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Facilitating the acquisition of UNDER by means of IN and ON – a training study in Polish*

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ABSTRACT

Forty Polish children aged between 1;8 and 2;3 were trained over two training sessions in the comprehension of the preposition POD [UNDER]. In the experiment, two variables were manipulated: a within subjects variable of SITUATION and a between subjects variable of LINGUISTIC INPUT. The effect of situation could be found in all trained groups, showing that children's understanding in familiar and transfer situations differed significantly from the performance of the control group in the post-test. The results further suggest that depending on the type of a situation, the linguistic task requires different word learning abilities from a child.

INTRODUCTION

Crosslinguistic research reports a quite robust phenomenon that can be best observed in an experimental situation: imagine a child between 1;8 to 2;3 years old with a small toy dog and a toy table in front of her. The child then hears *Put the dog under the table!* Many children of this age will put the dog ON the table as if they could not understand the preposition UNDER (Clark, 1973; Wilcox & Palermo, 1974; Grieve, Hoogenraad & Murray, 1977; Dromi, 1979; Paprotté, 1979; Ahnert, Klix & Schmidt, 1980; Halpern, Corrigan & Aviezer, 1983; Thiel, 1985). The question pursued in

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this paper is what makes UNDER difficult to understand and how learning of the preposition can be facilitated.

In the literature, it has been proposed that IN and ON are understood prior to UNDER (Clark, 1973; Thiel, 1985; Bowerman & Choi, 2003). The difficulties in learning to understand UNDER have been related to concepts children may already have formed on the basis of their experiences (Johnston & Slobin, 1979). Accordingly, since some prepositions like IN and ON are more frequent than UNDER in everyday communication, children are given more opportunities to establish corresponding concepts. Thus, the seemingly obvious reason for the temporal order in the acquisition of prepositions could be sought in the frequency of the spatial terms in the input to children. In support of this view, Savic & Andjelkovic (2005) identify correlations in the acquisition of Serbian prepositions showing that the frequency of prepositions in adults' language is a very good predictor of order of acquisition and distribution in children. However, even though the role of the input in understanding UNDER is undisputed, it may not be the crucial factor for observed phenomena in language acquisition. Data presented in, for example, Sinha, Thorseng, Hayashi & Plunkett (1999) indicate that frequency can modulate but not substantially determine semantic contents in language acquisition. Thus, the fact that UNDER is less present in the input to the children does not answer the question WHY UNDER is less present in everyday communication. This could just be due to intuitions of the caregivers who do not mention the relation UNDER because it is easier (or in a more salient way) to describe this location by using other relational terms as Rohlfing & Choi (2004) suggested. In observing how parents communicate a relation such as 'a boy under an umbrella' and 'a horse under a bridge' to their children, they noticed that parents paraphrase the UNDER-relation more often than, for example, an ON-relation and use more specific verbs like '*sit* the boy' or '*hide* the horsey' and other prepositions like '*by/close to* the umbrella' and '*in* the space'. If in talking to children parents paraphrase the UNDER-relation and this is the reason why UNDER is less present in the input to children, then the question remains why the parents paraphrase. In doing it, caregivers might adjust to the knowledge of their children and rather use spatial relations that the children know more about.

Along these lines, Clark (1973) suggested that, in comparison to UNDER, children know more about IN- and ON-events, because of their greater 'perceptual salience' (see also v. Geert, 1985, p. 15). The ON-relation, for example, is constrained by gravity. According to Johnson (1998), gravity is a fundamental environmental constraint on object behaviour, because it induces, highly reliably, the ways in which objects behave. In this sense, through the geometry of the ON-relation, children can easily discern the function of support, which in turn can simply be

tested by whether an object is supported by another or not. The function is even easier to discern in the case of a container relationship (as the meaning for IN) where the hollow space establishes the crucial physical feature and the motion of one object will induce a parallel motion in the other object. In supporting the salience of this relationship, Hespos & Spelke (2004) report that containment seems to be understood very early in the development, around 5 months of age.

In studies concerned with sociocultural salience, rather then perceptual salience, Freeman, Lloyd & Sinha (1980) found evidence for the proposition that if, for example, cups are used in their customary orientation (upright), children's understanding of instructions for actions on the cups is better than if they are inverted. The authors called the evidence the 'canonicality effect' (Freeman, Lloyd & Sinha, 1980, p. 259). Applying this effect to the understanding of UNDER, it is plausible to argue that UNDER could be understood much earlier, if objects in UNDER relationships were more common. A study by Jensen de López (2002) confirms precisely this hypothesis. In the Zapotec culture, baskets, for example, are used to cover food or in children's games to catch something, so that the objects are frequently UNDER. In a task, in which an UNDER-relation was required, Zapotec-speaking children performed better than Danish-speaking children. This observation suggests that not just physical salience – as claimed by Clark (1973) – but also sociocultural salience will influence children's understanding of spatial events and their verbal labels (Nelson, 1996; Sinha & Jensen de López, 2000).

