

# Language-Specific Patterns in Danish and Zapotec Children's Comprehension of Spatial Grams

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## 1 Introduction

Existing cross-linguistic studies of children's comprehension and production of basic spatial relationships, expressed between two objects, indicate that a considerable degree of similarity exists with regard to the order of acquisition of the grams which, when expressed in English are glossed as: IN, ON & UNDER (Clark, 1973; Wilcox and Palermo, 1974; Johnston and Slobin, 1979; Freeman; Lloyd and Sinha, 1980; Sinha, 1982; Zlatev, 1997; Sinha, Thorseng, Hayashi and Plunkett, 1999; Rohlfing, 2002; Caselli, Casadio and Bates, 2001). Researchers agree that during the process of acquisition of meanings underlying these non-ostensive lexems, pre-linguistic children respond in accordance with either the perceptual salience and affordance offered by the involved landmark<sup>1</sup> (LM) object, or in accordance with the use-based canonical orientation or inherent position of the specific object (Clark, 1973; Freeman, Lloyd and Sinha 1980; Toivonen, 1997). This leads children to adopt the hypothesis that, if the landmark object is a container object, then the trajector object should be placed INSIDE it, while if the landmark object affords a support surface, then the trajector object should be placed ON TOP OF it – and finally if the landmark object affords a hollow non-perceptual space, then the trajector object should be placed UNDER it.

Explanations as to why UNDER is acquired much later than IN and ON suggest that this is due to UNDER relationships being perceptually less salient than IN and ON relationships – e.g. you cannot see a toy hidden under an inverted box, but you are able to see a toy on top of, or inside an inverted box (Rohlfing, 2002). A second explanation is that UNDER relationships do not share the same schematic properties as IN and ON. Hence when IN or ON affording objects are topicalized first, or placed in the target orientation, subsequent placement of the trajector object is straightforward, while for an UNDER configuration the object first needs to be topicalized prior to placement of the trajector object (you cannot place a block UNDER a cup without first manipulating the cup) (Sinha, 1982).

This study addresses the question whether the container-as-topic representation or the canonicity effect (the fact that children tend to put things inside rather than on top of container objects) acts as a universal guide for young children in their initial understanding of spatial relational grams. The second question addressed here consists of investigating whether children's acquisition of the concept of UNDER is only due to conceptual development and to UNDER being organised around the more difficult

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<sup>1</sup> I use the concepts landmark (LM) and trajector (TR) to refer to the two objects involved in a spatial relationship. LM is usually the larger object, and TR the smaller object e.g. the cat /TR object is on the mat /LM object.

“core” meaning of non-perceptual space, or whether language specific partitioning can foster an early comprehension of, and attention to, the notion of a hollow non-perceptual space. This paper is based on the notion that languages vary in the way they refer to spatial relationships and that children are influenced at an early age by these different conceptualisations (Bowerman, 1996). In order to illuminate the above questions two groups of monolingual infants were tested for their ability to comprehend spatial relationships in Danish and Zapotec. Danish is a Germanic language, which relies on prepositions for referring to spatial relationships and for the purpose of this study, can be perceived as similar to English in the way it refers to spatial relationships. Zapotec on the other hand, belongs to the Otomanguean language family, and relies on a small subset of body part locative nouns used for referring to basic relationships (MacLaury, 1989, Jensen de López, 1998; Jensen de López, 2002). Body part (BP) locatives are preposed to the LM NP, their meanings being derived from a metaphorical extension of the human body in an upright position and these refer to a specific region of the landmark object. I provide the following examples in order to illustrate this particular schematisation:

(1) *Bidy quia yuu*

“chicken BP.loc.head house”

The chicken is upper.region.of.three dimensional.object the roof

Glossed in English as *the chicken is on the roof*

(2) *Niz láani cubet*

“water BP.loc.stomach bucket”

The water is inner.region of the bucket

Glossed in English as *the water is in the bucket*

BP locatives are obligatory and often rely on an intrinsic frame of reference (Levinson, 1996) whereby the lexeme remains the same despite the change of orientation of the LM object. Thus, in the case of an upright and canonical oriented basket, where the very lower region is referred to as *LLAAN* (bottom.region) basket, when the basket is inverted into a non-canonical orientation, what now “perceptually” becomes the upper.region of a three dimensional object, is still referred to as *LLAAN dxim* (bottom.region basket). In this case the notion of a metaphorical extension of the human body is overridden by the canonical function of the specific object resulting in an intrinsic rather than an extrinsic or relative frame of reference. The implications for children acquiring the meanings of BP locatives is that they need to be aware of how objects “normally” are used in their specific culture, and parallel to this, be able to construct an abstract and more feature-based category of the physical properties of containment, gravity support etc. which a particular locative gram conflates (Sinha and Jensen de López, 2000).

