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Vectors and frames of reference

Evidence from Seri and Yucatec*

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Most linguistic and cognitive representations of space depend on frames of reference (FoRs). We show that FoRs play an equally important role in representations of the orientation of entities and representations of their location and direction of motion. We propose that orientation is conceptually encoded, not in terms of metaphorical path functions (Jackendoff 1983), but in terms of vectors. Equipped with the notion of vectors, we introduce a distinction between two classes of FoRs: classical “angular-anchored” FoRs and the previously unrecognised “head-anchored” FoRs. In English, angular-anchored relative FoRs dominate in both locative and orientation descriptions. In contrast, in Seri and Yucatec, two indigenous languages of Mexico, object-centred angular-anchored FoRs dominate in locative descriptions, but head-anchored FoRs dominate in orientation descriptions.

Keywords: indigenous languages of Mexico, location, orientation, semantic typology

1. Introduction

This chapter, as in many other contributions to this volume, deals with the problem of coordinate systems used in regions of space and time (see Langacker, this

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volume; da Silva Sinha et al., this volume; Wallington, this volume). More specifically, we discuss the role of spatial frames of reference (FoRs) in location and orientation descriptions. Spatial frames of reference are coordinate systems that partition space into distinct regions that serve as search domains for the interpretation of spatial relators in language and cognition. These relators can be used to locate entities and describe their orientation and motion. Various classifications of FoRs have been proposed. In the psychological literature (e.g. Carlson-Radvansky and Irwin 1993; Wassmann and Dasen 1998; Li and Gleitman 2002), a ternary classification into egocentric or viewer-centred, intrinsic or object-centred, and geocentric or environment-centred frames is widely used. The basis of this classification is what Danziger (2010) calls the *anchor* of the FoR: the entity or feature that serves as the model for the axes of the coordinate system. In egocentric FoRs, the anchor is the body of the viewer; in object-centred FoRs, it is the reference entity or *ground*; and in geocentric FoRs, it is some environmental entity or feature. A different classification was developed by the members of the Cognitive Anthropology Research Group at the Max Planck Institute for Psycholinguistics in the 1990s (Levinson 1996, 2003; Pederson et al. 1998; cf. also Pederson 2003; Danziger 2010). The Nijmegen classification singles out those egocentric FoRs that involve transposition of the coordinate system from the body of the observer onto an external ground as *relative*. Likewise, a proper subclass of geocentric FoRs is singled out as *absolute*: those that involve abstraction of the coordinate system from its environmental anchor such that its axes are defined by fixed bearings regardless of where the origin – in locative descriptions always the ground – is located vis-à-vis the anchor. All other FoRs, whether they are egocentric, geocentric, or neither, are grouped into a super-large *intrinsic* category. Consider the Examples in (1)–(2):

- (1) a. The ball is left/in front of the chair.
b. The ball is left/in front of me.
- (2) a. The ball is toward the door from the chair.
b. The ball is seaward from the chair.
c. The ball is uphill from the chair.

In terms of the traditional psychological classification, (1a) is ambiguous between egocentric and object-centred interpretations, whereas (1b) is unambiguously egocentric. In contrast, following the Nijmegen classification, (1a) is ambiguous between a relative and an intrinsic sense, whereas (1b) is unambiguously intrinsic, not relative, since it does not involve transposition of the coordinate system. The descriptions in (2) are geocentric on the classification preferred in the psychological literature. The frames in (2a) and (2b) are what we call *landmark-based* in this article: their axes point towards a local landmark, which happens to be human-made in (2a), but a landscape entity in (2b). In contrast, (2c) exhibits what we call

a *geomorphic* FoR: the axis does not point towards the anchor, the hill or mountain, but is transposed or abstracted from the slope of it. In the Nijmegen classification, (2a) is treated as intrinsic, whereas (2b) and (2c) could be either intrinsic or absolute. Suppose the ball and chair, as a configuration, without changing their location and orientation with respect to one another, are moved from a location at which (2b) is true along a straight line to some place on the other side of the ‘sea’. If (2b) continues to be true after this transformation, it is considered absolute; otherwise, it is treated as intrinsic. Similarly, (2c) is considered absolute if it can be true of the same configuration of ball and chair on either side of the mountain and intrinsic otherwise. In reality there are no known dialects of English in which (2b) or (2c) is used absolutely. The Nijmegen classification is motivated by data from language typology. From a typological perspective, the relative egocentric interpretation of (1a) should be distinguished from the intrinsic egocentric interpretation of (1b) because the former does not occur, or occurs only marginally, in many languages, whereas the latter appears to be available universally. Similarly, while intrinsic geocentric FoRs are available in all languages – including, as (2) demonstrates, in English – absolute ones are much more restricted. The only type of absolute FoR used in English that we are aware of is the system of cardinal compass directions, and its use is largely restricted to geographic-scale space – descriptions such as ‘The ball is east of the chair’ are not used at all by most native speakers.

In this chapter, we introduce a distinction between two *anchoring types* of FoRs that cross-cuts both the psychological classification and the typological one. Both egocentric and geocentric FoRs can be either *angular-anchored*, in which case their axes are derived through transposition or abstraction from axes or gradients of the anchor, or *head-anchored*, in which case their axes point towards the anchor. Object-centred descriptions are by necessity angular-anchored. The descriptions in (1), in the context of their egocentric interpretations, involve angular-anchored FoRs. Examples of head-anchored egocentric descriptions are shown in (3):

- (3) a. The ball is toward me with respect to the chair.
- b. The ball is on my side of the chair.

Geomorphic descriptions such as (2c) are angular-anchored, whereas landmark-based descriptions such as (2a) and (2b) are head-anchored. In the Nijmegen classification, head-anchored egocentric descriptions such as those in (3) are necessarily intrinsic, whereas angular-anchored egocentric descriptions can (and generally will) have both intrinsic and relative interpretations. Both angular-anchored and head-anchored geocentric FoRs can be intrinsic or absolute depending on whether their axes are merely transposed or abstracted from those of the anchor. Table 1 summarises the relationship between the three classifications.