Sociocultural salience of a spatial relationship goes hand in hand with linguistic salience of its corresponding spatial term. Bowerman & Choi (2003) showed that languages highlight different aspects of a spatial event. These aspects are then crucial for how adult speakers of a particular language categorize spatial events. With reference to the socialcultural salience of the UNDER-relation in Zapotec, the contribution of linguistic categorization to the understanding of UNDER is depicted in Figure 1. As can be noticed in Figure 1, a single containment-relation in Zapotec is relevant for the semantics of English and Polish terms for IN and UNDER in those cases, in which the trajector is inaccessible to perception. This containment-relation is expressed in Zapotec by a single word *láani* (Jensen de López, 2002) and is glossed with the English term 'stomach' (Sinha & Jensen de López, 2000, p. 23).

Thus, in comparison to Zapotec, the relation UNDER in English as well as the Polish POD combines 'some aspects of both the basic container–contained and bearer–burden relation [...], which receive canonical marking by respectively in and on' (Sinha, Thorseng, Hayashi & Plunkett, 1999, p. 109). Given the different relational aspects involved, it is plausible to assume that this polysemy in languages such as English or Polish makes

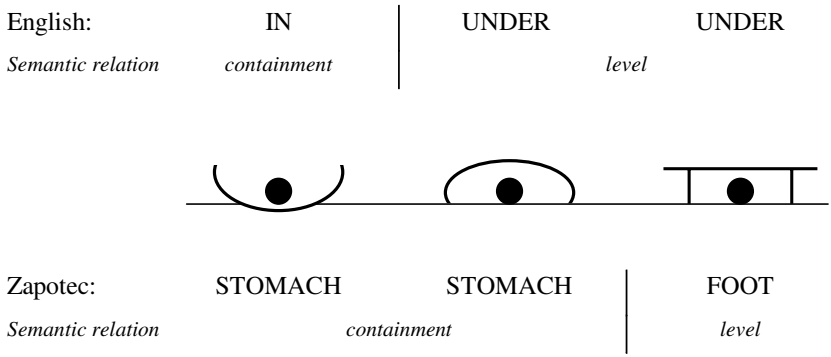

Fig. 1. Differences in categorizing the spatial relation UNDER in English and Zapotec. What the two languages have in common is the differentiation between the containment relationship (on the left) and the level relationship (on the right); in a level relationship, the landmark object has an easily discernible hollow space as, e.g. a table does. The crucially distinct relationship is depicted in the middle: while in Zapotec it is still regarded as a containment, it is already categorized as a level in English (also in Polish), even though some objects do not even have a hollow space (like a coin).

UNDER more complex to process (see also Halpern, Corrigan & Aviezer, 1983) and is resolved in Zapotec – where the semantics of the terms for the UNDER-relation might turn to children's advantage in spatial word understanding. The argument about the polysemy involved in English or Polish terms for UNDER is another explanation of a semantic nature to the question of why parents paraphrase the UNDER-relation.

Taken together, some researchers are convinced that prepositions like IN and ON belong to a 'limited subset of the most cognitively and semantically simple locative particles' (Sinha, Thorseng, Hayashi & Plunkett, 1999, p. 102). IN and ON might, therefore, function as 'basic relations [Basisrelationen]' (Thiel, 1985, p. 201) for UNDER, and/or parents might use them in explaining the semantics of UNDER. In learning spatial words, then, children gradually extend their repertoire to include cognitively and semantically more complex ones, such as UNDER.

Can the easier prepositions be used systematically to resolve or weaken the polysemy involved in UNDER and to facilitate its acquisition? IN and ON would not only have the potential of being conceptually basic for UNDER; when contrasted with UNDER during the mapping process, they may enable establishment of a richer representation of the meaning of UNDER in the mental lexicon. McGregor and her colleagues (2004) in a longitudinal study of children's word learning (McGregor, Sheng, Graham, Grohne-Reilly & Keegan, 2004) follow Carey (1978) in differentiating two stages of word learning: fast and slow mapping. Fast mapping involves the linking of a label to its referent and may be accomplished after only one

or two exposures to a word in context. With repeated exposure in multiple contexts, slow mapping develops. Slow mapping involves retaining the label over time and elaborating its meaning. One aspect of elaboration is the extension of a label to a category of referents. That is, to understand the meaning of any given word and to apply it to any given context, one must come to appreciate that the word applies not only to an individual referent but to a category of referents. One must also be able to decontextualize some aspects of the word meaning. Via extension, the child comes to apply a recently learned word to new exemplars and in new situations. Enriched semantic information is reported to facilitate the extension and retention processes.

In the following training study, the operationalization of the understanding process is based on the definition of word learning given in McGregor (2004) with the restriction that only the mapping and the extension processes (but not the retention) were in focus. This study was designed to teach children to understand the preposition UNDER. In order to influence children's learning of UNDER systematically, three kinds of linguistic input were applied between subjects; two of them were designed to provide enriched semantic information in form of the conceptually more basic relations IN and ON. Given the hypothesis that introducing and simultaneously explaining the UNDER-relation in terms of the basic relations (IN and ON) will facilitate learning, it was predicted that children should be more responsive to linguistic training in which input includes these basic relation terms. After the training, children's word learning was tested. To test how well children learn the new label, three types of situations within subjects were designed: (1) a familiar situation (with familiar objects), in which a mapping of a label was expected; (2) a transfer situation (with new objects) and (3) an artificial situation (with geometrically shaped objects). In these two latter situations children were expected to demonstrate an extension of the learned label. Learners were predicted to perform best in situations that involve familiar objects in trained relationships.

