Space in semantic typology: Object-centered geometries[*]

Jürgen Bohnemeyer and Randi Tucker
Department of Linguistics, University at Buffalo - SUNY

1. Introduction

In this chapter, we introduce and discuss the hypothesis that the pervasive use of shape-based meronymy as a resource for the expression of spatial relations in a language may bias its speakers against the use of relative frames of reference (FoRs). This hypothesis is currently being tested in the project "Spatial Language and Cognition in Mesoamerica" (MesoSpace). The Mesoamerican linguistic area is the starting point for our investigation because of the preliminary evidence for highly productive meronymies (MacLaury 1989; Levinson 1994; *inter alia*) and the disuse (Brown & Levinson 1992) or non-dominant use (Bohnemeyer & Stolz 2006) of relative frames. Using a battery of tools, the MesoSpace researchers have been probing frame use and the productivity of geometric meronyms in 13 indigenous languages of the Mesoamerican area, two non-Mesoamerican indigenous languages spoken nearby, and several varieties of Spanish. Here, we present preliminary evidence from just one language of the sample, Yucatec Maya. The Yucatec data indicate a fully productive meronymy for surfaces and one of somewhat more limited productivity for volume parts. In line with our hypothesis, intrinsic uses of the surface meronyms dominate.

1.1. *Semantic typology*

Semantic typology is the crosslinguistic study of semantic categorization – the study of uniformity and variation in how given contents are represented across languages. The extent and nature of variation in semantic categorization remains an open question in contemporary linguistics. Some view linguistic categorization as a mapping of a largely universal conceptual space into grammars and lexicons which vary only superficially across languages (e.g., Pinker 1994; Li & Gleitman 2002). Others assert that there is no crosslinguistic uniformity in semantic categorization except perhaps at the most abstract levels of analysis (e.g., Levinson 2003a; Evans & Levinson 2009). The discrepancy between these positions is the result of sparseness of empirical evidence combined with the biases of universalists and relativists. Relativism is the idea that cognitive representations are to a significant extent culture-specific, learned, and social rather than individual. Conversely, universalism assumes that cognitive representations - or at least core components of them – are culture-independent and possibly innate. Thus the relativism-universalism debate is one contemporary manifestation of the age-old nature-nurture debate. Along with cognitive psychology and the study of linguistic and cognitive

[*] The research presented in this chapter was fully supported by the National Science Foundation (award # BCS-0723694). We would like to thank the Yucatec speakers who participated in the studies reported on here. The presentation has benefited from helpful comments and discussion by the participants of the FRIAS Workshop *Grammar, space and cognition*, the members of the MesoSpace project, and the members of the semantic typology lab at the University at Buffalo. Special thanks to Gabriela Pérez Báez, who designed the Novel Objects stimuli and produced the Ball & Chair stimuli and prototypes of the Novel Objects.

development, semantic typology opens one of the few empirical windows onto the relativism-universalism debate.

A precursor of semantic typology is the research into the lexicalization of concepts of the natural world, in domains such as color, kinship, and ethnobiology, conducted by cognitive anthropologists and ethnosemanticists since the 1950s. Much of this work has been undertaken by proponents and opponents of the Linguistic Relativity Hypothesis (LRH), to lay the ground work for empirical tests of the LRH by charting the possibility space for "Whorfian" effects of language-specificity in nonlinguistic cognition. The LRH is but one aspect of the overarching question of relativity, or culture-specificity, in language and cognition: which properties of language and (non-linguistic) cognition are universal and innate and which properties are learned and culture-specific? The question of relativity in language and cognition has been one motivating factor driving research in semantic typology. A second, equally important objective of semantic typology is the search for universals and crosslinguistic variation in the principles governing the syntax-semantics interface. A methodological canon for semantic typology was first explicitly stated in the 1990s by the members of what is now the Language and Cognition group at the Max Planck Institute for Psycholinguistics. This method employs non-verbal stimuli such as pictures, videos, and toys to represent the conceptual distinctions of interest. Semantic categorizations – preferred descriptions and ranges of possible descriptions – of these stimuli are collected in samples of unrelated and structurally broadly diverse languages by administering a standardized protocol to sufficiently large populations of speakers of each language. Early precursors of this method were questionnaire studies dating back as far as the 19th century. Modern pre-Max-Planck-Institute studies include the World Color Survey conducted in the 1970s (Kay et al. 2009). Uniform patterns in the resulting data are attributed to species-specific properties of cognition, which in turn may be interpreted as directly or indirectly – mediated by neurophysiology – biologically grounded. The underlying assumption here is that there is no genetic variation in human populations that affects cognition – so far, none has been attested. Consequently, crosslinguistic variation in a particular property of semantic categorization is interpreted as evidence that the property in question is culture-specific and learned.

1.2. *Linguistic relativity and causal factors in frames-of-reference use*

Until recently, it was universally taken for granted by linguists and cognitive scientists that the use of spatial frames of reference is innate and does not vary with language and culture. All human populations were assumed to show the same bias in favor of egocentric, relative representations found in speakers of English or Japanese. In the late 1970s, the first reports emerged indicating that Aboriginal people of Australia tend to make almost exclusively use of geocentric, absolute frames. Crosslinguistic research on this phenomenon began in the 1990s. It was quickly discovered that there is in fact a bewildering array of different kinds of frames across human populations, often modeled, for example, after local topographic features such as mountain slopes or the courses of rivers. It became apparent that there is enormous variation across cultures in terms of which reference frames their members prefer for solving a given task. And this variation was found to have profound consequences for spatial cognition. Frames of reference are not mutually translatable: if one remembers a ball exclusively as being 'west of' a chair, this will not allow one to determine later where it was with respect to the

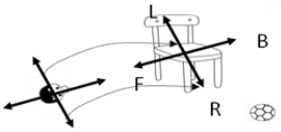
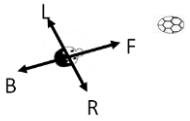
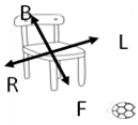
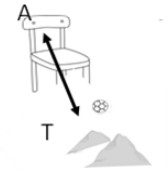
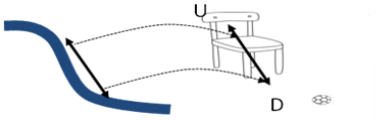
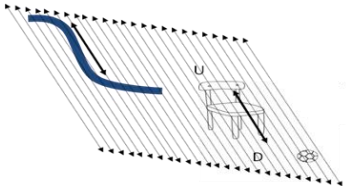
chair from the perspective of the observer. Conversely, if the location of the ball is remembered in egocentric terms, its location in absolute or geocentric space cannot be inferred from this representation. Consequently, people tend to memorize spatial information in the same frames they prefer to communicate it linguistically.

These findings raise important questions about the boundary between innate and cultural knowledge in spatial cognition and the relationship between spatial cognition and language. In order to be able to address these questions, it is vitally important to survey the linguistic systems and cognitive styles used by the speakers of different languages according to standardized scientific methods and protocols. This is the job of semantic typology, a subfield of linguistic typology. The members of the research project *Spatial language and cognition in Mesoamerica* ("MesoSpace"; NSF Award # BCS-0723694) have been undertaking the largest and most comprehensive survey of the use of spatial frames of reference in a large multilingual and multicultural geographic area to date. In doing so, they have also pioneered the application of methods of semantic typology to such an area. This areal approach to typology opens up unique opportunities for isolating linguistic, cultural, and topographic/environmental factors influencing spatial cognition.

A growing controversy has arisen around the demonstration in Levinson (1996, 2003a) and Pederson et al. (1998) of a robust crosslinguistic alignment of strategies used in the computation of spatial representations in language, recall memory, and spatial inferences. The perspectives or viewpoints of such representations – technically frames of reference (FoRs) – fall into a number of distinct types. Cultures differ in the types their members make use of and prefer in particular contexts. Reference frames are coordinate systems used to identify places (in the sense of regions) and directions, often with respect to some reference entity or **ground**. Various classifications of frames have been proposed. In the psychological literature, a distinction among **egocentric** (or "viewer-centered"), **intrinsic** (or "object-centered"), and **geocentric** (or "environment-centered") frames is widely used (e.g., Carlson-Radvansky & Irwin 1993, 1994; Carlson-Radvansky & Logan 1997; Li & Gleitman 2002; Mishra, Dasen, & Niraula 2003; Wassmann & Dasen 1998). The basis of this distinction is what Danziger (2010) calls the **anchor** of the frame: some entity or environmental feature which defines the axes of the coordinate system. In egocentric representations, the anchor is the body of an observer. In intrinsic representations, the ground functions as anchor, and in geocentric ones, some environmental entity or feature does. Levinson (1996, 2003a) has proposed a different classification on the basis of evidence from language typology. These two classifications are often misunderstood as terminological variants; they in fact group FoRs quite differently. Table 1 below exemplies these differences. Levinson's **relative** type singles out exclusively those egocentric representations in which the ground is distinct from the observer's body. 'The ball is left of the chair' is relative on Levinson's classification, but 'The ball is left of me' is intrinsic. And Levinson's **absolute** type includes only those geocentric frames whose axes are *abstracted* from some environmental gradient or feature and provide bearings treated as fixed throughout the totality of space. So 'The ball is uphill of the chair' counts as absolute if 'uphill' is understood to denote an abstracted direction vector that remains constant regardless of the actual location of ground or observer vis-à-vis the hill, and as intrinsic otherwise. Any frame that is neither relative nor absolute is classified as intrinsic. This classification is justified by crosslinguistic evidence: while all languages have both egocentric and geocentric frames, many languages lack

relative frames, absolute frames, or both (Pederson et al. 1998; Levinson 2003a; Levinson & Wilkins 2006).