In Jensen de López’ (1998, 2002) longitudinal analysis of early spontaneous usage of BP locatives, she demonstrated that Zapotec children, similar to children acquiring prepositions, are well on their way to using BP terms by the age of two years. The present study investigates children’s developmental progression in understanding of BP locatives, as well as whether and when in ontogenesis, the particular conceptual system underlying

BP locatives influences non-linguistic strategies of children. The particular method applied, consisted of testing Zapotec children's comprehension of two BP locatives; *LÁANI* "stomach" and *LLAAN* "bottom"<sup>2</sup> and comparing this to Danish children's comprehension of the prepositions I (in), PÅ (on) and UNDER (under). Overall the semantics of Danish and Zapotec conflate different conceptualisations, which make them ideal as a test group for investigating language specific developmental patterns. Zapotec, as opposed to Danish (and English), does not conflate the notion of containment within a separate locative gram. The BP locative, in some cases appears closest in meaning to the preposition IN refers to the notion of inner region. However, this particular notion also differs substantially from IN, as it equally refers to the spatial relationship glossed as *Under* "UNDER" in English and Danish. Thus one main difference between IN / I and *LÁANI* is that *LÁANI* does not profile the orientation of the LM object. These conceptual differences are illustrated in figure 1. Hence the BP term *LÁANI* does not pay attention to the notion of support from gravity or containment, which on the other hand is a central semantic feature expressed by the prepositions IN and I.

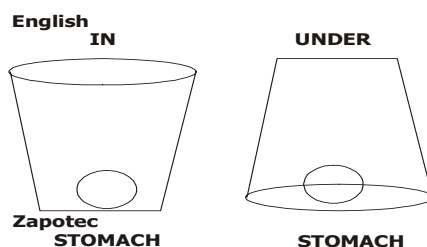


Figure 1: Semantic distinctions between English / Danish and Zapotec

If one follows the Embodiment hypothesis suggesting that the notion of containment forms part of children's universal inventory of spatial concepts, then in the case of the Zapotec term *LÁANI* this would predict that children initially understand *LÁANI* to mean containment only, while later on gradually expanding the meaning to convey the additional meaning of UNDER. On the other hand, a strong linguistic relative view would predict that Zapotec infants start off by understanding *LÁANI* to mean inner.region independent of whether this conflates the notion of containment and gravity support or not. This study sets out to assess whether language specific semantic partitioning of the spatial configurations underlying IN, ON and UNDER configuring locative grams plays a role in the early spatial lexical acquisition of children.

## 2 Method

A total of 104 children aged between 17 to 46 months participated in the study. These consisted of 71 monolingual Danish-speaking children living on mainland Denmark and 33 monolingual Valley Zapotec speaking children (southern Mexican children) living in a small indigenous rural Zapotec community. The material used in the study consisted of one woven basket (the LM object) and one piece of corn.maize (the TR object). The LM object

<sup>2</sup> The decision to focus on these particular two BP locatives was based on the way adult native Zapotec speaker's spontaneously refer to the spatial relationships IN, ON and UNDER when manipulating the material used in the present experiment.

was presented in two alternating conditions 1) an upright and canonical orientation and 2) an inverted and non-canonical orientation. The child was seated facing the instructor and asked to follow instructions given by the instructor. The set of language instructions consisted of three Danish instructions and two Zapotec instructions. Each instruction was presented twice to the child. Once with the basket oriented in its canonical orientation and once in its non-canonical orientation. These two sets of instructions are illustrated in table 1.