METHOD

Participants

Forty-two (20 female and 22 male) subjects were selected through local contacts in the area and testing took place in a parish room in a small town in the south of Poland. Two girls were excluded from the scoring due to behaviour problems, which became apparent in their first training session. Two boys (one from the UNDER- and the other from the UNDER-IN-group) were excluded because they seemed unwell during the test session. The 38 included in the study were between 1;8 to 2;3 years old (mean age: 1;11)

TABLE 1. *Settings and instructions in the pretest*

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 wiadro POD drabinę!* [Put the bucket UNDER the ladder!] *Daj ptaszka POD umywalkę!* [Put the bird UNDER the washbasin!] *Daj pieniążek POD talerzyk!* [Put the coin UNDER the plate!] *Daj pieniążek NA talerzyk!* [Put the coin ON the plate!]
	*Daj piłkę POD kostkę!* [Put the ball UNDER the cube!]

and monolingual native speakers of Polish. For the training, the children were divided into four groups. The exclusion of two children caused an unequal number of participants in the training groups: UNDER- ($N=9$), UNDER-ON- ($N=10$), UNDER-IN-group ($N=9$) and the control group ($N=10$). A book was given to each child after the study, and parents were reimbursed for transportation costs.

Procedure

The training study took place on four successive days in each of which one session was held. The procedure in the pretest and the test was the same, and children were tested individually without the presence of another child. However, organizational considerations necessitated that each training session was carried out with two children simultaneously. Two variables were manipulated during the training: a between subjects variable of LINGUISTIC INPUT (which will be explained in the section 'training') and a within subjects variable of SITUATION (see section 'test').

Pretest

In the pretest, children's understanding of the UNDER-preposition was tested. Understanding of ON was also probed to avoid conditioning to an UNDER-request (see the order of instructions in Table 1).

Fig. 2. The *HiK*-situation.

Six sets of toys were presented to the children in succession. In each set, a trajector- and a landmark-object were introduced. The landmark allowed at least two relations: ON and UNDER. Then, children were instructed in the schema *Daj X PREPOSITION Y!* [*Put the X PREPOSITION Y!*] Lastly, the participants were presented with the *HiK*-situation (see Figure 2) containing the cube-part and were instructed to put the ball under the cube.

The wooden construction (see Rohlfing, 2001) is called HiK (HEIDELBERGER INTERESSANTE KONSTRUKTION) and addresses the need to use 'neutral objects' (Grieve, Hoogenraad & Murray, 1977, p. 247) in testing children's lexical competence. The construction consists of two objects covered with Velcro. The two objects are an interchangeable landmark object (cube, shelf, sphere) and a mobile ball, introduced to the participants as 'piłka' [ball], that can be attached to each of the landmarks in an ON-, UNDER- or BEHIND-relation. The motoric action remains similar in each relation and does not require any other action like lifting the trajector-object to achieve the desired relation.

Training

In each of the two 15-minutes training sessions, an UNDER-relation was presented to the children in three situations (always in the order: the familiar, the transfer and the *HiK*-situation). The training sessions consisted of a variety of activities, all of which were designed to provide a rich learning experience to the participants. According to the training study by Borkowski, Levers & Gruenenfelder (1976), children learn prepositions more effectively, if they can act on the objects involved. Thus, the training activities allowed children to observe actions performed by an experimenter and their playmates as well as to participate in and practice to carry out an UNDER-relation.

The training procedure started with a small warm-up activity, in which a picture-book was shown to the children. This book includes four pictures

TABLE 2. *Variation in linguistic input given by the experimenter during the training*

Input during training sessions	Group UNDER only UNDER	Group UNDER-ON contrasting UNDER with ON	Group UNDER-IN explaining UNDER with IN
EXPRESSIONS	Piesek jest POD stołem! [The dog is UNDER the table!]	Piesek jest POD stołem, nie NA stole! [The dog is UNDER the table, not ON!]	Piesek jest W tej dziurze* POD stołem! [The dog is IN the hole UNDER the table!]
FEEDBACK (negative) with a final demonstration of a correct relation	Nie! Popatrz, daj go POD … [No! Look, put it UNDER …]	Nie NA, daj go POD …[Not ON, put it UNDER …]	Nie! Daj go DO tej dziury, POD … [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.

in which an animal is hiding UNDER an object (bed, table, wash-basin, blanket). After this warm-up, a roof and a dog were presented to the children. The dog was placed under the roof. Then, the experimenter told the children that she was a dog and that a table standing in the room was a roof. While she crawled under the table, she demonstrated and explained the relation UNDER, again following the specific input pattern in each group. The advantage of the self-action in this phase is that children only have to concentrate on the person opposite them and watch her passively.

This was in contrast to the next activity, where the UNDER-preposition was used in relation to an action between two toy objects and the children had to share the attention between what the experimenter was saying and how the objects were presented. In this presentation, other toy animals, a toy bed with a mattress, a toy table and a toy chair were put in front of the learners. Then, the animal was placed UNDER each of the three objects successively. At the end of this activity, both children were asked independently – but in the presence of the other participant – to put the animal under one of the objects. After the instruction (e.g. *Put the dog under the table!*) the child received feedback correcting her or his performance in the way it was designed for the different groups (see Table 2).