Table 1. Reference frame types and their classification (A - 'away from', B - 'back', D - 'downriver', F - 'front', L - 'left', R - 'right', T - 'toward', U - 'upriver')

frame type	constraint on anchor	example	Illustration	Levinson 1996	Psychology
relative	the body of an observer (speaker, addressee, or generic)	*The ball is right of the chair*		relative	egocentric
direct		*The ball is in front of me*		intrinsic	
intrinsic	the ground	*The ball is in front of the chair*			intrinsic
landmark-based	a salient environmental entity/feature	*The ball is mountainward of the chair*			geocentric
geo-morphic		*The ball is downriver of the chair*			
absolute	(abstracted from) a salient environmental entity/feature	*The ball is downriver of the chair*		absolute	

Pederson et al. (1998) show that a bias for relative or absolute frames in discourse among the speakers of a language predicts a bias in the same direction in recall memory and placement inferences. They suggest that language may be a causal factor in this alignment. Given that frame use is more varied across populations than within, communities must have some mechanism that allows their members to converge on the same preferences. A population's patterns of frame use form a cultural *habitus* that, like all procedural cultural knowledge, can only be transferred across generations through observable behaviors such as speech and gesture. But Li & Gleitman (2002) argue against the view of the population-specific reference frame profile as a *habitus* transferred through language. Levinson and colleagues view the cognitive ability to learn any frame as innate, but the actual use of a particular frame

type as learned and its mastery as requiring habituation over significant periods of time (Levinson 2003b). In contrast, in Li and Gleitman's account, all types of FoRs are innately available across populations and the observed population-specific preferences in frame use in both language and internal cognition are driven exclusively by variation in literacy, education, population geography, and topography. These preferences are superficial and readily mutable in response to changes in the factors mentioned. To demonstrate this, Li and Gleitman attempted to show that environmental manipulations can induce American college students to memorize spatial arrays in geocentric terms. In response, Levinson et al. (2002) argue that the geocentric responses in Li & Gleitman (2002) are intrinsic, rather than absolute, so their occurrence in English speakers is unsurprising. Moreover, Li & Gleitman failed to show that the use of linguistic strategies adapts as fluidly to contextual changes as the use of memory strategies. Similarly, Li et al. 2011 report the use of egocentric frames in the recall memory of Tseltal speakers from Tenejapa, Chiapas, a population shown to favor absolute frames and disuse relative ones in both discourse the internal cognition in Brown (2006), Brown & Levinson (1992, 1993), Levinson (1996, 2003a), and Levinson & Brown (1993). However, Li and colleagues' egocentric responses can again easily be reconstructed as intrinsic rather than relative, and there is again no test of corresponding linguistic representations. Abarbanell & Li (2009) present evidence seemingly confirming cognitive effects from lesser familiarity with relative frames in adult Tenejapans. However, although the specific hypotheses of Li & Gleitman have so far not been successfully tested, the broader question these scholars raised remains valid: are the different biases for types of reference frames found across different populations influenced by language or are they exclusively the result of cultural factors?

1.3. *MesoSpace*

The MesoSpace team is currently studying linguistic and non-linguistic factors involved in the use of spatial reference frames in 15 indigenous languages of Mexico, Guatemala, and Nicaragua. The language sample of the project consists of 13 languages of the Mesoamerican (MA) *sprachbund* (Campbell et al. 1986) and three non-MA "controls" spoken in the same geographic region. The MesoSpace sample includes members of four of the eight branches of the Mayan language family, represented by Chol (J. Vázquez), Q'anjob'al (E. Mateo), Tseltal (in three distinct communities; G. Polian), and Yucatec (J. Bohnemeyer (PI)). The three branches of the Mixe-Zoquean family are represented by Ayutla Mixe (R. Romero), Sierra Popoluca (S. Gutiérrez), and Tecpatán Zoque (R. Zavala). The Otomanguean language family is represented by Otomí (N. Green, S. Hernandez, E. Palancar) and Isthmus Zapotec (G. Pérez Báez). Huehuetla Tepehua (Totonacan; S. Smythe) and Purepecha (or Tarascan, an isolate; A. Capistrán) are likewise included in the sample. The Uto-Aztecan language family is represented by Pajapan Nawat (V. Peralta) and Meseño Cora (V. Vázquez), which is considered MA in Smith-Stark (1994), but not in Campbell et al. (1986). Seri (studied by C. O'Meara), a language of uncertain affiliation, spoken more than 1000km northwest of the Meseño Cora area, is included in the sample as a control to isolate possible areal features. There is no evidence of contact between Seri and MA languages, and yet Seri shows some of the traits of MA languages, such as dispositional roots (O'Meara 2010). With the same rationale, Sumo-Mayangna, a Misumalpan language of Nicaragua spoken some 350km to the east of the southernmost MA languages, was added as a southern control. The language is studied by E. Benedicto and A. Eggleston. Spanish

serves as a baseline because of its ubiquitous status as a socially dominant contact language in the MA area. So as to be able to detect possible substrate influences, three distinct varieties of Spanish are being compared: Mexican Spanish, recorded by R. Romero, and Nicaraguan and European Spanish, recorded by E. Benedicto and A. Eggleston.

MesoSpace focuses on two unusual traits of spatial reference in Mesoamerican languages: i) the widespread absence or paucity of use of relative frames and ii) the highly productive use of 'meronymic' terminologies for object parts and spatial regions based primarily on object geometry. With regard to the former, the question is to what extent the non-linguistic predictors proposed by Li & Gleitman – topography, population geography, education, and literacy – as opposed to the linguistic factors of contact with and bilingualism in Spanish are capable of boosting the use of relative frames in communities and in individual speakers. And as for meronyms, the project aims to test the hypothesis that the pervasive use of geometric meronyms in the expression of spatial relations is a linguistic factor that biases the speakers of a language against the use of relative frames.

Meronyms are terms that describe entities as parts of larger entities. Terms for parts of the human body are perhaps universally the prototypical meronyms. From the perspective of the available literature on the typology of spatial descriptions, MA meronymies are unusual in two respects: first, they represent perhaps the most important resource for the expression of **place functions** (Jackendoff 1983) in many MA languages – in particular, in languages without spatial case markers and with few or no adpositions. Examples (1) (from Isthmus Zapotec) and (2) (from Yucatec Maya) illustrate:[1]

(1)	Dxi!'ba=be*	i^ke	yoo	
	mounted=3SG	head	house	
	'He's on top of the house'			
(2)	…h-tàal	u=balak'	y=óok'ol	le=pak'=o'
	PRV-come(B3SG)	A3=roll	A3=top	DET=brickwork=D2
	'…it came rolling on/over the wall'			

[1] Key to abbreviations in interlinear glosses: 1 – 1st person; 3 – 3rd person; A – cross-reference set A (ergative/possessor); B – cross-reference set B; CL – numeral/possessive classifier; CMP – completive status; D2 – distal/anaphoric clause-final particle; D4 – negative/place-anaphoric clause-final particle; DET – demonstrative/article base; DIM – diminutive particle; DIS – dispositional conjugation; EXIST – locative/existential/possessive predicator; HORT – exhortative; HYPO – hypocoristic; IMPF – imperfective aspect; IN – inanimate class; INC – incompletive status; PL – plural; PREP – generic preposition; PRV – perfective aspect; RED – reduplication; REL – inalienable/nominalizing suffix; SG – singular.