Table 1: The Danish and Zapotec language instructions

Danish instructions	Zapotec instructions
1) <i>Læg majs en I kurven</i> “lay.IMP, corn.maize.DEF.- <i>In</i> .PREP.-basket.DEF” Put the corn.maize <u>in</u> the basket.	1) <i>Guluu llub LÁANI dxim.</i> “insert.COMPL corn.maize- <i>stomach</i> .LOC.-basket” Put the corn.maize <u>inner.region</u> the basket
2) <i>Læg majs en på kurven</i> “lay.IMP, corn.maize.DEF.- <i>On</i> .PREP.-basket.DEF” Put the corn.maize <u>on</u> the basket.	2) <i>Bzuub llub LLAAN dxim.</i> “put.COMPL corn.maize- <i>bottom</i> .LOC.-basket” Put the corn.maize <u>bottom.region</u> the basket.
3) <i>Læg majs en under kurven</i> “lay.IMP, corn.maize.DEF.- <i>Under</i> .PREP.-basket.DEF” Put the corn.maize <u>under</u> the basket.	

The spatial configurations produced by the children were coded etically (independent of the semantics of the specific language) and for correctness (dependent on the semantics of the specific language). In order to investigate the developmental progression of the children, the group was divided into the following three age groups: one-year-olds, two-year-olds and three-year-olds.

### 3 Results

The results of the etic coding showed that the Danish children primarily responded by placing the corn.maize IN the basket (44%) followed by ON and UNDER responses. The Zapotec children on the other hand responded with slightly more ON configuring responses than IN configuring responses (36 % versus 34 %). Thus, overall the two groups of children seemed to apply different response strategies to the task. Overall responses by Zapotec children contained fewer errors compared to the responses of Danish children.

#### Responses to I and LÁANI instructions

The two groups of children were compared for their abilities to respond in accordance with the specific semantics expressed by the locatives I and LÁANI. Comparisons of their responses were also made in respect of whether their non-linguistic strategies were influenced by the specific orientation of the basket when responding to the task. When presented to the language instructions in conjunction with presentation of the basket in an upright and canonical orientation, both groups of children responded mainly correctly. However, the correct responses produced by Zapotec one-year-olds consisted of In configuring responses only. When the two language groups were presented with the same instructions, now in conjunction with presentation of the basket in an inverted and non-canonical orientation, the one- and two-year-olds from both language groups differed in

terms of their ability to respond correctly. The main between group differences were visible by the fact that Zapotec children produced relatively more correct response to this trial than Danish children. This was especially noticeable in the two-year-old group. (See figure 2).

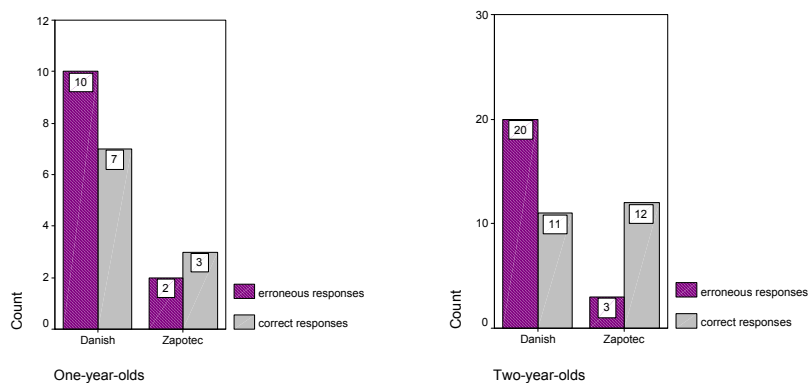


Figure 2: Correct and error responses to **I** and **LÁANI** instructions for the non-canonical trial by language group for the one- and two-year-olds

The difference in performance between the one-year-olds was due to the reliance of the two language groups on different response strategies. Strategies employed by Danish children consisted exclusively of either of the two following strategies; a) a motoric and perceptual guided response in which the child simple placed the TR object on top of the non-canonical oriented basket or b) a language guided or canonicity biased response in which the child turned the basket to its upright orientation and placed the TR object inside it (see figure 3, left-hand diagram). On the other hand, response strategies employed by Zapotec children consisted of relatively less ON TOP OF responses and relatively more UNDER responses than was the case for Danish children.

