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EARLY SHAPING OF SPATIAL MEANING IN THREE LANGUAGES AND CULTURES: LINGUISTIC OR CULTURAL RELATIVITY?

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IT HAS BEEN THE POINT OF DEPARTURE within psychology and linguistics that young children's understanding of spatial meanings is mainly based on a set of universal cognitive principles, which become mapped onto later developed linguistic concepts. Historically this view dates back to Piaget's theory of children's development of spatial cognition (Piaget & Inhelder 1948/1956) and also to his general view of cognition preceding language (Piaget 1926/72). Similarly Eve Clark (1973) suggests, in her study of the comprehension of prepositions by children acquiring English, that perceptual cues are good predictors of what guides infants in their acquisition of the meaning of prepositions. And furthermore infants in the early stage of understanding spatial words universally respond in the easiest motoric way in relation to the task. More recently Clark has explained the strategies relied on by infants in terms of a set of ordered rules that infants follow. The rules are described as follows:

> They (infants) place the small movable objects inside anything that can be treated as a container… and otherwise place it on top of anything that has an extended surface. These choices reflect ordered preferences where containers always take priority over surfaces (Clark 2003:153).

This suggests that if an infant is presented to a container object—such as a cup—in an upright and canonical orientation, the infant will most likely place a smaller object inside it. However, if the cup is presented in an inverted non-canonical orientation, we should instead predict that the infant would place the smaller object on top of it. In Freeman, Lloyd and Sinha (1980), infants similarly showed a preference for containers over surfaces. Clark argues that these non-linguistic strategies determine the order of acquisition of the English locative terms *in*, *on* and *under*. One of our main interests in this paper is to investigate whether this phenomenon is universal across different languages and cultures or whether the specific language being acquired by the child or the specific culture within which the children is acquiring its language play a role in determining the degree towards which an infant follows the rules proposed by Clark.

More recent work carried out by the developmental cognitive scientist Jean Mandler (1991, 1996) also supports the universal view on spatial cognition and language, suggesting that infants possess pre-linguistic, basic conceptual knowledge about distinctions in spatial relations or image-schemata of meaning packages, and that this knowledge is specifically sensitive to support and container relationships.

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The above theories thus assume that universal cognitive processes and principles are responsible for children's development of spatial language and that language for space emerges in transculturally similar environments for action and perception. However, this universal account of the cognitive determination of spatial language development has been criticized and questioned by recent cross-linguistic studies.

Recent studies have stressed that categorization for language use is not universal and that language-specific morphology affects children's developmental pattern, as seen in their spontaneous and elicited spatial language production. Choi and Bowerman (1991) and Bowerman (1996) show that infants develop language-specific lexicalization patterns which are influenced by the linguistic categorization they have been exposed to. Slobin (1996) also argues that the structure of one's language may influence one's thought in 'thinking for speaking' as early as the preschool age. Whorf's linguistic relativity hypothesis (Whorf 1956) is echoed in this recent view that infants tune into the linguistically relevant categories early on.

Furthermore the existence of a universal conceptual inventory necessary for acquiring spatial language would led us to predict that similar error patterns will appear in children's early language production and in the cognitive strategies they apply while learning spatial words. However, evidence shows that children produce few errors and from the onset of acquiring their first language they seem to tune into the semantic categories within the particular language they are learning. This suggests that early language acquisition is less restricted by cognition than proposed and, since language typology shows that languages vary in how they partition the spatial array, children need to be flexible in shaping their cognitive categories to match these linguistic categories.

1. CULTURE IN DEVELOPMENT. Whereas there now exists some work demonstrating the role of language diversity in children's acquisition of language, culture has remained the neglected dimension in understanding how children acquire language. Schieffelin and Ochs (1986) shows that, across different cultures, the means and function of language as an important tool in the early socialization of children vary. However, these cross-cultural differences have mainly addressed the pragmatic aspects of the relationship between language and thought, whereas there has been little consideration, in language acquisition studies, of the cognitive consequences of cultural differences.