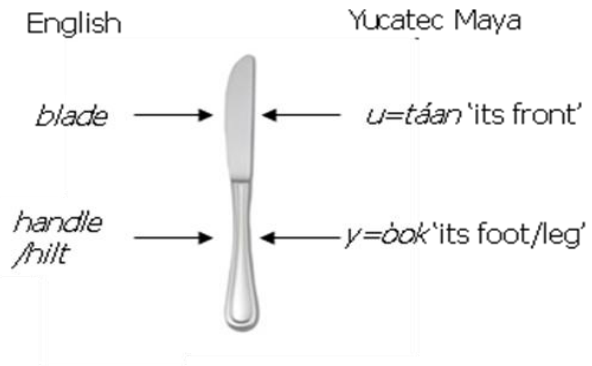


Figure 1. English vs. Yucatec meronymy of knifes

Secondly, MA meronyms are systematically assigned on the basis of the geometry of the object and the shapes of its parts, not on the basis of the parts' functions. Consider the example of a knife illustrated in Figure1. In Western languages, the 'blade' and the 'handle' are labeled by terms that apply to blades and handles of other objects on the basis of their function, regardless of shape. In Yucatec, the handle is the 'leg' of the knife. There is no word for the blade as such, but the two planar surfaces of the blade are identified as its 'fronts'. These terms are applied to parts of similar shape in arbitrary objects regardless of function.

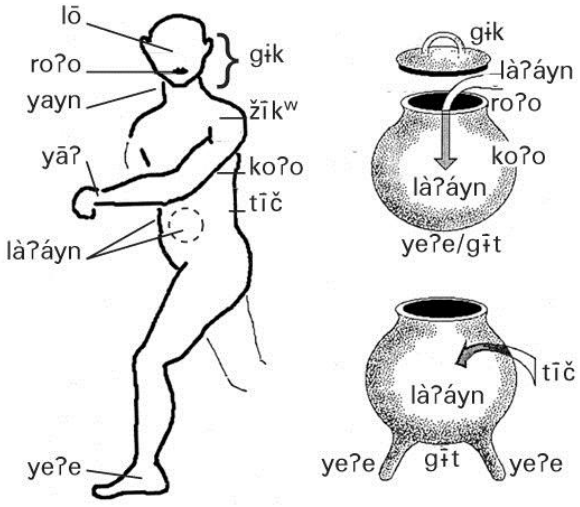


Figure 2. Zapotec meronymy (based on MacLaury 1989: 122-125)

Two different proposals have been advanced to account for the productivity of shape-based meronymy in MA. MacLaury (1989) describes Ayoquesco Zapotec meronyms as body part terms that are metaphorically extended to other entities on the basis of a global analogical mapping process with the structure of an erect human body as its source domain and the structure of the entity described by the "holonym" in its actual orientation as the target domain (cf. Figure 2). This mapping is orientation-sensitive: the highest part of the object becomes the metaphorical 'head' and the lowest part the 'buttocks' or 'feet', depending on its shape. In

contrast, Levinson (1994) describes meronym assignment in Tenejapan Tseltal as governed, not by a metaphorical mapping process, but by an algorithm that takes as input the visually segmented outline of the whole and labels parts on the basis of their shape and the axis of the entity they occur on (cf. Figure 3).

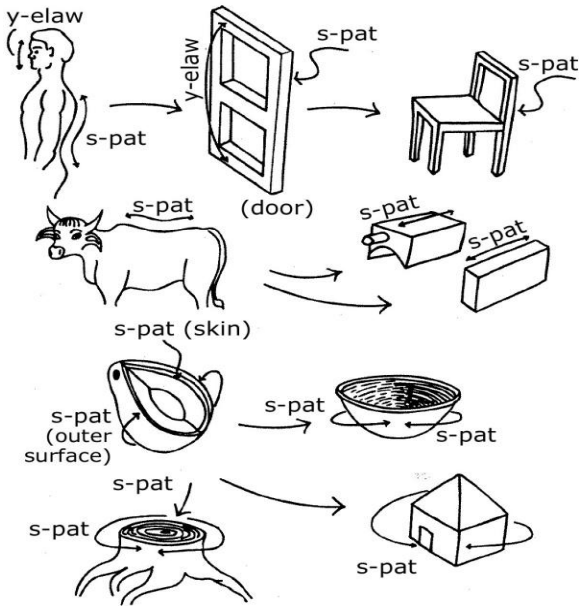


Figure 3. Tseltal meronymy (based on Levinson 1994: 811)

The MesoSpace team of researchers is examining the conceptual basis for meronym assignment, testing predictions derived from the global-analogy account proposed by MacLaury for Zapotec and the shape-analytical algorithm proposed by Levinson for Tseltal in their field languages. The overarching hypothesis informing MesoSpace is the idea that the pervasive use of shape-based meronyms as a resource in spatial descriptions may bias the speakers of a language against relative frames. In languages such as Tseltal, Yucatec, and Zapotec, relative descriptions necessarily involve meronyms. But meronyms always permit alternative object-centered (intrinsic) interpretations. And since speakers are habituated to analyzing an object's geometry when applying meronyms to it, the intrinsic interpretations are favored. Absolute frames are not affected by this pattern, since they do not occur with meronyms. The pattern thus favors the use of both absolute and intrinsic over relative frames. If confirmed, this nexus between meronyms and reference frames would represent evidence for a purely linguistic determinant of reference frame use (as opposed to the mere availability of frames, which is trivially in part a function of the lexicon of the language).

1.4. *Overview*

In the remainder of this paper, we present a test of the hypothesis that the pervasive use of meronyms as expressions of spatial relations biases the speakers of a language against the use of relative frames in just one of the languages of the MesoSpace sample, Yucatec Maya. We discuss Yucatec meronymy in Section 4.1. We show on the basis of data from a referential

communication study that those Yucatec meronyms that are interpreted in intrinsic or relative frames are fully productive, extending to arbitrary ground objects with the requisite parts. In Section 4.2, we summarize the results of a second referential communication study, presented more fully in Bohnemeyer (2011), which indicate that Yucatec speakers as a community are versatile in using all major types of reference frames, but that intrinsic frames are the most frequently used type of reference frame overall across the two types of spatial descriptions represented in our data, in line with what the hypothesis of a bias induced by the use of meronyms as spatial relators predicts. For most, though not all, speakers, the intrinsic type of frame is also the most frequently used one within each class of descriptions. We discuss our results in Section 5. The following sections provide some background information on Yucatec and on how the data drawn on in Section 4 were collected.

2. Some background on Yucatec

2.1. *The language and its speakers*

Yucatec belongs to the Yucatecan branch of the Mayan language family. In 2005, it was spoken by 759,000 speakers age 5 or older in the three Mexican states of the Yucatán peninsula according to census data (PHLI 2009) and by an estimated 5,000 speakers in neighboring Belize (Lewis 2009). It is a strictly head-marking, polysynthetic language. Argument satisfaction is expressed by bound pronominal indices. The coindexed noun phrases are syntactically optional and follow their heads unless they are left- or right-dislocated. The high frequency of left-dislocations in certain genres of connected speech make the ordering of nominal constituents in the sentence superficially similar to the familiar SVO pattern of European languages. Yucatec has a typologically uncommon split-intransitive argument marking system governed by aspect-mood marking (Bohnemeyer 2004 and references therein). The linking between thematic relations and syntactic arguments has been argued to be controlled, not by global grammatical relations, but intraclausally by an obviation/alignment system and interclausally by construction-specific mechanisms (Bohnemeyer 2009).

2.2. *Spatial descriptions and frames of reference in Yucatec*

Spatial reference frames are involved in the interpretation of three types of spatial representations: locative, motion, and orientation representations. Here, we restrict our attention to locative descriptions, in view of the space limitations of the format. Information on reference frames in Yucatec orientation descriptions can be found in Bohnemeyer & Stolz (2006), Bohnemeyer (2011), and Bohnemeyer & O'Meara (in press). The structure of Yucatec motion descriptions is described in detail in Bohnemeyer & Stolz (2006), Bohnemeyer & Brown (2007), Bohnemeyer (2010), and Bohnemeyer (2011). The default head of Yucatec locative predicates is the generic (in the sense of not specific to the **figure**, the entity whose location is at issue) locative/existential/possessive predicator *yàan* illustrated in (5) below. Alternatively, to provide more information about the figure, the locative predicate may be headed by a stative form derived from a 'dispositional' root, such as *wa'l* 'stand' in (3), or some action verb root. Dispositionals are a special class of roots in Mayan languages that lexicalize spatial properties such as support/suspension, orientation, and non-inherent shape. Postures of animate beings can be argued to be the prototypical dispositions; however, Mayan dispositionals include many more roots selecting for inanimate figures/themes than for

animate ones. The head of the predicate combines with what has been called a **ground phrase** in the accounts referenced above, which describes the place at which the figure is located. We restrict our attention to representations in which this place is defined with respect to another entity, the **ground** (the terms 'figure' and 'ground' being understood here in the sense of Talmy (2000)). In this case, the ground phrase can be either a prepositional phrase or a noun phrase in Yucatec. In the former case, the ground phrase is headed either by the semantically pale preposition *ti'* or by the containment preposition *ich(il)*, whose base is homophonous with and presumably grammaticalized from the meronym *ich* 'eye/face'. *Ti'* flags a wide range of adjuncts and obliques, including ground phrases in locative and motion descriptions, but also recipients, benefactives, and experiencers. It also occurs as part of complex causal and purposive prepositions. In locative descriptions, its NP argument/complement is either the nominal that designates the ground, as in (3), or a possessed nominal in which a meronym, such as *táan* 'front' in (4), selects a part of the ground (*ti'* is fused with the following element in both examples; its surviving segment is bolded).