When analysing the between group responses produced by the two-year-olds in their comprehension of the terms *I* and *LÁANI* for the non-canonical trial, a whole 80 % of the Zapotec children responded correctly compared to only 36 % of correct responses produced by Danish children (see figure 2, right-hand diagram).

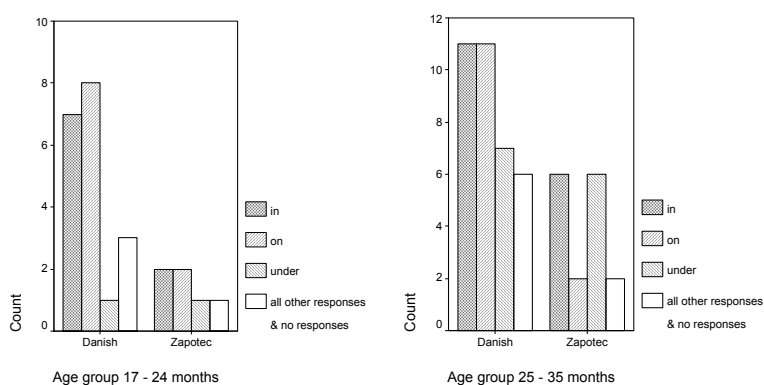


Figure 3: Distribution of the response types IN, ON and UNDER to the non-canonical **I** / **LÁANI** trial by language group and by age group one and age group two

In fact, in this specific test trial, the one-year-old Danish children actually produced slightly more correct responses to *I* instructions compared to the two-year-olds. This may be explainable by the fact that responses of the youngest children were in accordance with an IN bias, which resulted in them simply placing the corn.maize inside the basket. The performance of this task by Danish children gradually became more correct, although even at the age of three only 50 % of their responses were correct in this trial. By comparison 73 % of the Zapotec children responded correctly to this trial.

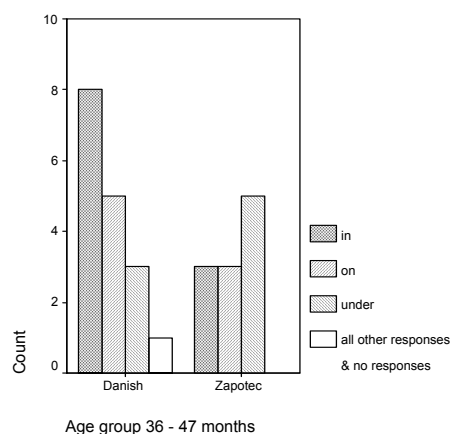


Figure 4: Distribution of the response types IN, ON and UNDER to the non-canonical *I* / *LÁANI* trial by language group

The Zapotec children produced an inverted U-shaped developmental progression in respect of their IN configuring responses to *LÁANI* in the non-canonical oriented basket trial. This was due to the one-year-old children primarily producing IN and ON responses (but also some UNDER responses), while the two-year-olds responded more in accordance with the language specific semantics of the BP locative *LÁANI*, hence taking *LÁANI* to conflate the notion of containment as well as the notion of occlusion or non-perceptual space. Zapotec children at this age therefore mainly produced IN and UNDER responses in the task. By contrast, Danish children mainly produced IN and ON responses, and seemed frequently to apply the easiest motoric and perceptually most salient response. This was less the case for the Zapotec children. Consistent with these different strategies, the three-year-old Zapotec children mainly produced UNDER configuring – (46 % of their responses) compared to IN configuring responses (27 % of responses) to the non-canonical trial condition (see figure 4). This language specific performance was motivated by the semantic partitioning conflated in the body part locative *LÁANI*, which conveyed the notion of an inner.region independent of the notion of gravity support.

These results also suggest that understanding by Zapotec children of the BP locative *LÁANI* gradually altered during development. In the initial stage, the children responded primarily but not exclusively, to *LÁANI* as meaning the inner.region of the basket in its canonical orientation. During stage two the children appeared to have developed a broader understanding of the term, and now responded to it as meaning inner.region of the basket independent of the basket’s orientation, thus including the notion

of a hollow non-perceptual space. Finally, the older children in the test seemed to follow a different strategy in which they primarily responded to LÁANI as meaning inner.region of the LM object involving the occlusion of the TR object. When learning to understand the meaning of LÁANI, the Zapotec children seemed less occupied with the notion of gravity support and more occupied with the notion of a hollow non-perceptual space compared to children who were acquiring the preposition I in Danish. In reviewing responses produced by Danish children, this group of children seemed to include the notion of gravity support, or containment as the main physical attribute of the I preposition expression. These language specific developmental trajectories, relating to children learning to understand the meaning of locative terms, seem motivated by specific semantic partitioning, which each language offered the children during the process of semantic acquisition of these spatial grams.