Table 1. Existing classifications of FoRs and anchoring type

Psych. classification	Egocentric				Object-centred		Geocentric			
typological classification	intrinsic		relative		intrinsic		intrinsic		absolute	
anchoring type	ang.-anch.	head-anch.	ang.-anch.	head-anch.	ang.-anch.	head-anch.	ang.-anch.	head-anch.	ang.-anch.	head-anch.
comment	“direct” in Danziger (2010)			N/A		N/A	“geomorphic”	“landmark-based”		
example (locative descriptions)	<i>The ball is left/ in front of me</i>	<i>The ball is on my side of the chair</i>	<i>The ball is left/in front of the chair</i>		<i>The ball is left/in front of the chair</i>		<i>The ball is uphill/downriver from the chair</i>	<i>The ball is toward the door/sea-ward from the chair</i>	<i>The ball is north of the chair</i>	N/A

We intend the classification by anchoring type as complementary to the existing classifications of FoRs, not as replacing any of them. We show that the two anchoring types have distinct effects on the truth conditions of representations employing them: angular-anchored FoRs depend on the *orientation* of the anchor, whereas head-anchored FoRs depend on the *location* of the anchor. We examine the role of anchoring type in spatial descriptions of Seri and Yucatec, two indigenous languages of Mexico, which in terms of the typological classification show a preference for intrinsic over relative and absolute FoRs. In both Seri and Yucatec, angular-anchored FoRs dominate in locative descriptions, whereas head-anchored FoRs dominate in orientation descriptions. In contrast, in English, relative FoRs are the predominant choice in both types of spatial representations. We propose an explanation of these cross-linguistic differences in terms of two factors: the preference for intrinsic FoRs in Seri and Yucatec combined with the (language-independent) unavailability of object-centred FoRs in orientation descriptions. En passant, we offer a reanalysis of Terrill and Burenhult’s (2008)

treatment of orientation as an alternative to FoRs and to the treatment of orientation in terms of metaphorical path functions in Jackendoff (1983).

We begin our discussion with a background on previous research on FoRs and the role that orientation has played in these studies, as well as a discussion for the motivations of this study. We then introduce the methods we used for data collection, as well as some background information on the languages under study. The following section presents the relevant data from Seri and Yucatec, including detailed descriptions of FoR preferences in both languages. Section 5 presents a more in-depth and technical discussion of the two types of FoRs, based on their anchoring properties, and the role of FoRs in locative and orientation representations. We examine the logical properties of angular-anchored and head-anchored FoRs and propose explanations for their distribution in locative and orientation descriptions across languages. Section 6 concludes.

2. Orientation and frames of reference

We are not the first to notice a connection between FoR use and the orientation of entities. In previous cross-linguistic research into the use of FoRs in discourse, a battery of tasks and stimuli developed during the 1990s by the Cognitive Anthropology Research Group (CARG) – now the Language and Cognition Group – at the Max Planck Institute for Psycholinguistics has played a prominent role. The most widely used among these for the study of FoRs in representations of static spatial configurations is the Men and Tree (M&T) task developed by Eve Danziger and Eric Pederson and released with the very first CARG field manual in November 1992. M&T features four sets of twelve photos each, designed for a picture-to-picture matching referential communication task. The target pictures show a toy man and a toy tree in various spatial configurations. They differ from one another in terms of the orientation (i.e. facing direction) of the man and the locations of the man and the tree in the pictures – these are the types of information participants have to rely on to match the pictures. In the analysis of M&T data, it was noted early on that the FoRs preferred by the speakers of particular languages may differ between representations of “standing information” and “facing information”; cf. in particular Levinson and Wilkins (2006: 545–547).

Terrill and Burenholt (2008) introduce a new perspective, comparing M&T data from two languages whose speakers use, in terms of the typological classification developed by CARG, (almost) exclusively intrinsic FoRs in discourse: the Mon-Khmer language Jahai of Malaysia and the Papuan language Lavukaleve of the Solomon Islands. Terrill and Burenholt show that speakers of both languages

make pervasive use of a strategy that on the authors' account avoids the encoding of "standing", i.e. locative, information altogether, relying instead on combinations of two orientation descriptions to identify and match the pictures: one that orients the man vis-à-vis some external cue and one that orients it with respect to the tree. The following example from Lavukaleve illustrates:¹

- (4) *Ali na o'ase me e-hamail fi*
 LAV man(M) ART.SG.M bush SPEC.SG.N 3SG.N.O-towards 3SG.N.FOC
fala-re o-lei, houla la o-mutuo-n
 stand-NF 3SG.SBJ-exist tree.F ART.SG.F 3SG.POSS-back-LOC
 'The man is standing facing/towards the bush, the tree at his back'
 (Terrill and Burenhult 2008: 116)

Syntactically, the second clause of (4), which is translated as 'the tree at his back', is actually a locative description, albeit an atypical one in that it locates a normally unmovable *figure*, a tree, with respect to a movable ground, a person; we return to this point shortly. Terrill and Burenhult treat this clause as an orientation description with the man as figure in semantic terms due to the equivalence of the proposition 'The tree is behind the man' on its object-centred interpretation with the proposition 'The man's back is turned towards the tree.' They argue that orientation descriptions represent an alternative strategy that allow speakers of Jahai and Lavukaleve to avoid using FoRs altogether. We would like to suggest a different analysis of Terrill and Burenhult's data. Where we disagree is in the assumption that orientation descriptions do not require FoRs for their interpretation. Descriptions such as (5) and (6), produced by Dutch and Arrernte speakers during the M&T task, clearly involve relative (5) and absolute (6) FoRs.

1. The following abbreviations are used in the interlinear glosses: 1/2/3 – 1st/2nd/3rd person; A – cross-reference set A (actor, possessor); ARR – Arrernte; B – cross-reference set B (undergoer, theme of stative predications); ABS – absolutive; ART – article; CAUS – causative; CL – (numeral/possessive) classifier; CONT – continuous; D1 – proximal deictic particle; D2 – distal/anaphoric particle; D3 – text-deictic particle; D4 – place-anaphoric particle; DADV – demonstrative adverbial base; DEF – definite; DEP – dependent; DET – adnominal demonstrative/determiner base; DIM – diminutive; DIS – dispositional stative derivation; DP – distant past; DUT – Dutch; EXFOC – extra focal status inflection; EXIST – locative/existential predicator; F – feminine; FOC – focus marker; HESIT – hesitation; IMPF – imperfective aspect; IN – inanimate (classifier); INC – incompletive status inflection; INCH – inchoative derivation; IRR – irrealis; LAV – Lavukaleve; LOC – locative; M – masculine; N – neuter; NF – non-finite; NMLZ – nominaliser; NPP – non-past progressive; O – object; OBL – oblique; POSS – possessive; PL – plural; PREP – generic preposition; RC – relative clause; REAL – realis; REL – relational derivation/nominaliser; RES – resultative derivation; RP – recent past; SBJ – subject; SEI – Seri; SG – singular; SPEC – specifier; SR – switch reference; SUP – superlative; UNSPEC – unspecified; YUC – Yucatec.