In the next activity, children were trained within the *HiK*-situation. As described above, the *HiK*-situation consists of a wooden construction, which can be put on a table in front of the child. The relation UNDER

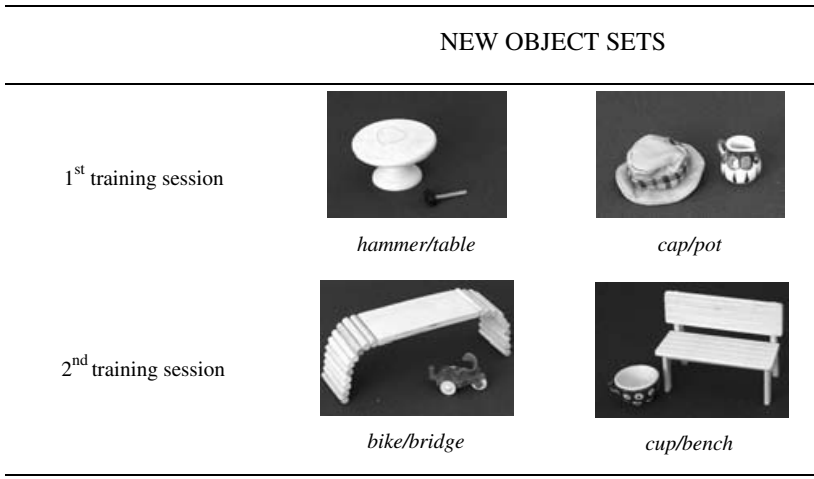

Fig. 3. New objects in the training.

was presented on this construction with the shelf part as the landmark-object (see Figure 4). Every child was asked to *put the ball UNDER the shelf* [*Daj piłkę POD półkę*] at the end of this phase and received different feedback on her or his performance depending on the group.

Finally, new objects were introduced to the children (see Figure 3). The aim of this last activity was to familiarize the subjects with the procedure of the test consisting of presenting new objects and requesting the children to follow the UNDER-relation. After the children's answer to the experimenter's request, i.e. to put one object under the other, different feedback was given to the children depending on their group.

All activities were repeated in the second session of training. As already mentioned above, in both training sessions two children participated simultaneously. It turned out that this solution not only had organizational advantages. In a training situation, in which two children participated, learning seemed to be more natural, as one child could learn by observing the other, and the focus of the experimenter's attention was not on a single 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 also played more with the toys while the other observed more. Interestingly, 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. In short, the naturalness of the training with two children was probably 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.

For the training sessions described above, children were randomly assigned to one of four groups. To each of the groups, a different kind of linguistic input was applied in all training activities. The purpose of the different input groups was to systematically provide additional semantic information about the IN- and ON-relation in order to facilitate the learning process of the preposition UNDER. The features of the input are presented in Table 2.

(1) The input applied to the training group UNDER was neutral, introducing the new relation by showing and labeling. Thus, the group UNDER received linguistic input without a reference to any basic relation, i.e. IN and ON (e.g. *Look, the dog is under the table!*).
(2) In the UNDER-ON condition, the new UNDER relation was introduced by contrasting it with the ON-relation (e.g. *Look, the dog is under the table, not on!*), whereas
(3) In the UNDER-IN group, the experimenter explained the UNDER-space by referring to it as a hollow space and using the IN-relation (e.g. *Look, the dog is in the hole, under the table*).
(4) The control group played with the same toys during the training sessions, but did not receive any instructions.

The design of the instructions in the test session is another important feature of the linguistic input that did not differ across the groups. In Polish, usually not only the preposition specifies the spatial relation, but the verb also includes some additional information.

Example 1	*Wrzuć*	*gruszk-ę*	*do*	*misk-i!*
	[in-throw	the pear-AKK	IN	the bowl-GEN]

In the example (1), in addition to the preposition DO [INTO], which refers to the dynamic IN-relation, the verb's imperative mood *wrzuć* also indicates the direction. To avoid the additional information via the verb, the instructions in this study always began with *Daj* … [Give …]. This formulation is less typical but has the advantage of being semantically neutral with regard to directionality. Other verbs like *Postaw* … or *Połóż* … [Put …] imply a state in which one object is supported by another (e.g. lying on a table) and could thus influence performance.