### Responses to PÅ and LLAAN instructions

The Danish two-year-olds produced significantly more correct responses to the canonical ON trial than to the non-canonical On trial. This was not however the case for Zapotec children. Hence, it was mainly Danish children who depended on the basket being presented in the target orientation in order to respond correctly to the support conflating locative gram at this age. This particular response type is also consistent with the strategy that involved the child relying on the perceptual and easiest motoric response. As in the case of I and LÁANI it was the trial version, requiring the child to first reorient the LM object in order to respond correctly, that provided most information with regard to which, underlying cognitive strategies were employed by each language group when performing the task. For the PÅ and LLAAN instructions this involved a task situation where the basket was presented to the child in a canonical orientation, thus requiring the child to first invert it in order to execute the correct response of placing the TR object on the basket. As in the case of responses to I & LÁANI, the three most dominant response types produced by both language groups to the PÅ/LLAAN instructions were IN, ON and UNDER.

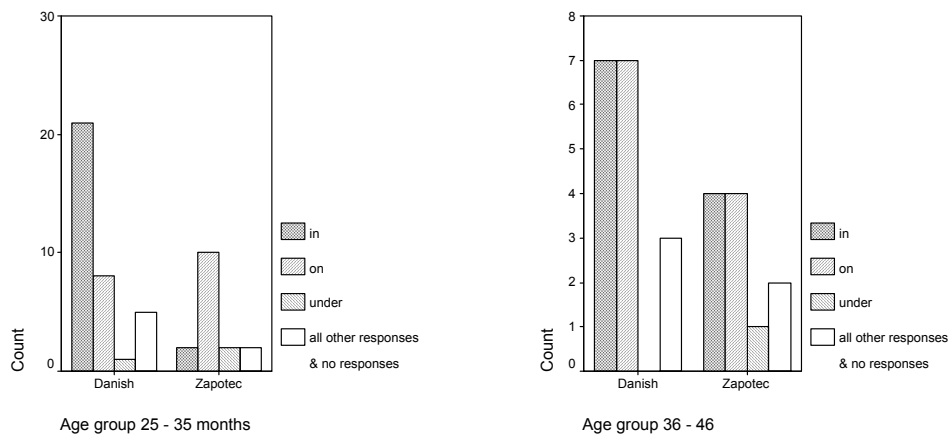


Figure 5: Distribution of the response types IN, ON and UNDER to the canonical PÅ / LLAAN trial by language group and by age group two and age group three

However, it should be noted that not only did the Zapotec children perform significantly better than Danish children when responding to support configuring spatial relational grams, Zapotec children also responded with a more varied set of error types than the group of Danish children tested. Errors produced by Zapotec children consisted equally of placing the TR object IN as well as UNDER the basket, while those produced by Danish children exclusively consisted of IN biased errors resulting in placing the TR object inside the LM object (see figure 5). In fact the Zapotec children frequently produced erroneous responses, which, demanded the most DIFFICULT motoric response rather than the easiest motoric response, as they had to invert the basket first in order to place the corn.maize under it. This particular non-linguistic strategy is contradictory to those reported in the literature for children acquiring spatial relational grams in prepositional languages.

The response pattern of Zapotec children in understanding the meaning of the BP locative LLAAN in the canonical trial condition produced an inverted U-shaped developmental progression. This particular developmental pattern was due to the fact that one-year-olds did not as yet show a preference for any of the three target response types, while the two-year-olds clearly mastered the concept of LLAAN independent of the contextual cues (that is for both trial conditions). Finally the three-year-olds produced errors of the kind IN as well as UNDER (see figure 5, right-hand diagram). A plausible explanation as to why the response strategy of three-year-olds appeared to have changed is that the children now were being influenced by the ongoing reorganisation of the meaning of the term LÁANI, and this may have influenced them to produce these specific types of errors involving the notion of a hollow non-perceptual space. By contrast, the ability of Danish children to respond correctly to the term PÅ in both task conditions gradually improved. Consistent with this the ability by Danish children to comprehend the preposition UNDER improved gradually; though only 36 % of their responses to the canonical (and motoric most difficult task) trial condition were correct at the age of three years.