- (5) *En de foto waarvan ze naar links kijken...*
 DUT and the photo of which they to the left look
 ‘And the photo on which they look to the left ...’
 (van Staden, Bowerman, and Verhelst 2006: 508)
- (6) *Nhenhe-le alturle-theke atne-rlē.ne-me-rlē...*
 ARR this-LOC west-wards stand-CONT-NPP-RC
 ‘In this one (he’s) standing (facing) westwards...’ (Wilkins 2006: 55)

The same kinds of mental computations used in relative and absolute locative descriptions to create coordinate systems that assign regions to the reference of locative relators (“place functions” in the framework of Jackendoff 1983; “localizers” in that of Kracht 2002) are used here to create coordinate systems whose axes serve to interpret directional expressions (‘to the left’, ‘westwards’). We speculate that Terrill and Burenhult consider the first clause of (4) a more prototypical example of an orientation description. This is an instance of what we consider a head-anchored description: instead of a transposition of axes from the body of an observer, as in (5), or a system of axes abstracted from the environment, as in (6), it involves the definition of a direction in terms of the location of an entity (‘the bush’) that this direction “points to”. In treating this as the prototype of representations of orientation, Terrill and Burenhult may be making a similar assumption to Jackendoff (1983: 166–174), who proposes that orientation is encoded in terms of the conceptual “path functions” TOWARD and AWAY-FROM, which take objects or places as their arguments and return motion paths. In the case of representations of orientation, these motion paths are interpreted metaphorically, along the lines of Talmy’s (1996) “fictive motion” (see also Langacker, this volume). In this format, the meaning of the first clause of (4) might be represented as in (7):

- (7) [_{State} ORIENT ([_{Thing} MAN], [_{Path} TOWARD ([_{Thing} BUSH])])]

It is impossible, however, to analyse (5) and (6) in this fashion. ‘Left’ and ‘west’ are inherently directional terms. Rather than being defined as pointing towards some entity or place, they name the axes of coordinate systems used in their turn to define places at which entities are located.² Moreover, as we demonstrate with English pilot data in Section 4, it is by no means obvious that descriptions of type (4) are more typical orientation descriptions than descriptions of type (5) in

2. ‘West’ may very well be defined as the direction pointing to the place on the horizon in which the sun sets. In this case, it functions as a head-anchored descriptor in our sense. However, if the direction denoted by the term is understood – in the language, dialect, and register at issue – as *abstracted* from the direction of the sunset in the sense discussed in Section 1, then there is no entity or place that could fill the argument position of the path function in (7).

English. Similarly, it is not obvious that (4), rather than (6), instantiates the prototype of orientation descriptions in Arrernte. We propose to overcome these weaknesses of Jackendoff's and Terrill and Burenhult's treatments of orientation by turning the underlying reasoning on its head. We claim that orientation descriptions *always* depend on FoRs. In cases such as (4), these are head-anchored FoRs, whereas in cases such as (5) and (6), they are angular-anchored (although (6) may have evolved from a non-abstracted celestial landmark system, which would be head-anchored on our account). The claim that the first clause of (4) involves a FoR is certainly not self-evident. In its defence, we point to locative descriptions such as those in (3) above, repeated here for the sake of convenience:

- (8) a. The ball is toward me with respect to the chair.
- b. The ball is on my side of the chair.

Just as the first clause of (4), (8a) involves a directional term. Formally, the reference of this term can be described as a *vector* whose head is marked by (the place occupied by) an entity – in this case, the speaker's body. In (8a), this vector is used to locate the figure, the ball, on it. The second example is slightly more abstract: here the vector projects an axis orthogonal to it which divides space into two regions, one containing the vector and one that does not contain it. What this illustrates, however, is that any vector has the logical power to define an entire coordinate system – a FoR. What lies at the heart of this power is the fact that the half-axes of coordinate systems are themselves vectors. This is precisely the reason why the terms labelling the axes of FoRs, such as '(to the) left' in (5) and 'west(wards)' in (6), are directional terms. We develop this argument more fully in Section 5. Furthermore, we suggest that if expressions of orientation and direction depend on FoRs for their interpretation, they should be treated on a par with place functions, and not in terms of metaphorical path functions, as Jackendoff suggests. Vectors seem to us the appropriate conceptual primitives for encoding the meanings of direction and orientation terms in conceptual structure.

But we still need to explain Terrill and Burenhult's finding that in descriptions of the M&T pictures in Jahai and Lavukaleve, representations of orientation often seem to supplant representations of location entirely. We think that this is an artefact of the M&T stimulus. A man and a tree make for non-prototypical spatial configurations. In prototypical locative scenes, the ground is less movable and more featured than the figure (Talmy 2000:183). The man and the tree split the key properties of mobility and horizontal asymmetry between them. The result is a clash. This clash has particularly important consequences in languages such as Jahai and Lavukaleve, which rely predominantly on intrinsic FoRs, since it is impossible to base object-centred descriptions on a ground that, like the tree,

lacks an intrinsic front–back axis. Our conjecture is that this clash may have been responsible for descriptions that, instead of locating the man with respect to the tree, either locate the tree with respect to the man (‘The tree is behind the man’) or orient the man with respect to the tree (‘The man has his back toward the tree’). We demonstrate this in Section 4 with data collected with a new stimulus, which avoids the feature clash of M&T, from speakers of Seri and Yucatec, two other languages that, like Jahai and Lavukaleve, favour intrinsic FoRs, following the Nijmegen classification of FoRs.