In addressing the question of linguistic relativity we thus have yet to learn more about the cognitive consequences of acquiring different languages in different cultures. The approach we take in investigating this aspect is the socio-cultural approach of Vygotsky (1978, 1986), viewing cognition in the context of culture-specific and semiotically mediated social practices. In Vygotsky's view language and culture are most appropriately understood as two sides of the same coin (Sinha & Jensen de Lopez 2000). Jensen de López (2002a, 2002b) recently investigated the development of spatial language and cognition based on a comparison of Danish and Zapotec (a Mexican indigenous language and community) children's comprehension of spatial language. The results show that Zapotec children perform better in comprehending *in*-, *on*- and *under*-configuring spatial relationships than Danish children do. This difference was in part due to the fact

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that the two languages rely on very different semantic structures. While Danish uses prepositions to designate where objects and people are located, Zapotec relies on body-part regional nouns (Jensen de López in press a), which seem to be more transparent in their meanings than prepositions are in Danish. The Jensen de López study also identifies important cultural differences, which like the language-specific explanation, may help us understand the differences in the performance of the two groups of children (Jensen de López in press b).

In relation to the set of ordered rules proposed by Clark, Zapotec children do not seem to rely on theses rules to the same degree as Danish children do. Whereas Danish children overall did treat the container object as a putting-things-inside object, the Zapotec children proved just as likely to treat the respective object as a putting-things-on-top-of or a putting-things-underneath object. However, because language structure and culture practices mutually influence infants' conceptual development, it was unclear whether it was the language structure per se, the cultural practices, or both which were influencing the Danish and Zapotec children to perform in different ways.

One methodological reason why no clear answer could be given was that the study included two languages and two cultures only. In order to discover whether culture, as well as language, influences the cognitive or non-linguistic strategies children use to comprehend spatial language, we need to study at least three languages and cultures. In the present study Japanese was added in order to control for these variables. Before we present our predictions we describe the three languages and cultures forming part of the study.

2. THREE LANGUAGES AND CULTURES.

2.1. THE LANGUAGES. The three languages studied, Danish, Japanese and Zapotec are presented in the following. Danish is a Germanic language and of the three languages is most similar to English. Danish predominantly uses prepositions to refer to the location of things and people. The different spatial relational words conveying the notion of what in English is expressed as *in*, *on* and *under* spatial relationships can be seen in **Figure 1a** (overleaf). The figure illustrates the four main spatial relational configurations one can carry out with a container object (in this case a basket). The figure shows that the Danish preposition *under* 'under' conveys the meanings depicted by two of the configurations. Danish uses *under* to convey the location of an object underneath a basket while in a canonical upright orientation, as well as when the basket is positioned in a non-canonical, inverted orientation. The meanings of *i* 'in' and *på* 'on', on the other hand, only convey one of the four configurations illustrated in **Figure 1a**.

Although there is not yet a consensus as to the origin of the Japanese language, many linguists assign it to the Altaic language family. The spatial configurations *on, in* and *under* are typically lexicalised in Japanese by the three relational locative nouns, *ue*, *naka* and *sita*, respectively (see **Figure 1b**, overleaf). *Naka* mainly denotes inner regions of landmark objects. The meaning of *sita* 'lower region' is shared by the configuration of an object underneath a basket whether in canonical and upright or in

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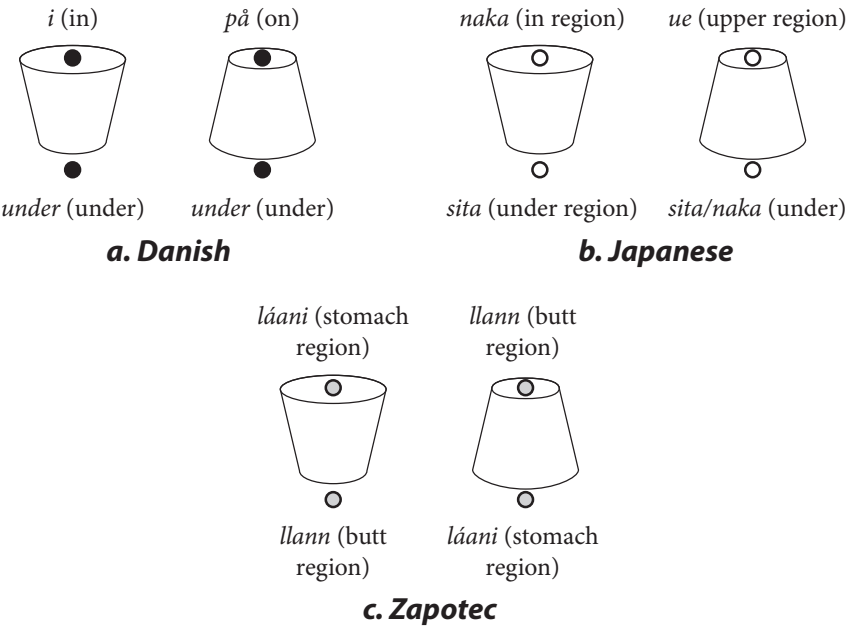