(3) Ti'=wa'l-un-wa'l-o'b **t**e=lu'm=o'
PREP=RED-DIS.PL-stand-B3PL PREP:DET=ground=D2
'There [the bottles] are standing one by one on the ground'

(4) Le=mehen x-ch'úupal-al-o'b=o'
DET=DIM HYPO-female:child-PL-PL=D2
ti' k-u=bàaxal-o'b **t**-u=táan le=máak-o'b=o'
PREP IMPF-A3=play-3PL PREP-A3=front DET=person-PL=D2
'The little girls, there they play in front of the people'

(Example (4) illustrates an event location description. The ground phrase has the same form as in stative locative descriptions, but the overall form of the predicate is that of a dynamic event description.)

2.2.1 *Meronymy in Yucatec spatial descriptions*

Meronyms are lexicalized as relational, inalienably possessed nouns in Yucatec. In addition to the possessed form, several of the meronyms occur in an alternative, adverbialized form, in which the prepositional phrase headed by *ti'* appears as a dependent of the meronym. This is illustrated for *táan* 'front' in (5) (the ground designator, which in the adverbial construction becomes the argument of *ti'*, is left-dislocated in (5)):

(5) Le=x-ya'x+che'=o' yàan hun-túul máak
DET=HYPO-green+tree=D2 EXIST(B3SG) one-CL.AN person
wa'l-akbal táan-il ti'
stand-DIS(B3SG) front-REL PREP(B3SG)
'The *ceiba*, there's a person standing in front of it'

Three of the meronyms of Yucatec may head the ground phrase themselves, which in this case is a noun phrase. This is illustrated by *óok'ol* 'top surface', 'on', 'above' in (6):[2]

(6) Le=lùuch=o' ti=yàan y=**óok'ol** le=mèesa=o'
DET=gourd=D2 PREP=EXIST(B3SG) A3=top DET=table=D2
'The cup (lit. 'gourd'), there it is on the table'

That *óok'ol* is indeed a meronym in this construction, and not a preposition grammaticalized from a meronym, can be seen by comparing (6) to (7):

(7) T-in=bon-ah y=**óok'ol** u=pàach le=pèek'=o'
PRV-A1SG=paint-CMP(B3SG) A3=top A3=back DET=dog=D2
(i) 'I painted the top of the dog's back'
(ii) 'I painted on top of the back of the dog'
(iii) 'I painted above the back of the dog'

In example (7), *óok'ol* can be interpreted as a spatial relator expressing support (ii) or superposition (iii), but also as selecting an entity part – here the top of the back of a dog – for the function of undergoer of the verb. The syntactic properties of *óok'ol* are identical under all three interpretations. In particular, it appears with a 'set-A' (ergative/possessor) pronominal clitic cross-referencing the possessor regardless of which of its senses is activated.

2.2.2 *Cardinal directions in Yucatec*

Yucatec has four basic celestial cardinal direction terms: *chik'in* 'west', *lak'in* 'east', *nohol* 'south', and *xaman* 'north'. Although these can be possessed by ground descriptors just like meronyms, they are much more commonly used as unpossessed nouns in adverbial constructions similar to that of the meronym illustrated in (5). Semantically, they appear to denote directions and regions defined with respect to them, not object parts. Many Yucatec speakers – predominately men – use cardinal direction terms routinely in reference to small-scale space. An example is (8), where the directional term is part of a left-dislocated adverbial:

(8) Te'l **chik'in**=o', náats' te=lu'm=o',
there west=D2 near(B3SG) PREP:DET=earth=D2
ti'=pek-ekbal hun-p'éel chan=bòola=i'
PREP=lie.as.if.dropped-DIS(B3SG) one-CL.IN DIM=ball=D4
'There **in the west**, close by on the ground, there is lying a little ball'

[2] There is one relational nouns which, like *óok'ol* in (6) and *àanal* 'bottom surface', 'under', frequently heads a ground phrase in spatial descriptions, but cannot easily be interpreted as a meronym: *iknal*, which designates a region of proximity defined with respect to the referent of its possessor. The latter is a saliently one-dimensional entity oriented vertically, such as a person or a tree.

As argued in Bohnemeyer 2011, these cardinal direction terms are generally interpreted in abstract absolute frames in terms of the classification in Levinson (1996, 2003a) (cf. Section 1.2).

Section 4 below reports on the semantics of the meronyms that occur in spatial descriptions and on the frames of reference these descriptions occur with. The next section describes the methods we used to collect the data these sections draw on.

3. Methodology

3.1. *Ball and Chair: FoR selection*

The *Ball & Chair (B&C)* pictures are a tool for the study of the use of FoRs in reference to small-scale space in discourse developed by the MesoSpace team (Bohnemeyer 2008). They comprise four sets of 12 photographs that feature a ball and a chair in different spatial configurations. The stimuli are designed to be used in a picture-to-picture matching referential communication task to induce speakers to explicitly contrast the spatial configurations they show. The task is closely modeled after the Men & Tree task developed by the members of the Language & Cognition Group at the Max Planck Institute for Psycholinguistics (Danziger 1993). In every trial two speakers are seated side by side, both facing in the same direction, with identical sets of pictures spread out on a table in front of them, with the pictures arranged in different orders. A screen is placed between the two speakers to prevent visual attention sharing. One speaker – the 'director' – selects a picture of their choosing and describes it so their fellow participant – the 'matcher' – can find its match in their copy of the set. Both matcher and director are free to ask and answer questions until they believe they have found a match. The ID numbers of the selected photos are recorded, and the participants proceed to the next item; this occurs regardless of whether the matcher has selected a "correct" match, and the participants are not told of the accuracy of their matches. The director places a coin or other marker on the photos as he selects them, thereby reducing the set of live contrasts as the trial progresses. When a set has been completed, the screen is removed and the researcher reviews the matches one by one with the participants, encouraging them to evaluate the correctness of the matches and discuss possible sources of errors. Then the participants repeat the procedure with the remaining sets of photos.

For B&C, five dyads completed the task: one dyad consisted of a married couple, two were all-male, and the other two all-female. All participants were tested in a rented room at the first author's field site, sitting facing due north at a table whose longest axis was oriented in east-west direction. This layout was chosen to avoid suppression of the absolute frame type.

The sessions were video recorded and later directly coded by the first author with native speaker consultants checking and correcting his representations of what he heard the speakers saying on the tape and providing judgments as to the truth of given descriptions of given pictures under particular interpretations, i.e. especially assuming a particular kind of frame. Spatial descriptions were coded for six categories of information, only one of which, the location of the ball vis-à-vis the chair, is included in the analysis summarized in Section 5. Only affirmative descriptions offered by the 'director' of a given trial were coded. Negative descriptions of the director ('The ball is not on the chair') and clarification questions by the matcher were excluded from coding and analysis.

The coding of the descriptions for the frames they rely on follows a fine-grained classification, which distinguishes abstract absolute frames from other kinds of geocentric frames as per the discussion in Section 1.2. Of particular relevance for the analysis of the Yucatec data are geocentric frames based on **landmarks**. The **anchor** of such frames -the model on which the axes of the frame are based (cf. Danziger 2010)- can be any (natural or human-made) entity or feature of the environment. One or more axes of the frame are defined as vectors pointing toward this entity or feature, as in 'The ball is seaward of the chair' and 'The ball is toward the door from the chair'.

3.2. *Novel Objects: Meronymy in action*

Another instrument created by the MesoSpace team is the Novel Objects set, designed to test MacLaury's and Levinson's hypotheses concerning the meronymy of MA languages.