3. Data collection and methods

We ran the Ball and Chair (B&C) referential communication task (Bohnenmeyer 2008) with five pairs of native speakers per language of Seri and Yucatec Maya in our respective field sites. Like the Men and Tree (M&T) task described in the previous section, this referential communication task involves four sets of twelve photographs. The B&C pictures all show a ball and a chair in varying spatial configurations; examples are reproduced in Section 4. B&C thus avoids the clash between properties relevant to figure–ground assignment in the M&T stimuli that we blame for the paucity of prototypical locative descriptions in Terrill and Burenhult’s (2008) data. These photographs are used in a photo-to-photo matching task, where in each trial two speakers sit side-by-side with a visual barrier in between them and try to match the twelve photographs in each set only using verbal communication. One of the speakers takes on the role of “director”. The job of this participant is to pick the photographs of the set one by one and describe them to the other speaker, the matcher, enabling them to pick the matching pictures.

Yucatec is a language of the Yucatecan branch of the Mayan language family.³ It is spoken across much of the Yucatan Peninsula, in the Mexican states of Campeche, Quintana Roo, and Yucatán and the north-western districts of Cayo, Corozal, and Orange Walk of Belize. Dialect differentiation is low; all contemporary varieties are readily mutually intelligible. The Seri language, on the other hand, is a language isolate spoken in two small coastal villages in north-western Sonora, Mexico by the Seri people, known to themselves as *comcaac* ‘Seri people’. The two Seri villages are *Haxöl Iihom* ‘El Desemboque (del Rio San Ignacio)’ and *Socaaix* ‘Punta Chueca’. As of 2007, there were around 900 speakers of

3. Only languages of the Yucatecan branch are called *Maya* by their speakers. Scholars have extended this term to the language family and invented the technical term *Yucatec* as a distinguisher for the largest of the languages that gave origin to the family name. The Mexican government and public media refer to Yucatec as *Maya*.

Seri (Lewis 2009). The two Seri villages are located along the coast of the Gulf of California north-west of Hermosillo, Sonora. There have been previous studies on the structure and semantics of spatial descriptions in both Yucatec and Seri, which have included more detailed descriptions of FoR preferences (Bohnemeyer 2011; O'Meara 2011) and works that cover larger components of spatial reference (Bohnemeyer and Stolz 2006; O'Meara 2010).

The Seri data were collected in the fall of 2008 with five pairs of native speakers in the Seri village of El Desemboque in north-western Sonora, Mexico. The native speaker consultants were eight women ranging from their teens to 60s and two men ranging from their 20s to 40s. All of them live in El Desemboque and were born in the larger Seri territory. Nine out of the ten speakers are bilingual (the tenth speaker has a very passive knowledge of Spanish). All learned Seri as their first language and Spanish was introduced primarily through school. Three of the five pairs were all-female dyads, while the other two were mixed with respect to gender. Four of the five trials were run inside the houses of the native speakers and only one was run outside.

The Yucatec data were collected with five pairs of Yucatec speakers in the summer of 2008 in Yaxley, a village of approximately 600 people in central Quintana Roo, Mexico. The participants were five men in their 30s to 60s and five women in their late teens to 40s. All participants were tested in a room rented by the first author in Yaxley, sitting side by side facing due north at a table whose longest axis was oriented in an east–west direction. As previous research has shown that cardinal direction terms play a significant role in reference to “manipulable” space (cf. Section 4) in Yucatec (Bohnemeyer and Stolz 2006; Le Guen 2006), this layout was chosen to ensure that the use of such terms would not be suppressed by the orientation of the table and the participants. All Yucatec participants are fluent in Spanish, but all except for one married couple use predominantly Yucatec in their everyday interactions.

4. Seri and Yucatec data

This section presents data on locative and orientation descriptions in Seri and Yucatec collected with the B&C task. The corpus includes 240 descriptions of B&C photos for Yucatec and 215 descriptions⁴ of B&C photos for Seri. Nearly all of the descriptions encoded the location of the ball in the photos and around 80 per cent encoded the orientation of the chair in the photos.

4. Descriptions of 240 B&C photos were recorded for Seri, but only 215 have been transcribed at this point.

4.1 Locative descriptions

Following Piaget and Inhelder (1956), the conceptually simplest kind of locative descriptions are “topological” ones, which do not involve a FoR. Take, for example, the following descriptions in English in (9) and (10):

(9) The ball is near the chair.

(10) The ball is at the chair’s corner.

This type was instantiated by 67.3 per cent of the locative descriptions in Seri and 52.4 per cent of the locative descriptions in Yucatec. Examples of topological descriptions in each of the languages are provided in (11) and (12), respectively (see Figures 1 and 2).

- (11) (...) *i-hiin hac, ziix c-oqueht quij*
 SEI 3POSS-near DEF.ART.SG.LOC thing SBJ.NMLZ-bounce DEF.ART.SG.sit
i-ti mijj.
 3POSS-on RP.sit
 ‘(...) the ball (lit. thing that bounces) is near it [the chair].’



Figure 1. B&C photograph 2-12, described in (11)

- (12) (...) *te'l tu'x k-u=kutal máak=o', te=lu'm=o',*
 YUC DADV where IMPF-A3=sit-INCH.INC person=D2 PREP:DET=earth=D2
hun-p'éeel bòola pek-ekbal hach tu=tu'k'o'.
 one-CL.IN ball lie.as.if.dropped-DIS(B3SG) really PREP:A3=corner=D2
 ‘(...) there where one sits, on (lit. with respect to) the ground, a ball is lying, right at its corner.’

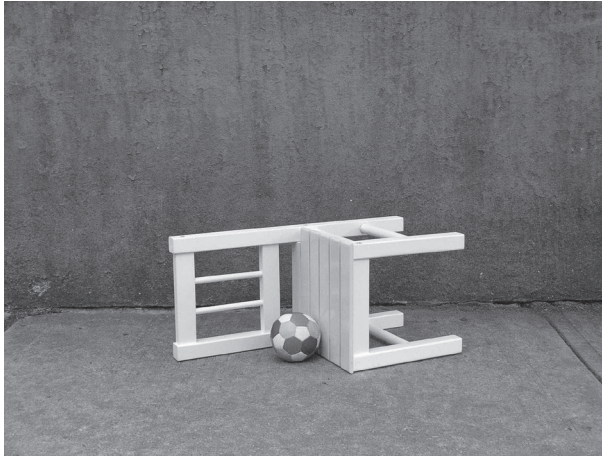


Figure 2. B&C photograph 2-6 described in (12)

In addition to topological descriptions, speakers of both languages provided locative descriptions that involve object-centred intrinsic FoRs. This type was instantiated by 19.9 per cent of the locative descriptions in Seri and 50.2 per cent of the locative descriptions in Yucatec.⁵ Examples of this type are provided in (13) for Seri and in (14) for Yucatec (see Figure 3).

