were selected for the study. Fourteen female and twelve male participants were confronted with the tasks. The youngest participant was 20 months old, the oldest 27 months. Two girls were excluded from the scoring due to social problems which became apparent in the first training session. Subjects were selected through local contact in the area, and testing took place in a parish room in a small town in the south of Poland. All children were monolingual native speakers of Polish. The parents came from different occupational backgrounds but most were non-academic.

Parent-care

Similar to the first experiment, the parents or caregivers accompanied their children for this study. An important challenge faced was that of avoiding the possibility that parents would practice the understanding of UNDER with their children at home. The first idea tried was to

3 Ptaszek DO umywalki [the bird IN the washbasin] and
Książka DO szafki [the book IN the cupboard]

divert their attention to other aspects of the study (e.g. the social interaction in the training) at the beginning and to inform them about the real goal of the study at the end. Paradoxically, as the pretest of a pilot study showed it turned out to be more likely that parents would train the understanding of UNDER with their children at home if another goal for the study was pretended. Given the pretend focus on social interaction, when parents realized that their child could not understand an instruction with the preposition UNDER, they became worried about whether the reaction of their child was 'normal' and whether they should improve the child's understanding of UNDER.

For the main study, therefore, it was decided to inform the parents about the focus on language acquisition, the development of prepositions and the various aims of the different studies (see the information sheet in Appendix B) and to rely on their understanding of the need to neither repeat the task of the training at home, nor talk about the training in the presence of the child.

Scoring

In the following section, infants' performance will be shown for the three phases of the study: the pretest, the training and the test.

Scoring in the pretest. Table 17 shows how many infants performed the POD→ relation based on the preposition in the instructions in the pretest. The learners' responses were summed across the sets in three different situations. The maximum possible number of correct responses was 18 in the familiar and also 18 in the transfer situation, because each group of six children was confronted with three sets from each of these two situations. In the **HiK**-situation, the maximum possible number of correct responses was six, because every child was confronted only once with the **HiK**-construction.

Table 17: NCRs in pretest

		LINGUISTIC INPUT (Groups)			
		UNDER	UNDER-ON	UNDER-IN	Control
mean age in months		23	24	23	23
SITUATION	familiar situation (3 sets)	1	3	2	2
	transfer situation (3 sets)	4	6	1	1
	HiK-situation (1 set)	0	2	2	1

N in every group = 6

It is important to notice that the group UNDER-ON displays the best performance in the pretest. The understanding of POD→ seems to be better than was previously the case in other groups.

Scoring in the training. The following Table 18 shows infants' correct performances at the end of each training session, in which every child has the possibility to respond to one instruction from the familiar and transfer situation. In each group, the maximum possible number of correct responses was six.

The data from the training sessions is too small for a statistical comparison. However, at the first glance, there seems to be a tendency for the group UNDER-IN to perform better in the familiar and the transfer situation than the groups UNDER-ON and UNDER on the first training day.

Table 18: NCRs in training

				LINGUISTIC INPUT (Groups)		
				UNDER	UNDER-ON	UNDER-IN
mean age in months				23	24	23
SITUATION	familiar situation	1. day:	dog / chair	3	2	4
		2. day:	hippo / roof	3	4	3
	transfer situation	1. day:	pot / hat	2	3	5
		2. day:	bike / bridge	4	2	3

Scoring in the test. After two training session, infants' performance in relation to the preposition POD→ was studied again. Table 19 presents the learners' responses summed across the three different situations. The maximum possible number of correct responses was 18.

Table 19: NCRs in the test

		LINGUISTIC INPUT (Groups)			
		UNDER	UNDER-ON	UNDER-IN	Control
mean age in months		23	24	23	23
SITUATION	familiar situation (3 sets)	12	13	15	2
	transfer situation (3 sets)	9	11	9	4
	HiK-situation (1 set)	0	2	2	1

N in every group = 6

5.2 Results

The results support the assumption that the understanding of the POD→ [UNDER]-preposition can be learned in the course of two training sessions. The analysis of infants' performance was carried out on two levels. On the first level, a comparison between subjects was made between the trained (18) and the untrained infants (6). Concerning the results in the pretest, an ANOVA showed no difference in performance with regard to the factor 'training' ($F(3,20) = 1.14$ $p > 0.3$). However, there was a significant difference between the four groups concerning infants' performance in the test ($F(3,20) = 5.85$ $p < 0.01$). The second level of the analysis (within groups) will be presented in detail.