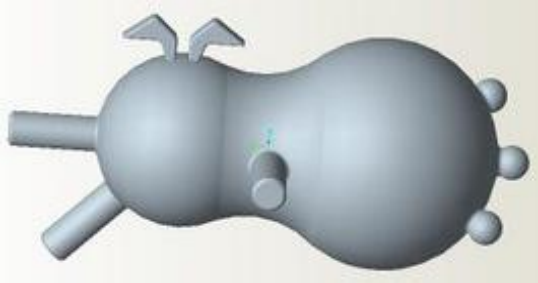


Figure 4. A novel object

Novel Objects comprise nine approximately fist-sized plastic objects of unfamiliar shape. One aim of the Novel Objects study is to test to what extent speakers agree on how to label object parts without being able to rely on convention and without needing to establish a global interpretation of the objects first. Both MacLaury's (1989) account of Ayoquesco Zapotec meronymy and Levinson's (1994) of Tenejapan Tseltal meronymy predict that this should be possible (see Section 1.3). A second goal is to test for distinctive properties predicted by the two accounts that should allow the researcher to type the meronym system of their field language with respect to the types described by MacLaury (1989) and Levinson (1994); cf. Section 1.3. The stimuli consist of nine objects of novel shape which do not resemble any artifacts or living creatures known in Mesoamerica or Euro-American culture.

Two tasks were carried out using the Novel Objects. The first – the 'part identification task' – targets labels for the parts of the objects (meronyms), the second – the 'placement task' – locative descriptions with respect to the parts. In the former case, the participants match parts of the stimuli designated by bits of play dough on them through verbal instructions, and in the latter, they match coins placed around the objects. Both tasks are realized as referential communication tasks (see below). The descriptions collected with these tasks were videotaped and coded for the descriptors used in reference to particular parts and, in the placement task, also the frames involved. The analysis of the Yucatec data summarized in Section 4.1 is based on the data collected with the part identification task only. The analysis proceeds by comparing the set of parts a given term is used to describe, the objects these parts belong to, the

morphosyntactic properties of the label, and the pragmatic properties of the descriptions in which they occur.

3.3. *Participants*

The research reported on here was conducted by the first author during a field trip in the summer of 2008 in Yaxley, a village that contained 589 inhabitants age five or older in 2005[3]. Yaxley is located in the municipal district of Felipe Carrillo Puerto, in the center of the state of Quintana Roo, Mexico. The participants in these tasks were five men in their 30s through 60s and five women in their teens through 40s. All were born in Yaxley and, with the exception of two, all still reside there. The two exceptions are the married couple that performed the B&C task together; they live in the municipal capital of Felipe Carrillo Puerto. All 10 participants are bilingual in Spanish and Yucatec and literate. All learned Yucatec as their first language and did not speak much Spanish before entering school.

4. Findings

4.1. *Meronymy: the Novel Objects tasks*

The central hypothesis that informs our study says that the pervasive use of meronyms as a resource for the expression of spatial relations biases the speakers of a language against the use of relative frames (Section 1.3). To test this hypothesis in Yucatec, we assess the use of meronyms in spatial descriptions in the present subsection, based on data collected with the Novel Objects referential communication task, and the use of spatial frames in Yucatec discourse in the following subsection on the basis of the Ball & Chair referential communication task. We predict specifically that meronyms that are used productively to express place functions (see section 1.3) in spatial representations are interpreted more frequently intrinsically than relatively.

A quantitative analysis of the Yucatec Novel Objects data remains to be performed. Here, we restrict ourselves to qualitative observations regarding the key issue of productivity in spatial descriptions. We break this property down into three components:

- the role of meronyms in spatial descriptions in relation to the frames in which these descriptions can be interpreted;
- the applicability of meronyms to objects of arbitrary shape and function;
- the semantic/conceptual basis for the application.

We address each of these points in turn and then discuss how these aspects of Yucatec meronymy and meronym use conspire to create the conditions that bias Yucatec speakers against the use of relative frames according to our hypothesis.

4.1.1. *Meronyms and the interpretation of locative descriptions.* Table 2 shows a complete list of the *lexical* meronyms produced in reference to the parts of the Novel Objects by the Yucatec participants. Together, the terms in Table 2 occur in approximately half of the descriptions. Alternative means for reference to the parts of the objects include (usually nominalized) descriptions of properties of the parts (e.g., ‘the thing that sticks out’; ‘the higher one’) and (usually metaphorical) non-meronymic object terms (e.g., ‘the (one that is like a) marble’; ‘the

[3] http://galileo.inegi.gob.mx/CubexConnector/validaDatos.do?geograficaE=230020287.

cross'). The participants also resorted to the strategy of defining parts in terms of spatial relations with respect to other parts (e.g., 'near/in the direction of (some other part)'). The meronyms in Table 2 are sorted into three classes on the basis of the reference frames the ground phrases in which they occur be interpreted in. This classification is based on data from the Ball & Chair task and prior research on reference frames in Yucatec, such as Bohnemeyer & Stolz (2006).[4]

Table 2. Lexical meronyms produced in reference to the parts of the Novel Objects stimuli

Meronyms	**frames of reference**
aanal 'bottom surface', 'below', 'beneath', 'under'; *óok'ol* 'top surface', 'on (support)', 'above'	absolute (vertical), intrinsic, relative
frèente '(in) front (of)'; *làado* '(be)side'; *no'h* 'right'; *pàach* 'back', 'outside (of)', 'behind'; *táan* '(in) front (of)'; *ts'íik* 'left'; *tséel* '(be)side'	intrinsic, relative
áam 'interstice'; *chi'* 'mouth'; *chúuch* 'stem (of a fruit)'; *chùun* 'trunk'; *hóol* 'whole'; *ho'l* 'head'; *ich* 'eye/face'; *k'ab* 'hand/arm'; *koh* 'tooth'; *nèeh* 'tail'; *ni'* 'nose'; *òok* 'leg/foot'; *pùunta* 'tip'; *tu'k'* 'corner'; *tùuch* 'navel'; *xáay* 'fork', 'crotch'; *xùul* 'edge', 'end'	none – only topological interpretations available

The availability of relative interpretations is strictly tied to the presence of one of the meronyms in the first two rows of Table 2 in the ground phrase. Prepositional phrases formed without meronyms and the meronyms in the third row are used exclusively with topological, non-perspectival interpretations.[5] Furthermore, all the meronyms that have relative interpretations also have intrinsic interpretations. This connection between intrinsic and relative FoRs and the use of meronyms is a critical link in the hypothetical causal chain from a meronym use to non-relative reference. Outside bare prepositional phrases and ground phrases formed with meronyms, it is of course possible to use cardinal direction terms with absolute interpretations.

4.1.2. *The applicability of meronyms to objects of arbitrary shape and function*. In terms of their applicability across the Novel Objects stimuli, the meronyms of Table 2 can be grouped into two broad classes. The items listed in the first two rows and a subset of the items listed in the third row readily apply to all Novel Objects that have the requisite parts. In contrast, the remainder of the items in the third row are only used in reference to parts of the Novel Objects if one or both of the following two conditions apply: (i) the meronym assignment is embedded in a simile

[4] *Frèente* '(in) front (of)', *làado* '(be)side', and *pùunta* 'tip' are Spanish loans.

[5] This is strictly true for relative FoRs. However, there is in fact one usage of the meronyms in the third row of Table 1 that does admit intrinsic interpretations. This use involves propositions such as 'The ball is toward one of the legs of the chair', with 'leg' being expressed by a meronym.

or flagged by a hedge, as in (9)-(11); (ii) the participants establish an overall interpretation of the object in question.

(9) *Le=chan* *bòola* ***bèey*** *kan-p'éel* *y=òok=a'*
DET=DIM sphere(B3SG) thus four-CL.IN(B3SG) A3=leg/foot=D2
'The little sphere is **as if** it had four legs (lit. four were its legs)'

(10) U=mehen ba'l-il-o'b **dée** mehen òok-o'b=o', ….
A3=small thing-REL-PL of small leg/foot-PL=D2
'Its little leg-**like** thingies, …'

(11) Ko'x a'l-ik u=k'ab
HORT say-INC(B3SG) A3=arm(B3SG)
'Let's say (it's) his arm'

Examples (9)-(10) were produced in reference to parts of the object shown in Figure 5, (11) in reference to parts of the one in Figure 6.

Figure 5. Novel Object #6

Figure 6. Novel Object #7

We take this use of meronyms with similes, hedges, and comparisons or interpretations of the entire object as evidence suggesting that the parts of the Novel Objects do not literally fall within the semantic extension of the terms in question and only allow their application after metaphorical transfer.