#### **4 Discussion**

These results indicate that Zapotec children understood the meaning of BP locative grams at an earlier age than children acquiring Danish locative prepositions (and, by implication, locative prepositions in other Indo-European languages). What might be the reason for this? A language typological explanation could suggest that Zapotec BP locatives “offer” the child more transparent and overt information with regard to a specific location than a prepositional language. In accordance with this, an intrinsic frame of reference might be easier for children to understand than extrinsic, or relative frame of reference. The language specific response patterns produced by each group of children, and in particular the different types of errors produced by each of the language groups, also supported the view that acquiring a semantic system calibrates cognition, at least for “understanding” language in a specific way (Slobin; 1996, Bowerman, 1996). With regard to the acquisition of UNDER spatial relationships, the emergence of such an ability may not only dependent on conceptual development. Explanations as to why UNDER is acquired later, which tend primarily to focus on the physical aspects related to the meaning of UNDER such as “perceptually less salient” or “more difficult motoric task” mostly do not take into account



language typology. When provided with transparent semantic cues children may in fact be able to understand the notion of UNDER involving the notion of non-perceptual space at an earlier age than previous research indicates. Thus it may be the case that UNDER is no more cognitively difficult *per se* than other spatial relationships, but that the semantic values conflated in the UNDER lexemes of typical prepositional languages present the child with a more difficult acquisition task. Further cross-linguistic studies can provide answers to these questions. Finally, the particular cross-linguistic differences presented in this study coincide with the response patterns produced by the same group of children to action imitation tasks (Jensen de López, 2002). This suggests that non-linguistic strategies of children are not ONLY the product of language specific semantics isolated from cultural practices, but may equally be due to the fact that spatial entities and their conceptualisations are interwoven with linguistic and cognitive habitus, and material culture (Sinha and Jensen de López, 2000).

## **5 Conclusion**

Children acquiring BP locatives in Zapotec perform relatively better in language comprehension compared to children acquiring Danish prepositions. The most significant developmental differences occurred during conditions when a child was presented with a LM object in such a way, that the child had to orient the object a second time in order to respond correctly. This type of task demanded a more difficult motoric response from the child, but also required that the child abstract from the immediate contextual cues or affordance offered by the LM object. One might thus argue that these tasks required that the child had developed a quite well-elaborated understanding of the respective spatial gram. The Zapotec one and two-year-olds performed better than Danish children in all stimulus trials involving these more difficult test conditions. However these differences had almost disappeared by the age of three years. Both groups of children relied on contextual cues for acquiring the underlying meanings of the spatial configurations IN, ON and UNDER. When responding to the terms I and LÁANI, relatively more Zapotec than Danish children reacted consistently to the notion that the respective spatial gram referred to a hollow non-perceptual space. The Danish children seemed to hypothesize that the TR object should always be placed inside the LM object when this was a container object, while when the LM was presented in an inverted and non-canonical orientation the TR should primarily be placed on top of the LM object, and subsequently underneath it as a last resort. In fact, at the age of three-years relatively similar numbers of Danish children responded with IN responses to the non-canonical trial condition as Zapotec children responding to UNDER responses to this same trial condition.

In acquiring the meaning of the support conflating spatial grams, respectively PÁ / LLAAN, the one-year-olds in both language groups produced nearly equal amounts of correct responses. However, performance by Danish children was slightly better in the non-canonical trial condition, while conversely, performance by Zapotec children was marginally better in the canonical trial condition. Errors by Danish children at the age of two-years consisted of children relying on the hypothesis that the TR object should be placed IN the basket, while errors produced by Zapotec children mainly indicated that they hypothesized that the TR object should be placed UNDER the LM object. Overall, Danish

two-year-olds relied on the perceptual salient, affordance based and easiest motoric cues when responding to PÅ, while responses by Zapotec children to LLAAN did not.

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