Linguistic Input

On the second level, the effect of the type of training on infants' understanding of UNDER in the test was compared against the performance of the control group (six infants in every group). The results of a paired t-test show (see Table 20) that before and after the training (ignoring the different situations for the time being), infants' performance across the trained groups differed significantly from their performance in the pretest. In contrast, the control group, who received no input concerning the UNDER-preposition in training sessions showed no learning effect.

Table 20: Results of the t-test comparing the performance in the test to the pretest

	LINGUISTIC INPUT (Groups)			
	UNDER	UNDER-ON	UNDER-IN	Control
mean age	23	24	23	23
ltl	5.39**	7.32***	5.22**	2.24

N in every group = 6; $\alpha(0.01;5) = 4.03$ * p < .05, ** p < .01, ***p < .001

An ANOVA-analysis confirmed the results of the t-test: there was no difference between the groups in the pretest ($F(3;20) = 1.14$ $p < 0.4$), whereas the performance differed significantly in the test ($F(3; 20) = 5.44$ $p < 0.007$). A post-test for ANOVA shows that especially the UNDER-ON and UNDER-IN group were more successful compared with the control group ($p < 0.02$). The difference between the UNDER group and the control group in the test ($p < 0.058$) also approached significance. These results confirm the hypothesis H_2 which argued for the importance of the variable linguistic input, particularly input that is assumed to correlate with infants' conceptualization.

Situation

Comparing the trained group (18 infants) to the control group (6 infants), the most significant results ($F(1;10) = 57.65$ $p < 0.001$) were found in the familiar, i.e. trained situation. In this case, infants had learned to make a difference between UNDER and other relations. During the test, it was frequently observed that infants spontaneously acted out the ON-relation when the objects were presented to them, but as soon as the instruction was given to them, they followed it correctly and carried out an UNDER-relation.

In the transfer situation with new objects, a significant learning effect was also observed ($F(1;10) = 6.52$ $p < 0.05$). In contrast, no learning effect was observed in the **HiK**-situation. Only four of 24 infants showed a successful performance in understanding UNDER during the **HiK-**test. However, these few infants had already mastered the artificial transfer situation well in the pretest (5 out of 24). Overall, none of the 24 infants learned to transfer the UNDER-relation to the **HiK**-situation. These results support the hypothesis H_1 that was made for the influence of situational stimuli:

NCR in the familiar situation > NCR in the transfer situation > NCR in the **HiK**-situation.

Situation versus Linguistic Input

Figure 27 depicts the results of infants' performance in the familiar situation condition and compares the pretest- to the test-session. The infants' number of correct responses in every group was scored as a percentage based on the number of infants and the number of instructions they responded to.[4]

For a presentation pointing out the development of understanding, infants' performance scored in both training-sessions is considered in the horizontal line of the diagram as well. However, in every training-session, every learner responded to only one instruction from the familiar situation, which automatically makes this response more weighty in the diagram.

As this presentation of the percentages shows, the best learning effect was achieved in the group UNDER-IN, if one considers only the difference between the performance in the pretest and the test. With regard to the group UNDER-ON, the learning effect is smaller due to the fact that in the pretest 18.75% of the infants were already performing correctly to the UNDER-instruction.

4 18 correct responses were possible in one group (each of the six children responded to three instructions in the familiar situation). However, if for example the answer of one child had to be excluded from scoring, 17 responses were taken as 100%.

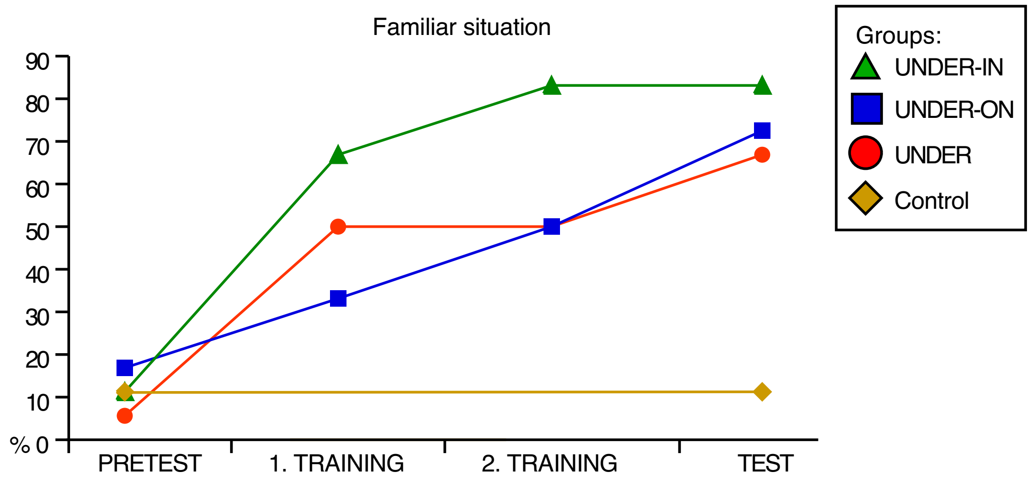


Figure 27: In percentage: infants' understanding of UNDER in the familiar situation