- (13) (...) *i-pac iicp hac, i-toaa iicp*
 SEI 3POSS-back 3POSS.side DEF.ART.SG.LOC 3POSS-foot 3POSS.side
hac hiic c-aap cap
 DEF.ART.SG.LOC 1POSS.side SBJ.NMLZ-stand DEF.ART.SG.stand
ha ziix c-oqueht quij i-ti yij.
 FOC thing SBJ.NMLZ-bounce DEF.ART.SG.sit 3POSS-on DP.sit
 ‘(...) the ball is **behind** it [the chair] and on the side of the leg that is on my side.’

- (14) (...) *tu=tséel=i’, bwèeno, tu=pàach*
 YUC PREP:A3=side=D4 well PREP:A3=back
te’l tu’x k-u=nak-tal máak=o’
 DADV where IMPF-A3=lean-INCH.DIS person=D2
 ‘(...) on its side, well, **behind** where one sits’

5. There is a one-to-one relation between locative or orientation description propositions and FoRs, but a one-to-many relation between picture descriptions and locative/orientation description propositions. The percentages presented here reflect the shared spatial descriptions of a given type (locative vs. orientation) that contain one or more proposition interpreted in a FoR of a given type.

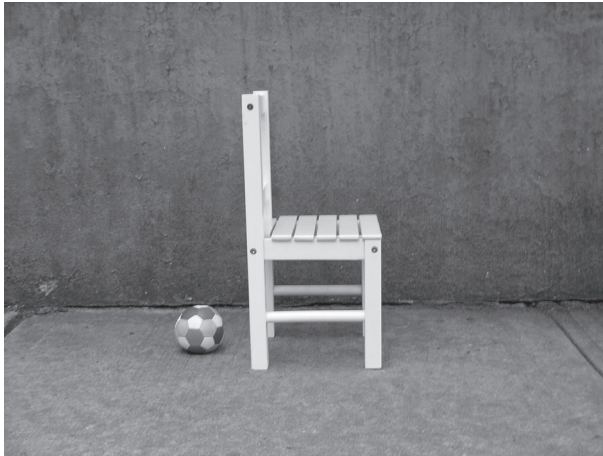


Figure 3. B&C photograph 2-11, described in (13)–(14)

These object-centred descriptions are prototypical locative descriptions, semantically as well as syntactically, as the ground, the chair, has an inherent front–back axis whereas the figure, the ball, does not. There is thus no reason to analyse these representations as covert orientation descriptions along the lines of Terrill and Burenhult’s (2008) analysis of examples of the kind illustrated in (4).

Locative descriptions involving a relative FoR occur in 18.6 per cent of the Yucatec locative descriptions and in 12.8 per cent of the Seri locative descriptions. A Yucatec example is provided in (15) and a Seri example is provided in (16) (see Figure 4).

(15) *Ti’=pek-kun-a’n*

YUC PREP=lie.as.if.dropped-CAUS-RES(B3SG)
hun-p’èel chan=bòola=i’ tu=tséel=e’
 one-CL.IN DIM=ball=D4 PREP:A3=side=D3
 ‘There lies a little ball, on (the chair’s) side.’

(16) (...) *hi-nol aapa quih iic hac,*
 SEI 1POSS-arm enormous DEF.ART.SG.UNSPEC 3POSS.side DEF.ART.SG.LOC
ziix c-oqueht quih hai cop
 thing SBJ.NMLZ-bounce DEF.ART.SG.UNSPEC wind DEF.ART.SG.stand
ano cola tiij, i-ti yij.
 3POSS.in up IRR.DEP.sit 3POSS-on DP.sit
 ‘(...) the ball is on my right (lit. my enormous arm) side and it is in the air.’



Figure 4. B&C photograph 2-1 described in (15) and (16)

Both Seri and Yucatec have available absolute FoRs for reference to “manipulable” and intermediate-scale space in the horizontal plane, however, in the case of Seri, the use of absolute FoRs is limited to older speakers. We assume here a broad distinction among three scales that the use of FoRs tends to be sensitive to: manipulable space, where the distances between objects that can easily be moved by humans do not vastly exceed their dimensions; geographic-scale space, populated by geographic entities; and intermediate-scale space.⁶ The configurations featured in the B&C pictures are at the manipulable scale. In languages such as Dutch, English, and Japanese, the use of absolute FoRs tends to be restricted to geographic-scale space (Levinson 1996, 2003; Levinson and Wilkins 2006; Majid et al. 2004; Pederson et al. 1998). English pilot data collected with the B&C task from four dyads of University at Buffalo undergraduates indeed do not contain a single instance of absolute usage. Not so in Seri and Yucatec. In Seri, this FoR type occurs with terms that refer to the directions of the wind. Yucatec has a celestial system. The terms for ‘east’ and ‘west’, *lak’in* and *chik’in*, etymologically refer to sunrise and sunset, respectively, and are understood to denote the places of sunrise and sunset on the horizon on the solstices (Villa Rojas 1988: 127–134). The terms customarily identified with ‘north’ and ‘south’ on the European compass, *xaman* and *nohol*, appear to denote directions defined as orthogonal to those described by *lak’in* and *chik’in* (cf. Paxton 2001: 23–25). 15.2 per cent of the Yucatec locative descriptions and less than 1 per cent of the Seri locative descriptions are of this type. The low number of occurrences of this type of description in Seri has

6. Cf. Tversky et al. (1999) for a different, but related, three-way classification.

to do with the fact mentioned above, that this FoR type is limited to older speakers and due to the fact that the second author ran the B&C task with primarily younger speakers, the numbers seem to be correspondingly low. An example of a locative description involving an absolute FoR in Yucatec is provided in (17) (see Figure 5).

- (17) *Te'l chik'in=o', náats' te=lu'm=o',*
 YUC DADV west=D2 near(B3SG) PREP:DET=earth=D2
ti'=pek-ekbal hun-p'èel 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.'



Figure 5. B&C photograph 3-12 described in (17)

Additionally, 19 per cent of the Seri and 24.7 per cent of the Yucatec locative descriptions employed an absolute FoR in the vertical plane (i.e. a FoR that involves gravitational force).