Semantically, the parts designated by the items in the first two rows of Table 2 are surfaces. The third row contains mostly terms for volume parts, and all of those require a simile or hedge or an overall interpretation of the object. In contrast, there is no evidence whatever that the assignment of surface meronyms to the Novel Objects was considered metaphorical by the Yucatec participants. The use of similes and hedges with surface meronyms is most likely anomalous in Yucatec, but this hypothesis has not yet been tested. The remaining items of the third row of Table 2 describe curvature extremes – edges, tips, and corners – and negative spaces. Table 3 summarizes the semantic breakdown.

Table 3. Semantic classification of the meronyms in Table 2

volume terms	**surface terms**	**terms for curvature extremes and negative spaces**
chi' 'mouth'; *chúuch* 'stem (of a fruit)'; *chùun* 'trunk'; *ho'l* 'head'; *ich* 'eye/face'; *k'ab* 'hand/arm'; *koh* 'tooth'; *nèeh* 'tail'; *ni'* 'nose'; *òok* 'leg/foot'; *tùuch* 'navel'; *xáay* 'fork', 'crotch';	*aanal* 'bottom surface', 'below', 'beneath', 'under'; *frèente* '(in) front (of)'; *làado* '(be)side'; *no'h* 'right'; *óok'ol* 'top surface', 'on (support)', 'above'; *pàach* 'back', 'outside (of)', 'behind'; *táan* '(in) front (of)'; *ts'íik* 'left'; *tséel* '(be)side'	*áam* 'interstice'; *hóol* 'whole'; *pùunta* 'tip'; *tu'k'* 'corner'; *xùul* 'edge', 'end'

4.1.3. *The semantic basis of meronym assignment*. The classification in Table 3 suggests that volume terms are (animal and plant) body part terms. These require metaphoric semantic transfer to apply to the Novel Objects. In contrast, the terms for surfaces, curvature extremes, and negative spaces have abstract geometric meanings which extend freely to arbitrary objects. Striking independent support for this conjecture comes from the fact that only volume terms, but not surface and curvature extreme terms, can be possessed by terms referring to people or animals. This holds with the exception of *pàach* 'back', which, as shown in (7) above, can be possessed for example by *pèek'* 'dog'. Not so, however, for example for *táan* 'front' or *tséel* 'side':

(12) *(T-in=bon-ah) **u=táan** le=pèek'=o'
PRV-A1SG=paint-CMP(B3SG) A3=front DET=dog=D2
intended: '(I painted) the front of the dog'

(13) *(T-in=bon-ah) **u=tséel** le=pèek'=o'
PRV-A1SG=paint-CMP(B3SG) A3=side DET=dog=D2
intended: '(I painted) the side of the dog'

It is only volume meronyms possessed by terms for people and animals that can possess surface meronyms in their turn. Thus, the forehead of the dog could be referred to as the 'front of its head', and the dog's side as the 'side of its belly'. While the reason for the incompatibility of surface and extreme meronyms with people and animals remains to be elucidated, the restriction strongly suggests that surface and curvature terms are not body part terms.

The difference in applicability between volume terms and other meronyms is directly reflected in the productivity of the terms. All Novel Objects have multiple parts that can be designated using surface or curvature extreme terms. In contrast, body part terms played only a relatively minor role during the Novel Objects sessions, except for *pàach* 'back'. Objects 3 and 5-7 were said to have 'legs', and 7 (see Figure 6 above) in addition for some speakers also has 'arms' and even a 'belly' and a 'head'. The latter two assignments, however, seem to be based on a local comparison to bottle gourds. Moreover, when asked to name inanimate objects that have, e.g., 'heads' or 'bellies', speakers quickly run out of examples. There is a great deal of variation in these judgments, contrasting with a striking uniformity in surface labeling. All of these pieces of evidence point towards a profound split in productivity between volume terms and other meronyms. Volume terms are animal or plant body part terms which are assigned to inanimate objects only metaphorically, and there appears to be some degree of conventionality involved in these metaphors. In contrast, surface and curvature extreme meronyms and terms for negative spaces have abstract geometric meanings that extend with perfect regularity to all inanimate objects of the appropriate geometric properties without any ingredient of conceptual transfer or conventionality being detectable, but do not apply directly to animals and plants. These findings have important implications for the theory of meronymy as discussed in Section 1.3, which will be explored elsewhere. What matters for present purposes is that the surface terms, which are required for the projection of intrinsic and relative FoRs (Table 2), are fully productive in their application to inanimate objects.

A final aspect of the semantics of Yucatec meronymy that is crucial for the hypothesis we are attempting to test is the general observer-independence of meronym assignment. All three classes of meronyms in Table 3 appear to be assigned according to shape-analytical algorithms similar to those proposed by Levinson (1994) for Tseltal. Support for this conjecture comes from the fact that meronym assignment appears to never be subject to uniqueness conditions or to the place of a labeled part in the overall structure of the object. For example, the two planar surfaces of the blade of a knife can both be referred to as 'fronts' of the knife (cf. Figure 1 above). The same holds for the two planar surfaces of a coin. An example of an object with two 'backs' is a fat cylinder squashed along the shortest axis such that the two ends are bulging outward. These two convex surfaces then become the 'backs' of the object. In general, a 'front' is any planar or less convex surface on one end of an axis orthogonal to the 'generating' axis in the sense of Marr (1982), and a 'back' any more convex surface of the same axis. If the object has only a convex surface on any axis in question – as for example in the case of the convex surface of a skinny cylinder – the entire convex surface is designated as the 'back'. The assignment may in some cases be influenced by functional properties (see below), but so far as this could be ascertained to date, observer perspective appears to never play a role.

In general, the region intrinsically referred to using the surface meronyms are the regions geometrically projected from the parts named by the same meronyms. There are at

least two important exceptions to this rule. The first concerns the intrinsic 'back' region of animals. This is not the region geometrically projected from the 'back' part, but rather the one opposite the 'front' region. The region above the 'back' part is referred to using *óok'ol* 'top'. The second exception concerns objects that have a canonically horizontal *táan* 'front', such as tables, altars, chairs, *comales* (griddles for cooking tortillas), and many more. *T-u=táan* is used for surface contact in these cases, but the region geometrically projected from the surface is exclusively referred to using *óok'ol* 'top'. If the object has an intrinsic horizontal front *part* in addition to the horizontal surface, *táanil ti'* will refer to that region. This is the case with altars. Both of these exceptions follow the same rationale: the region above the object in canonical orientation is always designated by *óok'ol* - whether or not there is a corresponding 'top' surface. Something similar happens in the horizontal. Humans and animals, even though they lack a part that can be identified as *u=táan* 'their front', project an intrinsic front region designated by *táan-il ti'* - the region in which they face in canonical orientation. So there is a sense in which projection relies on a 'fixed armatures' logic similar to what Levinson (2003a) attributes to Ayoquesco Zapotec on the basis of MacLaury's (1989) account.

4.1.4. *Implications for the hypothetical meronymy-FoR nexus*. In Yucatec, only spatial descriptions that employ surface meronyms are interpretable in intrinsic or relative FoRs. The results of the Novel Objects task show that these terms are applicable to all inanimate objects with the requisite geometric properties. In this respect, Yucatec surface meronyms behave very much like spatial prepositions of English. At the same time, however, one important semantic difference between Yucatec surface meronyms and English spatial prepositions is that the former, but not the latter, designate object parts and refer to spatial regions that are generally projected from those object parts. The assignment of object parts, however, is not sensitive to observer perspective in Yucatec. In intrinsic FoRs, spatial regions can be designated straightforwardly using surface meronyms on the basis of adjacency to the surfaces described by the same terms (with the exceptions mentioned in the preceding paragraph). However, to reference spatial regions in a relative FoR, the same set of surface meronyms is used, but the geometric structure of the ground object is ignored in this case, as the axes of the coordinate system are instead transposed from the axes of the body of the observer. This option is always available in Yucatec for all speakers we tested. However, we hypothesize that there is a processing bias against this type of use of the meronyms which is the result of speakers and hearers being more accustomed to assigning meronyms to objects on the basis of their geometric properties, due to the part-denoting function of the meronyms. This could be argued to be a 'thinking-for-speaking' effect in the sense of Slobin (1996, 2003).In the next section, we test the resulting prediction that Yucatec speakers should prefer intrinsic over relative FoRs.