For the transfer situation, the development of infants' understanding of UNDER expressed as the percentage of the correct responses in the pretest (3 sets), the first and second training session (each 1 set) and the test (3 sets) is shown in Figure 28.

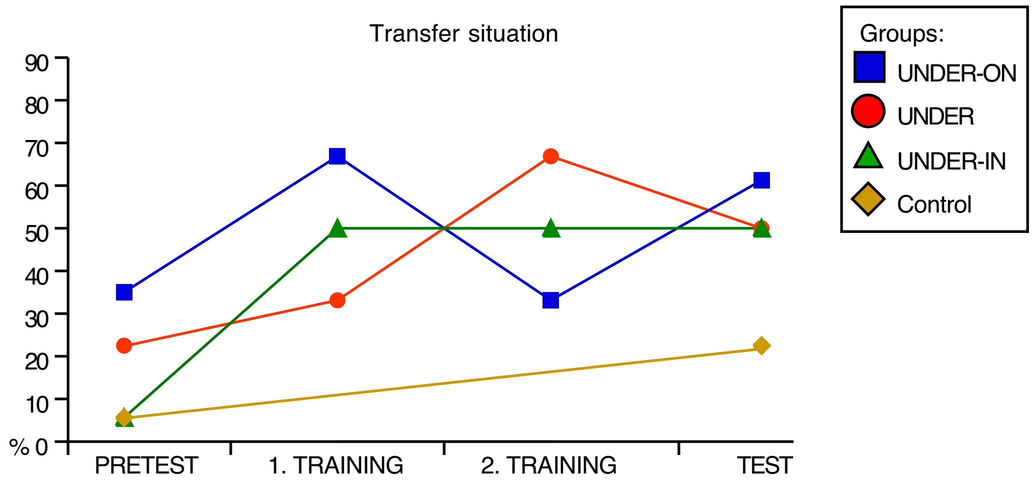


Figure 28: In percentage: infants' understanding of UNDER in the transfer situation

It should be noted here, that a few unexpected difficulties with regard to the setting emerged in the test-session. Unfortunately, these occurred in the test-session itself rather than in the test-session of the pilot study. It turned out that in the test-session the flannel in set 3 (flannel / pot) was interpreted by some children as a tablecloth[5], which automatically made the required relation a canonical one. Thus, instead of putting the flannel UNDER the pot as required by the instruction, infants put the pot ON the tablecloth. The spatial constellation was the same and the result therefore correct, however, it was derived from a different source of intracontextual information (knowledge of the canonical relations associated with a tablecloth). This explains the unexpected increase in successful performance in the control group despite lack of training in UNDER. Using probably the canonical relation just described, 50% of the non-trained infants performed correctly to the instruction to put the flannel UNDER the pot.

With regard to the diagram in Figure 28, the best learning effect again occurs in the group UNDER-IN. The best overall performance percentage, however, occurs in the group UNDER-ON. Nevertheless, this result in the group UNDER-ON could be due to the fact that the infants participating in the UNDER-ON group were on average one month older than the learners in the other groups. However, if this is the reason, their results for the previous test in the familiar situation should also be the best overall, which was not the case.

Comparing the data presented above from the familiar and the transfer situation, it is noticeable that while the understanding in the familiar situation shows a constant development within every training group and every session, the understanding for the transfer situation varies rather erratically from session to session and no regularities in the development can be determined. The most consistent developmental curve is achieved by the group UNDER-IN, where infants had learned to understand UNDER in 50% of the cases already after the first training session. The performance then remained constant over the following training session and the final test session. The group UNDER-ON achieved the best performance after the first training session, but it then descended and did not differ significantly in the test session. The same effect could be observed in the group UNDER, which also had the best performance after the second training session.