The new FoR type that we are proposing here, namely the head-anchored type, accounts for 16.6 per cent of Seri locative descriptions and 10.8 per cent of Yucatec locative descriptions. In this FoR type, the anchor is frequently the body of the speaker or the addressee, as is the case in Examples (18) and (19) from Seri and Yucatec, respectively (see Figure 6).

- (18) (...) *cmaax ziix c-oqueht quij*
 SEI now thing SBJ.NMLZ-bounce DEF.ART.SG.sit
hiicp hac ah iic mij.
 1POSS.side DEF.ART.SG.LOC FOC 3POSS.side RP.sit
 '(...) and now the ball (lit. thing that bounces) is **on my side**.'

- (19) *Te=pàarte t-ak=tòoh-il-o'n bèey he'x kul-ik-o'n*
 YUC PREP:DET=part PREP-ALPL=straight-REL-B1PL thus how sit-EXFOC-B1PL
bèey=a', ti'=pek-a'n te=lu'mo' hun-péel bòola
 thus=D1, PREP-lie.as.if.dropped-RES(B3SG) PREP=earth=D2 one-CL.IN ball
 'In the part in our direction the way we are sitting like this, there is a ball
 lying on the ground'



Figure 6. B&C photograph 3-10 described in (18) and (19)

These descriptions are *egocentric, but not relative*, since they do not involve a transposition of the axes of the viewer's body onto the ground, the chair. Consequently, their truth conditions do not depend on the orientation of the observer, as they would in a relative FoR. But neither are they object-centred, witness the independence of their truth conditions regarding the orientation of the chair.

Descriptions involving the head-anchored FoR type can also have an environmental entity as the anchor of the FoR, giving rise to a geocentric variant. An example of such a description in Seri is provided in (20), uttered with respect to the photograph in Figure 1.

- (20) (...) *ziix c-oqueht quij hant com*
 SEI thing SBJ.NMLZ-bounce DEF.ART.SG.sit land DEF.ART.SG.lie
i-ti tij ma, haco mos iglesia cop
 3POSS-ON REAL.DEP.sit SR already again church DEF.ART.SG.stand
iicp hac iicp tij...
 3POSS.side DEF.ART.SG.LOC 3POSS.side REAL.DEP.sit
 '...the ball (lit. thing that bounces) is on the ground, again, it is **on the side of the church...**'

Similar to the previous examples, the truth conditions of the description in (20) do not depend on the orientation of the anchor, in this case, the church. There is a coordinate system involved here, based on an axis through the ground – the chair – which divides space into a region containing the church and one that does not contain it. However, this axis is not modelled after an axis of the church, so the resulting FoR does not function like a geomorphic system. And, again, the system is clearly not derived from the axes of the ground, either – the truth of the description does not depend on the orientation of the chair so the FoR cannot be object-centred. Such head-anchored FoRs occur in 10.4 per cent of the Yucatec descriptions locating the ball vis-à-vis the chair. Nineteen of the twenty-four examples are of the egocentric type. There were six geocentric propositions; these were produced by a single dyad (five of them by the same speaker, in fact). Head-anchored FoRs occur in 14 per cent of the Seri locative descriptions, with twenty-nine of the thirty-five descriptions being of the geocentric type.

4.2 Orientation descriptions

This section looks at the types of descriptions used in the B&C task to provide information about the orientation of the chair. In such descriptions, Yucatec speakers frequently use cardinal direction terms and relative ‘left’ and ‘right’ terms. These two types account for around a third of the orientation descriptions collected from the B&C task. Examples of such orientation descriptions in Yucatec are provided in (21) and (22) (see Figures 7 and 8).

(21) (...) *le=pàarte tu’x k-u=kutal máak=o’*
 YUC DET=part where IMPF-A3=sit:INCH.INC person=D2
chik’in súut-ul (...)
 west turn\MIDDLE-INC(B3SG)
 ‘(...) the part where one sits, it’s **turned west** (...)’

(22) (...) *u=ho’l le=siiya=o’, estéen, x-no’h súut-ul*
 YUC A3=head DET=chair=D2 HESIT F-right(B3SG) turn\MIDDLE-INC(B3SG)
 ‘(...) the backrest (lit. head) of the chair, it’s **turned right**’

Of the Yucatec orientation descriptions 25.4 per cent featured absolute propositions and 17.5 per cent relative ones. In Seri, absolute propositions play a more marginal role in orientation descriptions with only 3.4 per cent of the descriptions being of this type. Relative propositions in Seri, however, are featured in 17.6 per cent of orientation descriptions. An example of such a proposition is provided in (23) (see Figure 9).

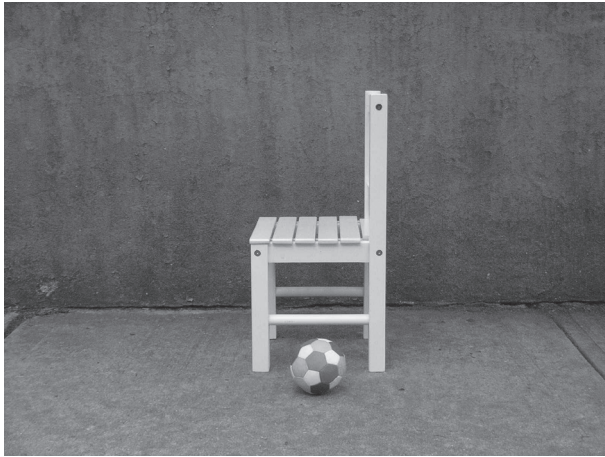


Figure 7. B&C photograph 3-9 described in (21)

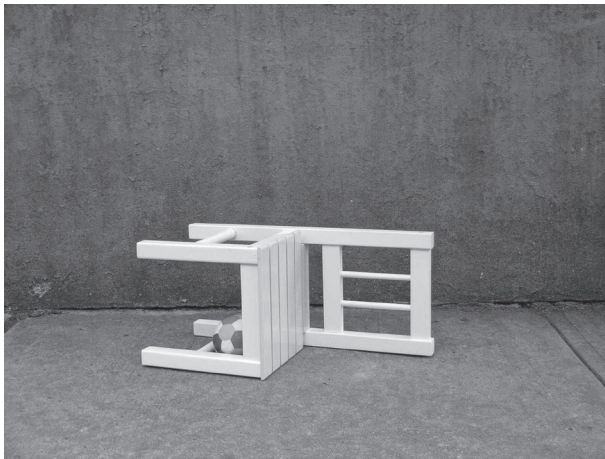


Figure 8. B&C photograph 1-12 described in (22)

- (23) *Hehe i-ti iquiicolim quij cmaax*
 SEI wood 3POSS-on OBL.NMLZ.ABS.POSS.sit.PL DEF.ART.SG.sit now
hi-nol aapjoj iicp hac iiqui
 1POSS-hand enormous.PL 3POSS.side DEF.ART.SG.LOC 3POSS.toward
tiizc ma (...)
 REAL.DEP.face SR
 ‘Now the chair is facing **our right** (...)’