4.2. *FoRs in discourse: Ball & Chair*

Figure 7 shows for each type of reference frame the number of locative propositions produced by the five dyads of Yucatec speakers which relied on that particular type for their interpretation. The total number of propositions exceeds the number of descriptions (5 dyads of speakers X 4 sets of pictures X 12 pictures per set = 240) due to the occurrence of multi-propositional descriptions, which were common. Only descriptions of the location of the ball with respect to the chair (see Section 3.1) are included in the analysis. Other locative

descriptions asserted the location of the ball in the picture. The breakdown by reference frame types distinguishes absolute frames in the vertical, which are anchored to the Earth's field of gravity, from celestially-based absolute frames used in the horizontal. Furthermore, landmark-based frames are distinguished from both intrinsic and absolute frames. This implies a narrow usage of the label *intrinsic* restricted to object-centered frames. As mentioned in §1.2, landmark-based frames are treated as intrinsic in some classifications, but as geocentric in others. Descriptions that hold true of a given stimulus photo in two different frames are coded as 'aligned' in Figure 1. Such alignment occurred between intrinsic and relative frames and between intrinsic and absolute frames in the vertical (these ambiguous vertical descriptions are in also true in relative frames). For a much more comprehensive and detailed analysis of the Yucatec Ball & Chair data, see Bohnemeyer (2011).

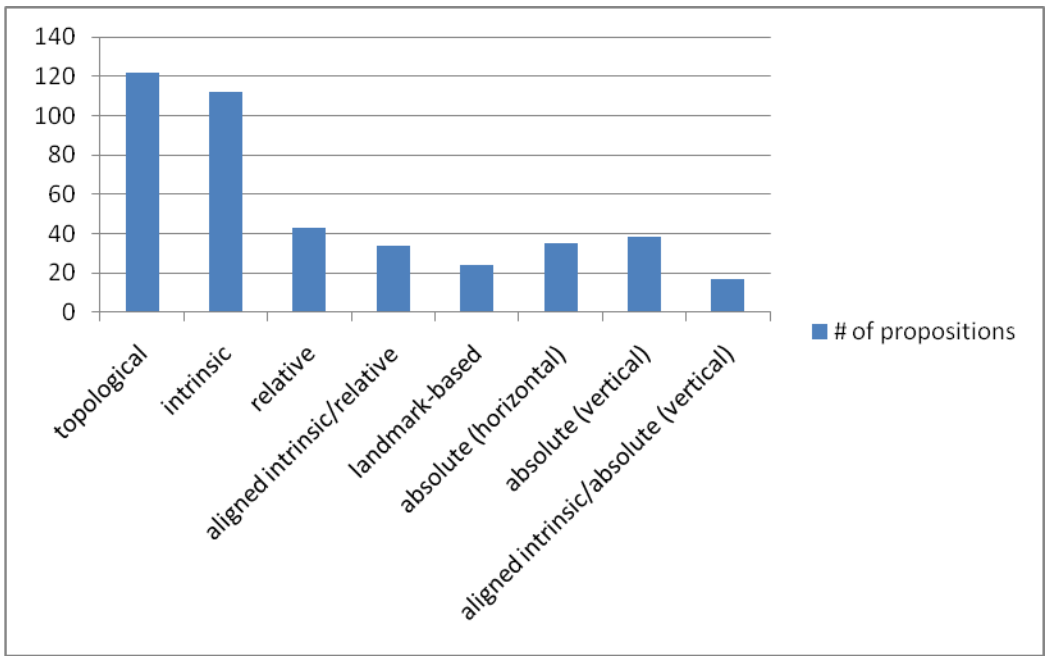


Figure 7. Locative descriptions produced during the Yucatec Ball & Chair sessions: number of propositions per FoR type

As Figure 1 shows, uniquely intrinsic propositions outnumbered uniquely relative ones almost three-to-one during the task. The effect is even more dramatic once the distribution across dyads is considered, as almost half of the uniquely relative propositions (20 out of 43) were produced by just one dyad. These two speakers distinguish themselves from the other participants by having far more exposure to Spanish in their everyday interactions, as both live mixed or predominantly Spanish-speaking networks, whereas the other participants live in the predominantly Maya-speaking village of Yaxley (cf. Section 3.3). It is likely that the use of Spanish is a factor favoring the use of relative frames due to the fact that relative frames are dominant in Spanish as they are in all European languages tested to date. This is supported by results from the pilot B&C tasks conducted with five dyads of English speaking University at Buffalo undergraduates, where almost half of the propositions locating the ball vis-à-vis the

chair involved uniquely relative frames. We thus conclude that the observed use of frames in Yucatec discourse is in line with the prediction derived from the hypothesis that the reliance on geometric meronyms as a major resource for the encoding of spatial relations in a language influences the speakers of that language against the use of relative frames.

5. Discussion

A central typological hypothesis of the MesoSpace project is the idea that the pervasive reliance on meronyms for the expression of spatial relations may bias the speakers of a language against the use of relative frames. The rationale behind this idea is that both relative and intrinsic reference requires the use of meronyms in the languages in question. Whereas Western languages have large, specialized meronymic vocabularies assigned according to the functions of the parts, many Mesoamerican languages have general-purpose meronyms that are assigned across arbitrary classes of objects according to the geometry of the parts and the whole. Since both intrinsic and relative reference to an object require the assignment of meronyms to it in languages such as Yucatec and relative reference is done on the basis of the geometry of the observer's body rather than that of the geometry of the reference object, the pervasive practice of assigning meronyms to an object on the basis of its shape habituates speakers against relative interpretations. This hypothesis is currently being tested by the members of the project in their respective field languages and so far has held up to these tests. The research summarized in this paper shows that the hypothesis is borne out in one Mesoamerican language, Yucatec. The preliminary findings presented above point to a much more restricted use of observer-dependent, relative frames to better studied European languages or Japanese. However, the hypothesis being of a typological nature, alignment in a single language can always be attributed to coincidence. The early reports by the other MesoSpace researchers point in the same direction (see contributions to O'Meara & Pérez Báez 2011). There is also evidence to the effect that the use of relative frames is on the rise among younger speakers as a function of integration in the dominant Spanish-speaking national cultures. In some languages of the area, absolute frames dominate; in many others, object-centered, intrinsic frames are the most frequently used type.

Even if the alignment is confirmed in other Mesoamerican languages, and no counter-evidence against the hypothesis emerges – as preliminary reports from the members of the MesoSpace team seem to indicate – it is still conceivable that the reliance on meronyms in spatial descriptions and the preference for intrinsic and absolute (depending on the language) over relative frames are independent areal features of the Mesoamerican *sprachbund*. It is necessary to carry out tests outside the Mesoamerican area, in other languages that make similarly use of highly productive, geometric all-purpose meronyms in their spatial descriptions. A follow-up project that will conduct just such tests on languages of Africa, Asia, and South America has been awarded funding by the National Science Foundation (award # BCS-1053123 "Spatial language and cognition beyond Mesoamerica") and has begun operations.

The discovery of the crosslinguistic variation in reference frame use and the alignment between population-specific preferences for frames in discourse and cognition has greatly fueled the debate about the possible role of language as a causal factor in non-linguistic cognition – in other words, the so-called Sapir-Whorf Hypothesis or Linguistic Relativity Hypothesis, according to which "language influences thought." Proponents of a "Whorfian" or

“relativistic” interpretation of the alignment argue that since cultures differ in their preferences or habits of spatial cognition, their members must learn their group’s preferences from observable behavior, and thus foremost from language use. Opponents claim instead that the observable cultural differences are shallow and easily mutable in response to factors such as literacy and the environment. On these accounts, spatial cognition is uniform across populations in terms of abilities and merely diverse in terms of the use of these abilities. The MesoSpace work on meronyms discussed in this paper has direct bearing on this question. If meronyms can be confirmed to be a linguistic factor influencing reference frame use in both language and spatial memory and reasoning, this would strengthen the relativistic view of habits of reference frame use as deeply culturally entrenched and of language as playing a key role in the intergenerational transfer and cultural diffusion of these habits.

6. Conclusion

The research summarized in this chapter tests the hypothesis that the pervasive use of shape-based meronyms as a resource in spatial descriptions may bias the speakers of a language against relative frames of reference. In languages such as Tseltal, Yucatec, and Zapotec, relative descriptions necessarily involve meronyms. But meronyms always permit alternative object-centered (intrinsic) interpretations. And since speakers are habituated to analyzing an object's geometry when applying meronyms to it, the intrinsic interpretations are favored. Absolute frames are not affected by this pattern, since they do not occur with meronyms. The pattern thus favors the use of both absolute and intrinsic over relative frames. If confirmed, this nexus between meronyms and reference frames would represent evidence for a purely linguistic determinant of reference frame use (the availability of frames in discourse is trivially in part a function of the lexicon of the language; however, meronymy may affect the actual *use* of frames in discourse, not merely their availability). The evidence summarized above from one language, Yucatec Maya, is in line with this prediction.

7. References

Abarbanell, Linda & Peggy Li. 2009. Spatial frames of reference and perspective taking in Tseltal Maya. *Proceedings of the 33rd Annual Boston University Conference on Language Development*, Vol (1). Cascadilla Press: Somerville, MA. 49-60.