In order to shed more light on the significance of the results presented in the percentage diagrams, the following presentation of the data is based on statistical tests. As Table 21 shows, an interesting result occurs for the group UNDER and concerns their performance in the transfer situation. The statistical data suggest that even after the training, UNDER-learners' understanding of the preposition remains the same — similar to the results for the control group. In contrast, the performance in the groups UNDER-ON and UNDER-IN differs after the training for both kinds of situation. This test already confirms the hypothesis H_2 for the transfer situation. The hypothesis is further confirmed by an ANOVA on the familiar situation, which showed a significant difference between the groups ($F(3;20) = 9.61$ $p < 0.01$). In the

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5 In the procedure of the test session (as in all sessions), every toy was introduced to the child with the question Co to jest? [What is that?] One child responded explicitly to the question relating to the flannel with obrus! [Tablecloth!]

post-test, the UNDER-, UNDER-ON- and UNDER-IN-groups all differ significantly ($p < 0.01$) from the control group.

Table 21: Results of t-tests comparing the pretest to the test in different situations

		LINGUISTIC INPUT (Groups)			
		UNDER	UNDER-ON	UNDER-IN	Control
mean age in months		23	24	23	23
SITUATION	familiar situation	3.84*	7.91***	7.05***	0
	transfer situation	1.75	5.00**	3.16*	2.24
	HiK-situation	0	0	0	0

N in every group = 6; $\alpha(0.05;5) = 2.57$ *p < .05; **p < .01; ***p < .001

Finally, as already pointed out above, the different kinds of training had no noticeable effect on infants' understanding of UNDER in the **HiK**-situation. Nevertheless, an interesting observation concerning the effect of the linguistic input can be found in the incorrect responses learners made in the **HiK**-situation during the test session. While in their incorrect responses to the UNDER-instruction, learners in the UNDER and UNDER-IN group reacted with a contact relation — best described as corresponding to the German AN-relation "that is somewhat specialized to relations of hanging and other projecting attachment" (Bowerman, 1996b: 395). The UNDER-ON group, in contrast, reacted with an ON-relation. No child from the UNDER-ON group performed an AN-relation when responding incorrectly to the UNDER-instruction, and conversely no child from the UNDER and UNDER-IN group performed an ON-relation when responding incorrectly to the request. This finding suggests that the training, in which infants learned the UNDER-preposition by contrasting it with the ON-relation, caused the learners to perpetuate the already better understood ON-relation. The result of this that if in the training of the two relations ON and UNDER are presented for a specific situation (**HiK**), the infants are more sensitive to the ON-relation and will choose it when responding to an instruction, even though this instruction contains an UNDER-relational request.

The way the infants behaved in the UNDER-ON group recalls certain observations made in the first experiment. There, the ON-relation was also dominant, however, this was for the well-known situation. It can therefore be proposed that the confidence in performing the ON-relation that was achieved in training led to a transfer of the dominance of the ON-relation to the artificial situation as well.

Correlation to a non-canonical request

Concerning the fourth hypothesis, the infants' performance did not show a direct correlation between the increasing understanding of UNDER and the ability to respond correctly to a non-canonical request. In 54% of the cases, the children studied were already able to achieve the requested non-canonical relation (an engine ON the tunnel) in the pretest, even though they could not understand UNDER at this time. However, the ability did not seem to be stable as some of the children who performed correctly on the non-canonical request in the pretest, failed in the actual test. Overall, 45% of all children tested put the engine ON the tunnel in the actual test.

A description of two individual cases makes the lack of a direct correlation more salient. While Beata (21 months old) from the group UNDER-ON performed correctly on every UNDER-request in the test, she failed in the non-canonical task both in the pretest and in the test. In contrast, Małgorzata (24 months old) from the control group did not show any learning effect in the understanding of UNDER but was able to perform correctly on the non-canonical request during the pretest as well as during the test.

5.3 Discussion

In considering the statistical results, it could be objected that they suffer from the small number of subjects in this study. However, Bennett-Kastor (1988) objects to large studies with high subject numbers with the argument that they are not sensitive enough to differentiate relationships of the complexity that is typical of language-related behaviors. In contrast, small N studies in child language research have the potential to be "exploratory analyses which serve the essential functions of 1) providing descriptive groundwork" and 2) "suggesting possible correlations to be systematically examined in subsequent research, usually with a larger sample population and greater attempts at control of other sources of variability" (Bennett-Kastor, 1988: 44).