Figure 1. *The four prototypical spatial relational configurations available with a basket glossed for Danish, Japanese and Zapotec.*

noncanonical and inverted orientation. The notion of *ue* 'upper region' conveys the configuration of a support relationship.

Zapotec, which is an Otomaguean language, uses bodypart locative nouns, which are preposed nominals (Jensen de Lopez 2002a; Jensen de Lopez in press a). As in Japanese, these bodypart locatives refer to the region of a landmark object. The meaning of a bodypart locative in Zapotec is mainly derived from metaphorical extensions of the human body in an upright orientation (MacLaury 1989). However, in some cases, as in the case of *llaan* in **Figure 1c**, the meaning of a bodypart locative is motivated from usage of an intrinsic frame of reference (Levinson 1996). Zapotec uses two bodypart locative nouns to convey the four spatial relational configurations depicted in **Figure 1c**, namely *láani* 'stomach region' and *llaan* 'butt region'. Each bodypart noun thus conveys two of the depicted configurations. If we compare the particular word class used to refer to the location of objects and people in each of the respective languages, we notice that Japanese and Zapotec both use nominals to refer to regions, whereas Danish uses prepositions.

2.2. THE CULTURES. Both Denmark and Japan are highly industrialized cultures, whereas Zapotec is a remote, rural agrarian culture situated in the mountains of southern Mexican state of Oaxaca. The Zapotec culture also differs from the Danish and Japanese cultures in that it offers a smaller variety of different objects. Thus, in the Zapotec culture

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objects are used with multi-functional purposes. This can be contrasted with the Danish and Japanese cultures, where many objects serve one specific function only, and are conventionally used with uni-functional purposes (Jensen de López, in press b).

When acquiring the full meaning of words for spatial relations, children rely on contextual and perceptual cues, including what they know objects are used for canonically. We need to take this notion into account when investigating children's understanding of words expressing spatial relationships. According to Clark's (1973) ordered rules, infants learning language may presume that when presented with a container object accompanied by a language instruction, the instruction probably will indicate that something should go inside the container rather than on top of or underneath it. However, if infants—as in the case of Zapotec children, through practice and observation, are accustomed to container objects equally likely to be used in an inverted orientation serving the purpose of covering something or constraining an object, they may not presume that container objects are exclusively for placing things inside. The following study addresses this issue in a preliminary analysis of Danish, Japanese and Zapotec infants' comprehension of instructions involving spatial relations using the configurations expressed in English as *in*, *on* and *under*.

In the Jensen de López (2002a) study the Zapotec children performed better than the Danish children in comprehending *in*, *on* and *under* configuring words. Jensen de López suggests that Zapotec bodypart regional nouns may be more transparent in their meanings than prepositions are in Danish. The Zapotec children also overall treated the container object differently than Danish children did. Jensen de López explains this as partly due to the role played by the Zapotec culture, in which people follow a general, multi-functional approach to objects and artefacts. We follow the line of the Jensen de López study and predict as follows.

1. If we assume that Zapotec bodypart nouns are more transparent than Japanese locative nouns, we may then predict that Zapotec children will perform better than Japanese children in comprehending *in*, *on* and *under* configuring words.
2. If we assume that the Japanese culture is like the Danish culture, in which many objects are uni-functional, we may then predict that Japanese children, like their Danish counterparts, should generally treat a container-object as a putting-things-inside object.

This set of predictions converges language acquisition into the act of learning the meaning of words through being a cultural participant and is consistent with Vygotsky's view. In order to validate these predictions we tested the three groups of children on their abilities to comprehend basic spatial relational instructions within their respective languages.