Test

In the test session on the fourth day, every child was tested – as in the pretest – without another child being present. This session took about ten minutes, and the procedure was similar to the pretest. In order to capture

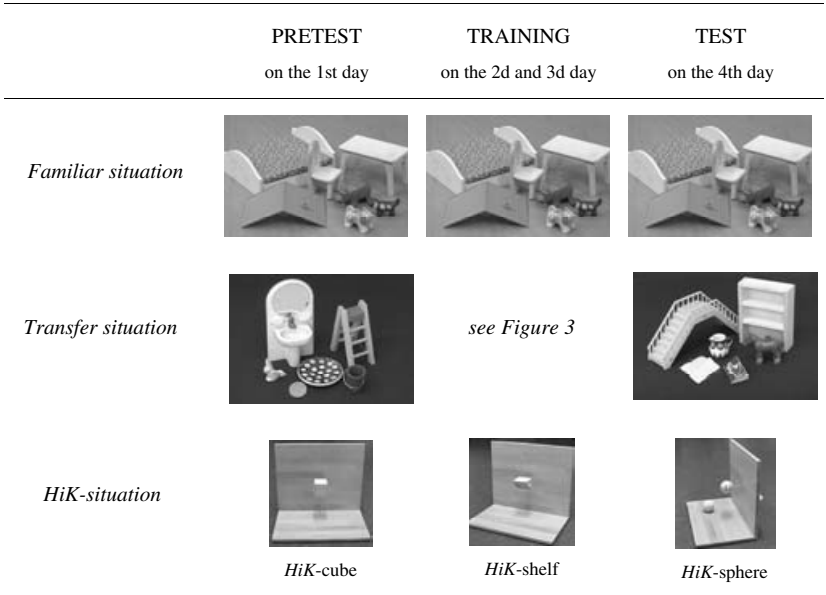

Fig. 4. Objects in different types of situation.

children's learning progress, the understanding of UNDER was tested in three types of situations, which were established by using different types of objects as they are shown in Figure 4.

(1) In the familiar situation, children had received the same objects/toys each session and learned to carry out the UNDER-relation with them.
(2) In the transfer situation, children were given *new* toys at every session; the toys made different relations possible (at least ON and UNDER).
(3) In the *HiK*-situation, a wooden construction with geometrically shaped objects was used (see Figure 2).

As already mentioned, in the wooden construction, the landmark objects are interchangeable. Children were pretested, trained and tested on different landmarks (see Figure 4): in the pretest, the children's performance was tested with the cube. In the two training sessions, the UNDER-relation was initially demonstrated and infants then were able to practice it on the shelf. The shelf was constructed in such a way that it makes an IN-, ON-, and UNDER-relation plausible because it implies both a surface and a hollow space. Finally, in the test, the participants were expected to place a ball in relation to the sphere, which was introduced to the child as 'kula' [sphere]. The test condition was designed to be the most abstract: in

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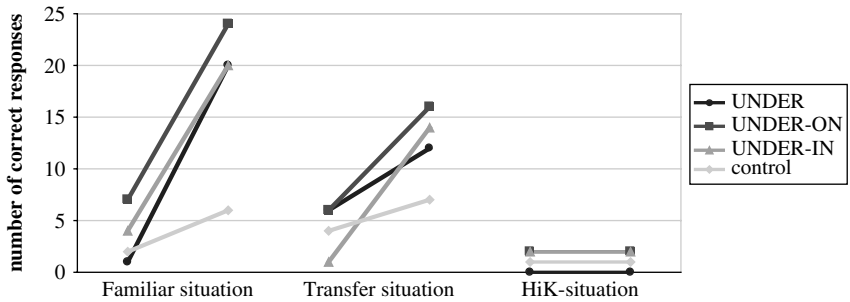

Fig. 5. The pre-/posttest differences in correct responses scored in each group under the training conditions.

contrast to the geometric shapes of the cube and the shelf in the pretest and training, no particular relation is suggested by the sphere. As it has neither a horizontal surface nor is it a container, it implies predominantly such well-known activities as rolling and throwing.

Learners were predicted to perform best in situation (1) that involve familiar objects in trained relationships. Children's ability to extend a novel label was tested in (2) and the performance of the participants was predicted to be lower than in (1). To solve the *HiK*-task (3) correctly it was hypothesized that the learners have to make use of their ability to abstract semantic features of the trained UNDER-relation and to apply them to the presented artificial objects. The children's number of correct responses in the test-performance was predicted to be the lowest in this condition.

Data scoring

A child's correct response to the instruction was scored as 1, otherwise as 0. The responses were then summed across the sets for three different situations. In the familiar as well as in the transfer situation, the maximum possible number of correct responses was three for each child. In the *HiK*-situation, the maximum possible number of correct responses was one, because every child was tested on one set. For the analysis of the training effect between the groups, a pretest–posttest score for each child was computed. These pre-post differences were then compared between the groups.

RESULTS

Statistical results

Figure 5 displays the number of correct responses that were counted in each group before and after the training across situations. A nonparametric

Kruskal Wallis analysis (with a correction for tied values) between subjects was carried out to test children's performance in the pretest, and no significant differences between the groups were found: $H(3)=2{\cdot}46$, $p>0{\cdot}4$. After the training, children's performance in the test differed significantly across the groups: $H(3)=14{\cdot}45$, $p<0{\cdot}01$. The performance in all trained groups was significantly different from the control group when comparing the trained groups combined ($N=28$) to the control group ($N=10$) in overall test performance collapsed across situations: $H(1)=14{\cdot}45$, $p<0{\cdot}001$.

For the analysis of the training effect between the groups, each child's pretest–posttest difference scores were compared between the groups. A nonparametric Kruskal Wallis analysis between subjects shows that the learning effect in the training groups combined ($N=28$) was significant when compared to the control group ($N=10$) in both, the familiar situation, in which learners were tested to perform POD [UNDER] on trained objects ($H(1)=12{\cdot}42$, $p<0{\cdot}001$) and the transfer situation with new toys ($H(1)=5{\cdot}36$, $p<0{\cdot}02$).