The results from the training study suggest that the increase of the frequency of a particular term in the input can improve the understanding of it. However, this understanding still depends on the situation, as infants achieved the best results in understanding UNDER in more concrete situations (cf. also Thorseng, 1997a: 33 on the production of locative particles). In such situations, children demonstrate the ability to carry out what they have learned. When they know how to react to a certain request, infants become more confident in understanding it. This corresponds to Tomasello's (1987: 93) view on the infants' learning process: "The learning process involved in the acquisition of object words presumably involves a relatively simple association between a sound [in this case, UNDER], highlighted in adult speech by stress or intonation, and a concrete sensory-motor referent [the given constellation between the two objects]". The more concrete the sensory-motor referent is (a recurrent and therefore familiar situation) the more confident the children are in understanding the request. A corresponding view is presented in Weigl (1977: 32) who claims that language acquisition is accompanied by “constructing the structures of an action [Aufbau von Handlungsstrukturen]”. This claim makes clear that infants at the age studied are most sensitive to recurrent situations, and their relational knowledge is based on concrete experiences and interactions with objects in recurrent situations. Infants were able to extend their relational knowledge about familiar objects – such as chair, table, etc. – on the basis of two training sessions, in which the new relations were demonstrated to them, i.e. due to the information about the objects involved.

However, as the results show, the infants had some difficulties transferring their knowledge to new objects. It is important to mention at this point that this observation may arise from the fact that objects used in the transfer situation are new for the children, as they may be more occupied with exploring them than paying attention to the requests in the task. This could possibly be controlled with an earlier and familiarization of children with these objects, e.g. during the training session. However, if any, this familiarization should be a careful one so that the required transfer remains a new task to the children. In light of the results presented here, the ability to transfer cannot be reduced to mere imitation. This is because the transfer situation requires the ability to understand a single linguistic unit – i.e. the preposition UNDER – and to find at least one possibility to implement an appropriate action (i.e. to find a hollow space or to lift the landmark-object) as well as to resist resorting to the canonical relation at the same time. Such behavior cannot be due to perceptual information about objects alone, but requires the information to be encoded into the knowledge system from the beginning as well. One could object that in the transfer situation, the learners merely showed the ability to discern the intentions required in the task, since responding to an instruction with UNDER had been trained with them before. This ability, however, still requires finding a possibility to implement an UNDER-relation, which the learners were not shown before the training. A number of different processes, therefore, seem to underlie language acquisition: processes of understanding based on imitation, and the ability to transfer understanding to a new situation, even though there are strong suggestions that infants rely more on their experiences with objects.

The results from this study show clearly that the infants had the most difficulties with understanding the preposition UNDER when confronted with the **HiK**-construction, as the results in this situation showed no learning effect. The purpose of the construction, which was to test the relational knowledge context-independently, proved to be difficult to realize. At this age, infants connect their relational knowledge to usable objects and have a high sensitivity to the actions that are possible with them. Accordingly, objects that are neutral or artificial provide a context that is too limited to be relevant for infants. Nevertheless, one cannot assume that the ability to transfer the understanding of UNDER to the **HiK**-situation is impossible for infants at this age, because four of the 24 infants tested performed well on this instruction and showed precisely this ability. It can only be concluded, therefore, that infants at this age respond more comfortably to a recurrent situation and – as was frequently observed – seek functional cues. This conclusion confirms for the acquisition of prepositions what Tomasello suggests for the acquisition of verbs and syntactic constructions: “before their third birthday children use individual verbs and syntactic constructions in just the way they have heard and understood them being used — with only very limited abilities to go beyond what they have heard” (Tomasello, 2000a: 71).

Taking the familiar and the transfer situation together, the results of a post-test for ANOVA of the differently trained groups show that, if during the training infants receive input, which is assumed to correlate with their conceptualization, they tend to show a better performance in understanding UNDER than learners receiving only pure linguistic input. However, a more detailed picture about the influence of different linguistic input on the understanding of UNDER reveals itself when the results in different situations are considered. This can be done using a t-test comparing the data from the pretest to the test in a transfer situation. In this situation, the group UNDER stands out from the groups UNDER-ON and UNDER-IN in showing no significant difference compared to the control group. This outcome strongly suggests that explaining spatial relations in terms of IN- and ON-prepositions facilitates transfer of the understanding of UNDER to new objects.

On the one hand, the fact that in the well-known situations all groups achieved good learning results argues against the hypothesis H_2 (which proposed that the form of the adult input to the infants could change the effectiveness of their word learning). On the other hand, it supports the argument that infants learn best in concrete situations and that situational cues help them in their linguistic understanding. A situation with new objects additionally requires a different ability in understanding, and children receive only limited situational cues. In such a situation, they show a better learning effect when the new relation is explained by already known relations (IN and ON).