Bohnemeyer, Jürgen. 2011. Spatial frames of reference in Yucatec: Referential promiscuity and task-specificity. *Language Sciences* 33(6): 892-914

Bohnemeyer, Jürgen. 2004. Split intransitivity, linking, and lexical representation: the case of Yukatek Maya. *Linguistics* 42(1): 67-107

Bohnemeyer, Jürgen. 2008. Elicitation task: frames of reference in discourse – the Ball & Chair pictures. In Gabriela Pérez Báez (ed.), *MesoSpace: Spatial language and cognition in Mesoamerica. 2008 Field Manual.* Unpublished results, University at Buffalo - SUNY http://www.acsu.buffalo.edu/~jb77/MesoSpaceManual2008.pdf. (last accessed 12/13/2010). 34-37.

Bohnemeyer, Jürgen. 2009. Linking without grammatical relations in Yucatec: Alignment, extraction, and control. In Y. Nishina, Y. M. Shin, S. Skopeteas, E. Verhoeven, & J. Helmbrecht (eds.), *Issues in functional-typological linguistics and language theory: A Festschrift for Christian Lehmann on the occasion of his 60th birthday*. Berlin: Mouton de Gruyter. 185-214.

Bohnemeyer, Jürgen. 2010. The language-specificity of Conceptual Structure: Path, Fictive Motion, and time relations. In Barbara Malt & Phillip Wolff (eds.), *Words and the mind: How words capture human experience*. Oxford: Oxford University Press. 111-137.

Bohnemeyer, Jürgen & Penelope Brown. 2007. Standing divided: Dispositionals and locative predications in two Mayan languages. *Linguistics* 45(5-6): 1105-1151.

Bohnemeyer, Jürgen & Carolyn O'Meara. In press. Vectors and frames of reference: Evidence from Seri and Yucatec. In Luna Filipović & Katarzyna M. Jaszczolt (eds.), *Space and Time across Languages and Cultures*. Amsterdam: John Benjamins.

Bohnemeyer, Jürgen and Christel Stolz. 2006. Spatial reference in Yukatek Maya: a survey. In Stephen C. Levinson & David P. Wilkins (eds.), *Grammars of Space*. Cambridge: Cambridge University Press. 273-310.

Brown, Penelope. 2006. A sketch of the grammar of space in Tzeltal. In Stephen C. Levinson & David P. Wilkins (eds.), *Grammars of space*. Cambridge: Cambridge University Press. 230-272.

Brown, Penelope & Stephen C. Levinson. 1992. 'Left' and 'right' in Tenejapa: Investigating a linguistic and conceptual gap. *Zeitschrift für Phonetik, Sprachwissenschaft und Kommunikationsforschung* 45(6): 590-611.

Brown, Penelope & Stephen C. Levinson. 1993. 'Uphill' and 'downhill' in Tzeltal. *Journal of Linguistic Anthropology* 3(1): 46-74.

Campbell, Lyle, Terrence Kaufman, & Thomas C. Smith-Stark. 1986. Meso-America as a linguistic area. *Language* 62(3): 530-570.

Carlson-Radvansky, Laura A. & David E. Irwin. 1993. Frames of reference in vision and language: Where is above? *Cognition* 46: 223-244.

Carlson-Radvansky, Laura A. & David E. Irwin. 1994. Reference frame activation during spatial term assignment. *Journal of Memory and Language* 33: 646-671.

Carlson-Radvansky, Laura A. & Gordon D. Logan. 1997. The influence of reference frame selection on spatial template construction. *Journal of Memory and Language* 37: 411–437.

Danziger, Eve (ed.). 1993. Cognition and Space Kit, Version 1.0. Cognitive Anthropology Research Group at the Max Planck Institute for Psycholinguistics, Nijmegen.

Danziger, Eve. 2010. Deixis, gesture, and cognition in spatial Frame of Reference typology. *Studies in Language* 34(1): 167-185.

Jackendoff, Ray S. 1983. *Semantics and cognition*. Cambridge, MA: MIT Press.

Kay, Paul, Brent Berlin, Luisa Maffi, William R. Merrifield & Richard Cook. 2009. *The World Color Survey.* Stanford: Center for the Study of Language and Information.

Levinson, Stephen C. 1994. Vision, shape, and linguistic description: Tzeltal body-part terminology and object description. In Stephen C. Levinson & John B. Haviland (eds.), *Space in Mayan languages*. [Special issue]. *Linguistics* 32(4): 791-856.

Levinson, Stephen C. 1996. Frames of reference and Molyneux's Question: Crosslinguistic evidence. In Paul Bloom, Mary A. Peterson, Lynn Nadel & Merrill F. Garrett (eds.), *Language and space*. Cambridge, MA: MIT Press. 109-169.

Levinson, Stephen C. 2003a. *Space in language and cognition*. Cambridge: Cambridge University Press.

Levinson, Stephen C. 2003b. Language and mind: Let's get the issues straight! In Dedre Gentner & Susan Goldin-Meadow (eds.), *Language in mind: Advances in the study of language and cognition*. Cambridge, MA: MIT Press. 25-46.

Levinson, Stephen C. & Brown, Penelope. 1994. Immanuel Kant among the Tenejapans: Anthropology as empirical philosophy. Ethos, 22(1): 3-41.

Levinson, Stephen C., Sotaro Kita, Daniel B. M. Haun, & Björn H. Rasch. 2002. Returning the tables. *Cognition* 84: 155-188.

Levinson, Stephen C. & David P. Wilkins. 2006. *Grammars of space*. Cambridge: Cambridge University Press.

Lewis, M. Paul (ed.). 2009. Ethnologue: Languages of the World, Sixteenth edition. Dallas, Tex.: SIL International. Online version: http://www.ethnologue.com/ (last accessed 12/13/2010).

Li, Peggy, Abarbanell, Linda, Gleitman, Lila & Papafragou, Anna. 2011. Spatial reasoning in Tenejapan Mayans. *Cognition* 120 (1): 33-53.

Li, Peggy & Lila Gleitman. 2002. Turning the tables: Language and spatial reasoning. *Cognition* 83: 265-294.

MacLaury, Robert E. 1989. Zapotec body-part locatives: prototypes and metaphoric extensions. *International Journal of American Linguistics* 55: 119-154.

Marr, David. 1982. *Vision*. New York: Freeman.

Mishra, Ramesh C., Pierre R. Dasen & Shanta Niraula. 2003. Ecology, language, and performance on spatial cognitive tasks. *International Journal of Psychology* 38: 366-383.

O'Meara, Carolyn. 2010. *Seri landscape classification and spatial reference*. Doctoral dissertation, University at Buffalo.

O'Meara, Carolyn & Gabriela Pérez Báez (eds.). 2011. Frames of reference in Mesoamerican languages. [Special issue]. *Language Sciences* 33(6).

Pederson, Eric, Eve Danziger, David P. Wilkins, Stephen C. Levinson, Sotaro Kita & Gunter Senft. 1998. Semantic typology and spatial conceptualization. *Language* 74: 557-589.

Pinker, Steven. 1994. *The Language Instinct: The New Science of Language and Mind*. London: Penguin.

PHLI, 2009. Perfil sociodemográfico de la población que habla lengua indígena [socio-demographic profile of the speakers of indigenous languages]. Aguascalientes: Instituto Nacional de Estadística y Geografía. http://www.inegi.org.mx/prod_serv/contenidos/espanol/bvinegi/productos/censos/poblacion/poblacion_indigena/leng_indi/PHLI.pdf (last accessed 6/8/2010).

Slobin, Dan I. 1996. Two ways to travel: Verbs of motion in English and Spanish. In Masayoshi S. Shibatani & Sandra A. Thompson (eds.), *Grammatical constructions: Their form and meaning*. Oxford: Clarendon Press. 195-220.

Slobin, Dan I. 2003. Language and thought online. In Dedre Gentner & Susan Goldin-Meadow (eds.), *Language in mind*. Cambridge, MA: MIT Press. 157-192.

Smith-Stark, Thomas C. 1994. Mesoamerican calques. In Carolyn J. MacKay & Verónica Vázquez (eds.), *Investigaciones lingüísticas en Mesoamérica*. Mexico City: Instituto de Investigaciones Filológicas, Universidad Nacional Autónoma de México. 15-50.

Talmy, Leonard. 2000. *Toward a Cognitive Semantics*. MIT Press, Cambridge, MA.

Wassmann, Jürg & Pierre R. Dasen. 1998. Balinese Spatial Orientation: Some Empirical Evidence of Moderate Linguistic Relativity. *The Journal of the Royal Anthropological Institute* 4(4): 689-711.