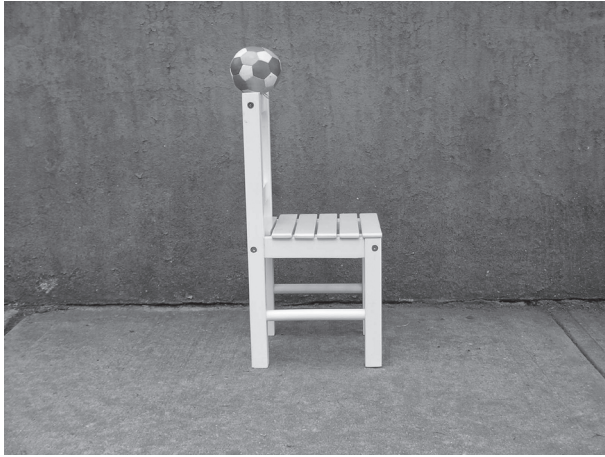


Figure 9. B&C photograph 1-1 described in (23)

The existence of these types of descriptions is important because it shows that orientation descriptions can occur with “traditional”, angular-anchored FoRs, as pointed out in Section 2.

However, the large majority of orientation descriptions in both Yucatec and Seri involve the new type of FoR discussed here, namely, the head-anchored type. As was discussed with respect to locative descriptions, these types of orientation descriptions are anchored either egocentrically, to the body of the speaker or addressee, or geocentrically, to some external landmark. In terms of descriptions that involve the speaker’s or addressee’s body as the anchor of the FoR, 51.7 per cent of the Seri and 75.7 per cent of the Yucatec orientation descriptions involve this type. The truth conditions of these types of descriptions do not depend on the orientation of the speaker’s or addressee’s body, as is the case with relative descriptions such as (22) above. Examples of such egocentric head-anchored orientation descriptions in Seri and Yucatec are provided in (24) and (25), respectively (see Figure 10).

- (24) *Hehe i-ti iquicolim quij*
 SEI wood 3POSS-on OBL.NMLZ.ABS.POSS.sit.PL DEF.ART.SG.sit
hiiqui t-ipac ma (...)
 1POSS.toward REAL.DEP-3POSS.back SR
 ‘The chair (lit. wood one sits on) has its back to me (...)’

- (25) *Tu'x k-u=nak-tal máak=o',*
 YUC where(B3SG) IMPF-A3=lean.against-INCH.INC person=D2
estée ta=frèente súut-ul
 HESIT PREP:A2=front turn\MIDDLE-INC(B3SG)
 'The back (lit. where one leans against), uh, it's turned towards your front.'



Figure 10. B&C photograph 2-5 described in (24) and (25)

As for the orientation descriptions involving the head-anchored type of FoR where the anchor is an external landmark, 17.6 per cent of the Seri descriptions and 10.1 per cent of the Yucatec descriptions instantiate this type. Examples of such descriptions are provided in (26) and (27) (see Figures 11 and 12). In these descriptions, the orientation of the landmark does not affect the truth conditions of the description, as it does in descriptions involving an absolute FoR.

- (26) *Hehe i-ti iquicolim quij Xpanohax*
 SEI wood 3POSS-on OBL.NMLZ.ABS.POSS.sit.PL DEF.ART.SG.sit Puerto.Libertad
ücp hac üqui tiizc (...)
 3POSS.side DEF.ART.SG.LOC 3POSS.toward REAL.DEP.3POSS.face
 'The chair (lit. what one sits on) is facing Puerto Libertad (...)'
- (27) (...) *u=frèente tu'x k-u=kutal máak=o',*
 YUC A3=front where IMPF-A3=sit:INCH.INC person=D2
tu=tòoh-il le=kàancha=o'
 PREP:A3=straight-REL DET=COURT=D2
 '(...) its front where one sits, it's in a straight line with respect to the volleyball court.'

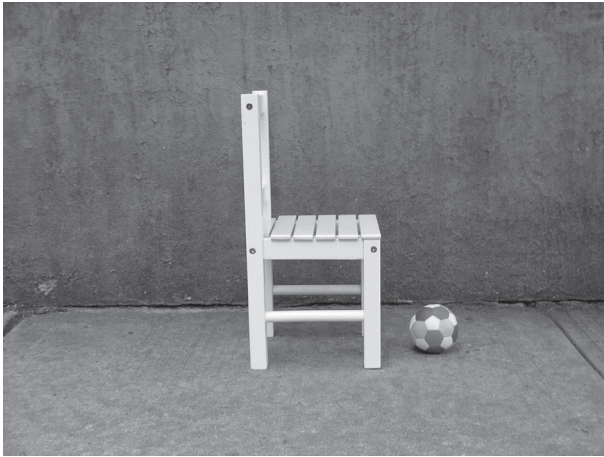


Figure 11. B&C photograph 2-10 described in (26)



Figure 12. B&C photograph 4-12 described in (27)

Overall, the head-anchored type of FoR occurs in 66.5 per cent of the orientation descriptions in Seri and 84.1 per cent of the orientation descriptions in Yucatec.

Summarising, three important findings emerge. First of all, in terms of the typological classification of FoRs developed at the Max Planck Institute for Psycholinguistics, both Seri and Yucatec are languages in which intrinsic FoRs dominate, just like Jahai and Lavukaleve in Terrill and Burenhult's (2008) characterisation. Seri can in fact be described as an intrinsic-only language, just like Mopan Maya of Belize and Guatemala (Danziger 2001, 2010) and the Austronesian language

Kilivila of the Trobriand Islands (Senft 2001, 2006),⁷ whereas Yucatec instantiates what Bohnemeyer (2011) calls a “referentially promiscuous” language, in which the intrinsic type still dominates, but the relative and absolute types are likewise common options in manipulable space.⁸ Yet, prototypical locative descriptions not only occur regularly alongside orientation descriptions, but are in fact more frequent than the latter. This supports our suspicion that the dominance of orientation descriptions that Terrill and Burenhult observed was an artefact of the Men and Tree task and not a property of Jahai, Lavukaleve, and other intrinsic-dominant languages.