Nevertheless, some doubts about the methodology for investigating infants conceptualization of space by means of the linguistic input arise. For example, the input-researchers could object that any additional input is helpful for language acquisition. In this sense, the UNDER-ON-group received more paralinguistic information (like gesture) through the presentation of the NA-[ON]-relation in contrasting it to UNDER. Similarly, the UNDER-IN-group received more gestures pointing to the hollow space under the objects. This objection corresponds to the view held by Ritterfeld (2000), according to which additional (paralinguistic) information helps infants to attend to the verbal input, interpret and structure it. Ritterfeld (2000: 412) emphasizes that especially young infants are sensitive to such additional information. In order to test the validity of this objection more concretely, however, infants’ performance in a more limited testing setting would need to be tested.

5.4 Conclusions

In the previous chapter, the question was asked as to why UNDER is more difficult to acquire. In the next step, four possible perspectives were suggested for approaching this question. On the basis of the results presented above, an answer to the question that brings the four possible perspectives together will now be attempted in this conclusion.

With regard to frequency as an important factor contributing to the establishment and maintenance of linguistic structure (cf. Bybee & Hopper, 2001: 3; see also section 4.1), the results from the training study confirm that an increase in the frequency of UNDER can improve its understanding. With regard to the pilot study, however, no difference in learning effects could be ascertained when the frequency in the training sessions was increased. What seems crucial then is not only mere linguistic experience via frequency but the connection of this linguistic experience to non-linguistic experiences within different situations. Therefore, the best results in understanding across all groups were achieved when a certain situation was repeated frequently.

Even though it is difficult to show whether children access IN and ON in understanding UNDER, it does seem "that children start by acquiring terms with impetus meanings corresponding to simple canonical relational and directional concepts" (Sinha et al., 1999: 120). These first terms with initial meanings are cognitively motivated. The "conceptual glue" (Tomasello, 2000a: 73), that attaches a relation to an object, is its function in the sense that the child is sensitive to intentions and has the "ability to understand that other persons act intentionally towards her intentional states" (Tomasello, 2001: 152, see also Woodward, 1999). The acquisition of language is therefore a communicative process. This might explain why UNDER is less present in the input to the children: adults basically use relations which are useful for children in exploring objects, and most of the objects in children's everyday life occur in other canonical relations than UNDER, even if an UNDER-relation is also possible with them.

In their everyday life, children primarily learn to use objects, and understanding in a communicative process requires acting on these object in an appropriate way. If children discern that the relation 'UNDER a certain object' has a specific function – as presented to them by the experimenter in the familiar situation, i.e. as was the case for the table and the dog in the familiar situation –, they extend their relational knowledge about this landmark and can understand instructions with a different relational request more confidently. This was the case in the test, where the most infants could differentiate between instructions containing ON or UNDER in the familiar condition. From these findings two concluding points for the semantics of UNDER can be drawn.

The first point regards the general complexity of the semantics of UNDER as suggested in section 4.3. The polysemy of UNDER, already mentioned in Sinha et al. (1999: 109), was explained in terms of everyday concepts relevant for the meaning of spatial prepositions, which were developed by Nüse (1999; see section 2.1.2). Within this framework, English UNDER, German UNTER and Polish POD relate to two everyday concepts such as INSIDE and UNDERSIDE depending on the objects involved. Form the developmental perspective, the following argument arises. If children conceptualize the meaning of UNDER in terms of everyday concepts as developed in Nüse (1999), and it depends on the particular object as to where its SURFACE, SIDE, INSIDE and UNDERSIDE are, then a child has to have had experience with the particular object in order to decide where the UNDERSIDE is. This argument is supported by the results presented above which indicate that children are more confident with objects they know — the best learning effects were achieved in the well-known situation. In the **HiK**-situation, however, the objects were still too abstract and children could not determine the UNDERSIDE.

The second point takes up the issue of the functionality. Since functionality is an important aspect of children's experiences with objects, the second point is therefore related to the first. Concerning the interplay of functionality and geometry as semantic factors, the results from the **HiK**-situation suggest that at the age studied, infants' functional knowledge dominates over their geometrical knowledge in understanding spatial prepositions. That is, the infants seem to seek functional cues rather than they try to abstract the geometry of a relation to an unknown situation. These observations correspond to the findings in a study by Feist (2000) with adults. In a similar way, the role of functionality seems to dominate over geometry in the adults' problem solving as well. It should not, however, be concluded that functionality is thus more important or more primary as a semantic factor of spatial relational terms. Rather, it is the interplay between functionality and the geometry that is the central issue here. An interesting result concerning the interplay of geometry and function is also presented in Garrod, Ferrier and Campbell (1999). The authors propose a "hybrid account of the semantic representation underlying the prepositions with both a geometric and functional component to it" (ibid: 167). They suggest that depending on the situation, the geometry can act as a primary perceptual indicator of location control (ibid: 186). In this sense, for an ON-relation, it may be easier to relate this to the function of support, because the geometry is much more transparent as constrained by physical laws.