No significant differences could be found between the learning effect in the trained groups $H(2)=1{\cdot}209$, $p>0{\cdot}5$. The results suggest, so far, that all types of training were successful in teaching children the preposition POD [UNDER].

However, a paired *t*-test analysis comparing children's scores achieved in the pretest to their performance in the test shows an advantage of those groups who received a semantically enriched input. More specifically, while the *t*-test calculation for the familiar situation reveals that children in all trained groups learned to understand the preposition UNDER [POD], when trained objects were present (UNDER: $t(8)=6{\cdot}01$, $p<0{\cdot}01$, UNDER-ON: $t(9)=4{\cdot}39$, $p<0{\cdot}01$, and UNDER-IN: $t(8)=5{\cdot}49$, $p<0{\cdot}01$), the results for the transfer situation suggest that after the training, the learners of the groups UNDER-ON ($t(9)=4{\cdot}74$, $p<0{\cdot}01$) and UNDER-IN ($t(8)=4{\cdot}91$, $p<0{\cdot}01$) but not UNDER ($t(8)=2{\cdot}0$, $p>0{\cdot}1$) were able to transfer, and thus to extend, their understanding of POD [UNDER] to a situation with new objects. An unpaired *t*-test analysis further shows that in contrast to the learners who received additional semantic information (UNDER-ON: $t(18)=2{\cdot}25$, $p<0{\cdot}05$ and UNDER-IN: $t(17)=3{\cdot}19$, $p<0{\cdot}01$), the learning effect of the participants in the UNDER group does not differ significantly from the learning effect achieved by the participants of the control group: $t(17)=1{\cdot}20$, $p>0{\cdot}2$ in the transfer situation.

As is clear from Figure 5 already, no learning effect could be observed in the *HiK*-situation. Only five of 38 children showed a successful performance in understanding POD [UNDER] during the *HiK*-test. However, these few children had already mastered the artificial transfer situation well in the pretest (4 out of 38). Overall, only one participant

(from the group UNDER-ON) learned to transfer the UNDER-relation to the *HiK*-situation.

These results support the hypothesis that was made for the word learning process, according to which the performance in mapping a label to a familiar situation is best, followed by the number of correct responses in the transfer situation, where a learned label had to be extended to novel objects. The lowest performance was observed in the *HiK*-condition suggesting the highest difficulty level for an extension of a learned label. For this artificial situation, it was hypothesized that children have to make use of their ability to abstract semantic features of the trained UNDER-relation and apply them to the presented artificial objects, which – according to the results – does not seem to be the privileged strategy for understanding at this age.

Consistency in children's performance

In addition to the statistical analysis, the consistency in children's performance was of interest. It was analysed how many children scored 2 out of 3 correct answers in a familiar and how many in a transfer situation. As can be viewed in Table 3, with the exception of one child from the UNDER-IN group, children demonstrated their understanding of UNDER on at least two sets of the transfer situation only if their performance in the familiar situation was outstanding as well. This suggests that the process of extending a word is based on the mapping process.

A subtle effect of the linguistic input was observed in children's incorrect responses in the *HiK*-situation. In this test condition, there is no canonical relation known to the children, and when instructed to put the ball under the sphere, learners from the UNDER and UNDER-IN group reacted with a contact relation, i.e. attached the ball in front of the sphere, so the ball has vertical support only. The UNDER-ON group, in contrast, performed an ON-TOP-OF-relation, so that the sphere supported the ball horizontally. Only two children (out of 10) from the UNDER-ON group performed a contact relation when responding incorrectly to the UNDER-instruction, and conversely out of 18, only two children from the UNDER-IN group performed an ON-TOP-OF-relation when responding incorrectly to the request.

DISCUSSION

The study was designed to investigate the question whether a systematic use of NA [ON] and DO [IN] facilitates the acquisition of the Polish preposition POD [UNDER]. For this goal, two types of linguistic input were designed, in which the UNDER-relation was explained by means of either the preposition NA [ON] or the preposition DO [IN] to the learners

TABLE 3. *Consistency in children's performance in different training groups*

Training group	Familiar situation	Transfer situation
UNDER	+	+
	−	−
	+	+
	+	−
	+	+
	+	−
	−	−
	+	−
	+	−
UNDER-ON	+	−
	+	+
	+	+
	+	−
	−	−
	+	+
	+	−
	+	−
	+	+
	+	+
UNDER-IN	−	−
	+	−
	+	+
	+	−
	+	+
	+	−
	+	+
	+	−
	−	+

(The '+' indicates that the child performed correctly at least on two (out of three) sets from one situational type.)

during the training. In the test, children's learning in four different groups (three trained groups and a control group) was compared. In addition, the effects of training in understanding the preposition POD [UNDER] was tested within subjects in three types of situations. In these situations, objects were presented which differed in their level of familiarity to children.