3. THE STUDY.

3.1. PARTICIPANTS. A total of 145 children participated: 71 Danish, 48 Japanese and 26 Zapotec. All the children were monolingual children living in their respective countries.

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	Danish (N = 71)	Japanese (N = 48)	Zapotec (N = 26)
Age	30 months	32 months	31 months
Range	17–40 months	21–42 months	17–46 months
Std. Deviation	6.97	5.79	8.77

Table 1. *Mean range and standard deviation of ages for the three groups of children.*

The mean range and standard deviation of the three groups are presented in **Table 1**. There were no between-group differences in age distribution (Kruskal-Wallis test).

3.2. PROCEDURE. The three groups of children were presented with a language comprehension task in which they were told to place a piece of corn-kernel[2] either *in*, *on* or *under* a basket which was presented to the child in two conditions: a) a canonical upright orientation and b) a non-canonical inverted orientation. The following examples show how the lexicalization patterns of the three languages differ in how each of them renders the English utterance 'put the corn kernel on the basket':

(1) Danish: *læg* *majsen* *på* *kurven*
lay.IMP corn.the PREP basket.the

(2) Japanese: *botan* *o* *kago* *no* *ue* *ni* *oite-kudasai*
button ACC basket GEN LOC.N LOC.PAR put.IMP

(3) Zapotec: *bzuub* *llub* *llaan* *dxim*
lay.COMPL corn BODYPART.LOC basket

Each response was coded in accordance with the end-state of the child's action, and coded language-independently. The data was analyzed for comparison of the proportion of correct responses and for comparison of the types of cognitive strategies reflected in the main error pattern produced by each language group.

4. THE RESULTS. The Zapotec children produced a greater proportion of correct responses than the Danish and Japanese children. This pattern was present in both experimental conditions, the canonical/upright and the non-canonical/inverted condition. **Table 2** shows the distribution of correct responses across the three language groups. The children's failures to respond to the task were excluded from both analyses.

Overall, the three groups of children were homogeneous in that they all responded by primarily placed the corn kernel inside, on top of or underneath the basket. The Zapotec children were the only group performing at a ceiling level, and this was to the *láani* instruction, when the basket was presented in the upright condition. They also performed better than the Danish and Japanese children on these items, when the basket was presented in inverted condition, although they were not at a ceiling level. The Japanese children as a group produced the lowest proportion of correct responses,

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Trial condition	Danish children			Japanese children			Zapotec* children		
	i	*på*	*under*	*naka*	*ue*	*sita*	**láani*	*llaan*	**láani*
Upright	91%	26%	16%	85%	38%	6%	100%	50%	100%
Inverted	41%	88%	45%	45%	68%	9%	70%	87%	70%

Table 2. *The distribution of correct responses in % by trial and for each nation. *Because the Zapotec bodypart noun* láani *(stomach region) conflates the notion of inside an upright basket and under an inverted basket, the Zapotec children only received 4 trials.*

Error Type	Danish	Japanese	Zapotec
In-errors	**23%**	20%	7%
On-errors	11%	**16%**	7%
Under-errors	3%	1%	**15%**

Table 3. *The three dominant error types across the language groups (% errors of all the responses).*

and this was in response to the *sita* instruction, where only 6% of their responses were correct in the upright condition and 9% correct in the inverted condition.

We were also interested to know how the three groups of children responded to the task independently of whether they were able to respond correctly. We find that children's response strategies are informative about their cognitive strategies in a different way than correct responses are. In order to appreciate the cognitive strategies underlying children's response patterns, one needs to look at the types of errors produced by each of the language groups. We suggest that an analysis of error patterns may serve as a window into the particular cognitive strategies applied by children.

4.1. ERROR PATTERNS. Consistent with the results of the analysis of correct responses, the three language-groups predominately produced errors of the type putting the corn kernel inside the basket, on top of or underneath the basket in an inverted orientation. We analysed each of these three error types, comparing the proportion of errors produced by the three language-groups. The results are depicted in **Table 3**. Once more, these results represent proportions of errors where the children's failures to respond have been excluded.