Thus, in accordance with this view, what makes ON more basic as a relation is that it is more physically constrained (see section 3.8). Gravity, for example, constrains in highly reliable ways the manner in which objects behave. Against this background, the geometry of an ON-relation is strongly bound to its function. The function of support, or "Stütze" in German (Klein, 1991: 101), can be easily discerned by the geometry. The conceptual glue, i.e. the function of an ON-relation is reinforced by physical features of the landmark such as its surface. Precisely this additional reinforcement is less salient in the UNDER-relation. Klein (ibid) suggests that the function of the relation UNDER is "concealment, shelter [Verdecktsein, Schutz]". Correspondingly, it could be observed that children frequently took the training of the UNDER-relation as a game of hide-and-seek.

The interaction between geometry and function establishes an interface, at which semantic aspects and cognitive organization seem to interact. From this, a number of conclusions about the child's organization of knowledge can be drawn. In 4.4 the question was raised of whether the understanding of UNDER involves conceptual prerequisites. The meaning of UNDER does indeed seem to incorporate aspects of the initial meanings of other earlier-acquired terms. This is because the functions of other relations are more geometry-oriented, whereas UNDER often plays a secondary role in an object's function. A relation UNDER is possible with, for example, a bridge, particulary since it allows an ON-relation through its surface.

> [...] wenn man das Thema sieht, ist es "auf" dem Relatum, wenn es von selbigem verdeckt wird, dann ist es "unter" dem Relatum. Letzteres ist natürlich besonders dann der Fall, wenn das Relatum eine ausgedehnte Oberfläche hat, wie eine Tapete, eine Decke oder ein Wams. Es ist klar, daß "unter" in diesem System oft mit "in" und mit "hinter" (im dreidimensionalen System) konkurriert (Klein, 1991: 101).[6]

These considerations seem justified against the background of Nüse's (1999) approach to the meaning of spatial prepositions. The contrast of the preposition ON against UNDER, in terms of the suggested everyday concepts like SURFACE, SIDE, UNDERSIDE and INSIDE sheds more light on the question of why parents may use different spatial relations for describing a spatial alignment when the use of UNDER is also appropriate. ON refers to a region, which can be determined easily by testing whether other objects are supported by this region. The relation ON is, therefore, inextricably linked with a concrete part of a landmark, the SURFACE that makes this function of support possible. UNDER, in contrast, refers to an abstract space emerging on the INSIDE or UNDERSIDE. It lacks concrete cues such as an association with a concrete part of an object. This makes UNDER difficult to determine on physical properties of the landmark (in other words, the geometry of the landmark, respectively) alone. Klein (1991: 98) also points out that UNDER refers to a location that is lower than the landmark itself: ""unter" [weist] dem Eigenort des Relatums einen Ort tiefer als diesen zu".[7] Furthermore, INSIDE (IN) can be motorically accessed immediately while for some objects the UNDERSIDE (UNDER) is linked to the surface of an object, and this surface needs to be perceived initially and the object sometimes lifted in order to access the underside. This point was already suggested in Halpern, Corrigan and Aviezer (1983; see 4.3). In sum up all of these reasons, English UNDER, German UNTER and Polish POD are more difficult to understand for young learners because they are functionally less transparent and because they 'compete' (cf. Klein, 1991: 101) with other relations usually possible with the objects like IN, ON and BEHIND.

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6 "when the trajector is focussed, it is "on" the landmark, when it is covered by it, it is "under" the landmark. The latter is particularly the case, when the landmark has an extensive surface like wallpaper, a blanket or a vest. It is clear that in this system "under" often competes with "in" and in a three dimensional system with "behind" as well".

7 "To the actual location of the landmark, UNDER assigns a location that is lower than this".

A number of general conclusions on the development of spatial meaning can be drawn as well. Building up a core meaning that includes geometric aspects seems to require a significant amount of experience with objects and their relations. This is particularly the case when the geometry of a relation is polysemous or more complicated (like UNDER) and is not supported in a reliable manner by physical constraints (like ON). As a result, a geometric core meaning of this type seems to be established later in development and is probably driven by the increasing complexity of children's everyday life. Because they are continually being exposed to different kinds of activities and their knowledge about objects and events are extending, children cannot rely on one canonical relation alone in order to act appropriately. In this sense, the conclusion already made by Tomasello (2000a: 70) for other linguistic constructions also accounts for the understanding of prepositions: "The reason that children do not operate with more abstract linguistic categories and schemas is quite simply because they have not yet had sufficient linguistic experience in particular usage events to construct these adult-like linguistic abstractions".