The best performance in understanding POD [UNDER] was achieved in the familiar situation, where children had to map the learned label to what they experienced before in the training. The results show that children at this age are most sensitive to recurrent situations, and their understanding is based on concrete interactions with objects. Thorseng (1997) refers to similar findings in the production of locative particles. In reference to the effect of facilitation in acquisition of POD [UNDER], however, no differences were found between the different input groups. It can, thus,

be concluded that the process of mapping is neither hindered nor facilitated by providing additional semantic information in terms of NA [ON] and DO [IN].

A challenging task for the children was to transfer their understanding of UNDER-relation to new objects. The ability to transfer their knowledge and extend the new word cannot be reduced to mere imitation as might be suggested for children's performance in the familiar situation. The understanding in the transfer situation is a more complex process: It requires understanding a single linguistic unit (i.e. the preposition POD [UNDER]), implementing an appropriate action (i.e. to find a hollow space or to lift the landmark-object), and resisting the tendency to resort to the canonical relation at the same time. Such behaviour cannot be due to perceptual information about objects alone, but requires the information to be encoded into the knowledge system. In contrast to their performance in the familiar situation, in the transfer situation, the learning effect of the group, which participants receive only the preposition POD [UNDER], i.e. without additional semantic information, seems to be moderate. In this condition, the other trained groups, UNDER-ON and UNDER-IN, seem to take advantage of their training and show a significant learning effect. Thus, when an extension of the preposition to new objects is requested, children can benefit from the additional semantic information about IN- and ON-relations as a basis for learning UNDER.

The statistical results presented above suggest that a number of different processes underlie language learning: processes of understanding based on imitation, i.e. mapping a learned label to a familiar situation, and the ability to transfer understanding to a new situation, i.e. extending a learned label to a new situation. The results shown in Table 3 indicating the children's consistency in their responses point to a hierarchical structure of these processes implying that the extension process is based on the mapping process. However, with the difference in children's performance to new objects and the *HiK*-objects, a difference between the extension tasks becomes apparent: while in both tasks, an extension of a label was required, to extend the understanding of a label to new object seems to be a more feasible task than to extend it to artificial objects. The purpose of the *HiK*-condition was to test the lexical knowledge context-independently, without providing situational cues, and this proved to be the most difficult task for the learners. The results indicate the limits of learning in children of this age, as there was no noticeable learning effect in this situation. According to studies with adults in comparable conditions (e.g. Garrod, Ferrier & Campbell, 1999; Coventry, Prat-Sala & Richards, 2001), it was assumed that in the *HiK*-situation, an abstraction of the features typical for an UNDER-relation is required. These features are probably based on the geometric characterization of a relation, and adults show precisely this

kind of abstraction in a situation that provides little context information about the objects involved. As Coventry, Prat-Sala & Richards (2001) show, adults, like children, also make use of their knowledge about objects when they process spatial relations. But in scenes where there are no object properties of functional relevance, geometric properties alone can still be used for the understanding of spatial terms.

Unlike adults, children at the age of 1;8 to 2;3 seem to struggle with the extraction of geometric features from known objects to objects that are neutral or artificial and provide too limited context to be relevant. Nevertheless, one cannot assume that children of this age are unable to transfer the understanding of UNDER to the *HiK*-situation, because five of the 38 children tested performed well on this instruction and showed precisely this ability. It can only be concluded that children at this age respond more comfortably to a recurrent situation and – as was frequently observed – seek functional cues.

Facing a situation such as *HiK*, where little functional context is provided, it seems that the experience of relationships in the training influences children's behaviour as could be shown by the learners' incorrect responses: children who learned the UNDER-relation by contrasting it with the more transparent relation ON, were more likely to carry out the ON-relation in the *HiK*-situation. The training involving the ON-relation seems to cause the learners to perpetuate the already better understood ON-relation. 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. More systematic research is needed to answer the question of whether the training described has an impact on lexical knowledge about the ON-relation.

The involvement of different processes, such as mapping and two forms of extension, presented here supports the idea formulated in the usage-based model to language acquisition. Accordingly, the linguistic representations that support understanding are viewed as an inventory of symbolic resources, which differ across the level of entrenchment. The understanding of a linguistic expression correlates, thus, with frequency in language use: Expressions that occur with high frequency in performance are more deeply entrenched and can be understood more easily than expressions that are infrequent (see Tomasello, 2000). However, the role of situation as a factor contributing to the process of language acquisition should be emphasized more in the usage-based model, because, as the data presented above shows, the effect of situation is more powerful than the way the linguistic input is provided. Accordingly, when children experience linguistic input, it is mostly in situations in which language is accompanying nonlinguistic events. Thus, it is primarily the recurrent situation including

linguistic and nonlinguistic cues, which makes a performance frequent and thus easy to learn.

REFERENCES

Ahnert, L., Klix, F. & Schmidt, H.-D. (1980). The acquisition of local prepositions in early childhood. *Zeitschrift für Psychologie* **188**, 226–34.

Borkowski, J. G., Levers, S. & Gruenenfelder, T. M. (1976). Transfer of mediational strategies in children: the role of activity and awareness during strategy acquisition. *Child Development* **47**, 779–89.