For the *in*-errors we found that the Danish and Japanese children produced relatively similar amounts of this error type and they produced significantly more in-errors than the Zapotec children did, p=.01 on a Kruskal-Wallis test. For the *on*-errors we found that the Japanese children produced significantly more errors of this type than the Danish or the Zapotec children did. The difference between the frequency of *on*-errors produced by the Japanese and Zapotec children was highly significant, p=.00 on a Mann-Whitney U test, and the Danish and Zapotec children approached significance, p=.07 on a Mann-Whitney U test. Finally the differences between the relative

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frequencies of *under*-errors produced by the three language groups showed a reversed pattern in that the Zapotec children produced significantly more errors of this type compared to the Danish and Japanese groups. The difference between the Zapotec and Danish children was significant, p=.01, and for the Zapotec and Japanese children, the difference was significant at p=.00 on a Mann-Whitney U test. The Danish and Japanese children did not differ in the relative proportion of *under*-errors they produced. Hence, each of the language groups seemed to have developed a particular 'preference' concerning the dominant error type the children primarily engaged in while responding to the task. The Danish children mainly produced errors that consisted of placing the corn kernel inside the basket, while the Japanese children, although the Japanese children also produced a relatively high proportion of the error type consisting of placing the object on the surface region of the inverted basket. Finally the Zapotec children produced at higher preference for the error type consisting of placing the corn kernel underneath the inverted basket compared to the other two groups.

5. DISCUSSION AND CONCLUSION. From this cross-cultural and cross-linguistic study of children's early comprehension of the spatial relational instructions of placing an object in, on or under a basket across three different languages, we found that Zapotec children acquiring bodypart locatives performed better than Danish children acquiring prepositions and Japanese children acquiring locative nouns. Thus our first prediction that Zapotec children perform better than Japanese children in comprehending *in*, *on* and *under* configuring words receives support. Furthermore, the Danish and the Japanese children differ considerably across the *under* and *sita* trials. The Danish children performed better in comprehending *under* than the Japanese children did in comprehending *sita*. *Sita* thus seems to be more difficult to comprehend in acquisition than the Danish preposition *under* and the Zapotec bodypart locative *láani*.

The three groups of children also showed different error patterns. First, Zapotec children, unlike the Danish and the Japanese children, produced a higher proportion of the error-type of placing the corn kernel under the inverted basket. The error pattern produced by the Zapotec children may be explained as motivated by the fact that *láani* 'stomach region' conveys the notion of inside as well as under and is not constrained by the notion of support from gravity. This semantic overlap may influence the children to produce more errors of the type *under* as opposed to the error pattern of placing the corn kernel inside or on top of the basket. However a language-specific explanation does not account for why Danish children produce *in*-errors or why Japanese children mainly produce *on*-errors more frequently than the remaining two language groups. In the Danish and the Japanese cultures, on the other hand, baskets are usually used as containers in an upright orientation, which may explain the frequency of *in*-errors produced by children from these two industrialized cultures relative to Zapotec children from a non-industrialized culture. This is in accordance with our second prediction.

When looking closer at the data in order to explain why the Japanese children produced *on*-errors relatively more frequently, we notice that this was specifically to the instruction of placing the trajectory object in a *sita* relationship with the basket, when

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this was presented in the noncanonical and inverted orientation (Hayashi, 2001). This specific trial received the fewest correct responses from the Japanese children suggesting that they found it difficult to understand the meaning of *sita*. They compensated for this by placing the trajectory-object on top of the inverted basket, which is the easiest motoric solution. In other words, the Japanese children's frequent *on*-errors might be due to the specific problem presented to them in acquiring the meaning of *sita*.

The study supports the view that children bring to the language learning task prior experience of the social usage of everyday objects and may rely on this experience in acquiring the categories and meanings conveyed by language. It also supports the view that language structure is an important influential factor in learning a language. However more cross-cultural and cross-linguistic research is warranted. In short our study is in accordance with Vygotsky's socio-cultural approach to language learning.

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[2] In the Japanese experiment the corn-kernel was substituted for a button.

[3] One should be cautious in comparing the meaning of spatial words across typologically different languages and drawing conclusions as to which group of children acquires spatial words earliest. In other word it is important to keep in mind that the task of the children simply may vary, as does the typology of their language.

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