With regard to the issue of lexical knowledge, already discussed in chapter 3, in section 5.1.3 the question was asked whether children's linguistic knowledge becomes more desituated with development, which then manifests itself in the acquisition of more complex prepositions like UNDER. The results obtained with respect to hypothesis 4 suggest, however, that there is no qualitative change in the kind of reasoning used in understanding a preposition when infants are able to follow an UNDER-instruction. No correlation between infants' ability to perform to an instruction with a non-canonical relational request and the understanding of UNDER could be established. Thus, the sufficient linguistic experience referred to by Tomasello (2000a: 70) in the quote above does not seem to involve a qualitative change in the corresponding semantic representation. Understanding a linguistic unit involves using co-linguistic information rather than just reacting to an established core meaning of this linguistic unit. This view is consistent with the hypothesis that modular language processing is not the starting point for acquisition. Instead, if anything, it is the result of the processes in development (Weinert, 2000: 344; cf. also Thomas & Karmiloff-Smith, 1998). In the first instance, however, all linguistic knowledge "derives [...] from the comprehension and production of specific utterances on specific occasions of use (Tomasello, 2000b: 237-238). It is little wonder then that in understanding UNDER, infants achieved the best results in the familiar situation.

Being able to transfer the meaning of a relation to an artificial situation like **HiK** seems to require different cognitive abilities than the skills used in everyday communication about objects belonging to our daily routine. At this point, further research is needed to examine in more detail why infants experience these difficulties. For the time being, it is argued that the abstract meanings adults use to react correctly in situations like **HiK** is built up processually and continuously. In this developmental process, a child initially applies her or his situational knowledge about objects before gradually learning step by step the abstract system of language used to describe them. This situative reasoning which implies co-linguistic strategies (as suggested in chapter 3), nevertheless, remains a powerful ability that is also used in adult understanding of spatial terms (cf. Coventry, Prat-Sala and Richards, 2001).

5.5 Summary of chapter 5

In this chapter, a training study was presented as an approach to the question of how infants acquire UNDER. In the design, two variables were controlled: the situation and the linguistic input to the learners.

With respect to the situation, it was found that all learners displayed noticeable learning effects in situations that were well-known from the training sessions. This result supports the argument that infants learn best in concrete situations and that situational cues help them in their linguistic understanding. In contrast, a situation with new objects requires a different ability in understanding, and children receive only limited situational cues. In such situations, it was proposed that children would show a better learning effect if the new relation was explained in terms of known relations such as IN and ON. This was tested with the aid of the second control variable which involved giving different linguistic input to the learners during the training sessions. The outcome suggested that explaining spatial relations in terms of IN- and ON-prepositions did indeed facilitate transfer of the understanding of UNDER to new objects. With regard to the **HiK**-situation, it was found that a highly abstract decision about the landmark's geometry was required in order to understand the instructions given. In this respect infants showed no learning effects.

Concerning the question of what makes UNDER more difficult (already raised in chapter 4) the following argument was established, of which an important premise is that English UNDER, German UNTER and Polish POD refer to two everyday concepts developed for the meaning of prepositions in Nüse (1999) such as INSIDE and UNDERSIDE depending on the objects involved. 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 experience with the particular object in order to decide where the UNDERSIDE is. This argument is supported by the results which indicate that children learn to use objects in their specific function and are more confident with objects they know.

Finally, another aspect that makes the relation ON more basic than UNDER are processes of perception. It is easier to perceive something that is both physically and through its canonical orientation socially constrained. The assumption is therefore made that the interplay between functionality and the geometry is at the center of the meaning of a spatial relational term. The meaning of UNDER, moreover, appears to incorporate aspects of the basic meanings of other earlier-acquired terms. This occurs because the functions of other relations are more geometry-oriented. In contrast, UNDER often plays a secondary role in an object's function and thus 'competes' with other relations like IN, ON and BEHIND.

The results do not indicate that the development of the understanding of UNDER is accompanied by a qualitative change in the kind of reasoning in understanding a preposition, nor is it accompanied by the development of a core meaning including geometric aspects as suggested in Momos' semantic task (see section 1.5.2). Instead, learning to understand a linguistic unit requires using co-linguistic information and experiencing the linguistic unit within different situations with many different objects.