Bowerman, M. & Choi, S. (2003). Space under construction: language-specific spatial categorization in first language acquisition. In D. Gentner & S. Goldin-Meadow (eds), *Language in mind. Advances in the study of language and thought*. Cambridge, MA: MIT Press.

Carey, S. (1978). The child as word learner. In M. Halle, J. Bresnan & G. A. Miller (eds), *Linguistic theory and psychological reality*. Cambridge, MA: MIT Press.

Clark, E. V. (1973). Non-linguistic strategies and the acquisition of word meanings. *Cognition* **3**, 161–82.

Coventry, K. R., Prat-Sala, M. & Richards, L. (2001). The interplay between geometry and function in the comprehension of *over*, *under*, *above* and *below*. *Journal of Memory and Language* **44**, 376–98.

Dromi, E. (1979). More on the acquisition of locative prepositions: an analysis of Hebrew data. *Journal of Child Language* **6**, 547–62.

Freeman, N. H., Lloyd, S. & Sinha, C. G. (1980). Infant search tasks reveal early concepts of containment and canonical usage of objects. *Cognition* **8**, 243–63.

Garrod, S., Ferrier, G. & Campbell, S. (1999). *In* and *on*: investigating the functional geometry of spatial prepositions. *Cognition* **72**, 167–89.

Geert, P. van (1985). *In, on, under*: an essay on the modularity of infant spatial competence. *First Language* **6**, 7–28.

Grieve, R., Hoogenraad, R. & Murray, D. (1977). On the young child's use of lexis and syntax in understanding locative instructions. *Cognition* **5**, 235–50.

Halpern, E., Corrigan, R. & Aviezer, O. (1983). In, on, and under: examining the relationship between cognitive and language skills. *International Journal of Behavioral Development* **6**, 153–66.

Hespos, S. J. & Spelke, E. S. (2004). Conceptual precursors to language. *Nature* **430**, 453–6.

Jensen de López, K. (2002). Language-specific patterns in Danish and Zapotec children's comprehension of spatial grams. In E. Clark (ed.), *The proceedings of the 31st Stanford Child Language Forum, space in language location, motion, path, and manner*. Stanford: CSLI Publications.

Johnson, S. P. (1998). Object perception and object knowledge in young infants: a view from studies of visual development. In A. Slater (ed.), *Perceptual development: visual, auditory, and speech perception in infancy*. Sussex: Psychology Press.

Johnston, J. R. & Slobin, D. I. (1979). The development of locative expressions in English, Italian, Serbo-Croatian and Turkish. *Journal of Child Language* **6**, 529–45.

McGregor, K. K. (2004). Developmental dependencies between lexical semantics and reading. In C. A. Stone, E. R. Silliman, B. J. Ehren & K. Apel (eds), *Handbook of language and literacy*. New York: The Guilford Press.

McGregor, K. K., Sheng, L., Graham, A., Grohne-Reilly, K. & Keegan, M. (2004). The role of frequency and context in learning the phonology and semantics of words. Paper presented at the Annual Convention of the American Speech, Language, Hearing Association, November, Philadelphia.

Nelson, K. (1996). *Language in cognitive development. Emergence of the mediated mind*. CUP.

Paprotté, W. (1979). Zur Interaktion sprachlicher und nichtsprachlicher Strategien im Erwerb der lokalen Präpositionen *in, auf, unter*. In H. Weydt (ed.), *Die Partikeln der deutschen Sprache*. Berlin: de Gruyter.

Rohlfing, K. J. (2001). No preposition required. The role of prepositions for the understanding of spatial relations in language acquisition. In M. Pütz, S. Niemeier & R. Dirven (eds), *Applied cognitive linguistics I: theory and language acquisition*. Berlin: Mouton de Gruyter.

Rohlfing, K. J. & Choi, S. (2004). Getting you to understand. How mothers instruct their children to put two things together. Paper presented at the annual meeting of the International Association for Dialogue Analysis (IADA 2004), March, Chicago, USA.

Savic, M. & Andjelkovic, D. (2005). Input frequency effects in acquisition of Serbian prepositions from 20 to 44 months. Paper presented at the 27th Annual Meeting of the Deutsche Gesellschaft für Sprache (DGfS 2005), February, Köln, Germany.

Sinha, C. & Jensen de López, K. (2000). Language, culture and the embodiment of spatial cognition. *Cognitive Linguistics* **11**, 17–41.

Sinha, C., Thorseng, L., Hayashi, M. & Plunkett, K. (1999). Spatial language acquisition in Danish, English and Japanese. In P. Broeder & J. Murre (eds), *Language and thought in development. Crosslinguistic studies*. Tübingen: Gunter Narr.

Thiel, T. (1985). Räumliches Denken und Verständnis von Lokativen beim Spracherwerb. In H. Schweizer (ed.), *Sprache und Raum*. Stuttgart: Metzler.

Thorseng, L. A. (1997). Acquisition of spatial relational terms in Danish and English. A cognitive linguistic analysis. Dissertation, University of Aarhus.

Tomasello, M. (2000). First steps toward a usage-based theory of language acquisition. *Cognitive Linguistics* **11**, 61–82.

Wilcox, S. & Palermo, D. S. (1974). ''In'', ''on'', and ''under'' revisited. *Cognition* **3**, 245–54.