Secondly, our proposed head-anchored strategy, in which one half-axis of a coordinate system is defined as a vector whose head is the anchor of the system, occurs not only with orientation descriptions, but also with locative descriptions. This is key evidence in support of our analysis of this strategy as involving a FoR, *contra* the complementarity of FoRs and (head-anchored) orientation descriptions that Terrill and Burenhult propose. And thirdly, while head-anchored locative descriptions are common in both Seri and Yucatec, the head-anchored type does not dominate among locative descriptions, whereas it strongly does so among orientation descriptions. Combined with the assumption that head-anchored descriptions are non-perspectival, i.e. do not involve FoRs, this prevalence of head-anchored orientation descriptions is a key factor in Terrill and Burenhult’s analysis. However, head-anchored orientation descriptions are not universally dominant. English pilot data collected with the B&C task with four pairs of University at Buffalo undergraduate students in the spring of 2008 show the relative type of FoRs to be dominant in both locative and orientation descriptions (52.1 per cent of locative descriptions and 71.9 per cent of orientation descriptions involve relative propositions), although here, too, the head-anchored strategy is much more frequent with orientation descriptions (31.9 per cent) than with locative descriptions, where they did not in fact occur at all.⁹

7. As in Seri, relative use occurs in Kilivila according to Senft (2006), but is rare. Senft discusses the widespread use of landmark-based descriptions, which he labels “absolute”. However, in the Nijmegen classification as laid out in Levinson (1996, 2003), these are classified as intrinsic, not absolute.

8. Another example of a referentially promiscuous language appears to be Ewe, the Gbe language of Ghana and Togo (Ameka and Essegbey 2006).

9. The English data were collected by the second author and Rodrigo Romero Mendez and coded by Randi Tucker. Seven of the eight participants were native speakers; the remaining one was an L1-Spanish speaker. However, no obvious linguistic differences between the native speakers and this L2 speaker appeared.

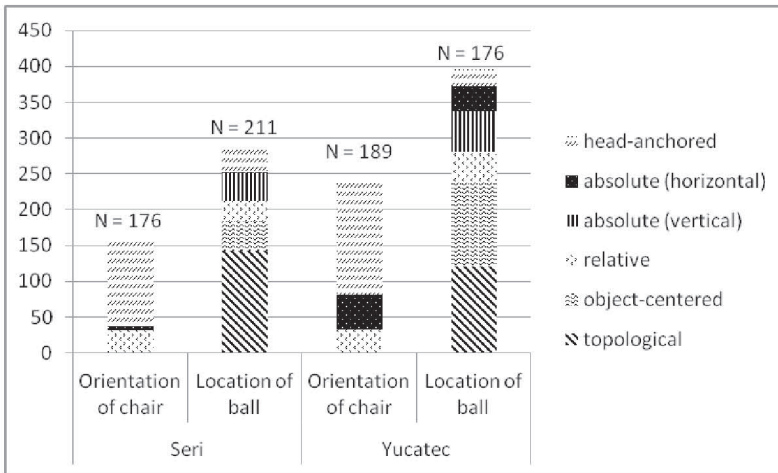


Figure 13. FoR distribution in Seri and Yucatec locative and orientation descriptions (the number N at the top of the bars is the number of locative/orientation descriptions in the particular language; the y-axis gives the number of descriptions containing propositions encoded in a FoR of the particular type)

In the next section, we provide a more explicit account of head-anchored FoRs. In the process, we offer explanations for both the dominance of the head-anchored type of FoRs in orientation descriptions in Jahai, Lavukaleve, Seri, and Yucatec and the relatively greater affinity of orientation descriptions to head-anchored FoRs compared to locative descriptions.

5. Frames of reference and vectors

The key notion that provides the link between FoRs and representations of orientation is that of *vectors*. We assume that vectors are semantic and cognitive primitives for the representation of orientation and direction of motion (see Bohnemeyer 2003; O’Keefe 1990, 1996, 2003; Zwarts 1997, 2003; Zwarts and Winter 2000). In this we disagree with Jackendoff (1983), who treats orientation in terms of metaphorical motion paths, as mentioned in Section 2.

We assume that in language and cognition, there are two ways in which one can define a vector: as an ordered pair of places, head and tail, and in terms of an ordered pair of a place, usually the tail, and an angle between the vector and the axis of some coordinate system. In English, the former format is tapped into by the prepositions *toward* and *away from*, whose arguments designate the head and tail, respectively, of sets of vectors. The second approach is instantiated by expressions such as *right*, *uphill*, *downstream*, and *(160°) SSE*. Only compass directions

admit specifications of the angle in English. In the absence of a specification, the angle is always interpreted as 0° . In this case, the angular direction expression effectively designates an axis of the FoR. In (28), the various direction expressions are illustrated in motion event descriptions.

- (28) a. The ball was rolling away from the door.
 b. The ball was rolling toward me.
 c. The ball was rolling right/uphill/downstream/(160°) SSE.

The location of the figure at reference time is understood as the head of the vector in (28a) and as the tail in (28b–c).

A FoR is a coordinate system of one or more axes centred on the referential ground in representations of location and the figure in representations of orientation and direction of motion. Each semi-axis can be represented as a vector whose tail is the origin of the FoR. In locative representations, the semi-axes define regions (cylindrical if the system includes only a single axis, cone-shaped otherwise) radiating out from the origin that contain the points closer to them than to any of the other axes. These regions are designated by place-functions (in Jackendoff's 1983 terms; cf. Section 2) interpreted in the particular FoR when the place functions take the ground, or the region occupied by it, as their argument. For example, the region intrinsically 'in front of' the ground is the set of points closer to the extension of the front semi-axis than to any other intrinsic axis of the ground, and the region relatively 'left of' the ground is the set of points closer to the transposition of the extension of the left semi-axis of the observer's body onto the ground by a vector from the observer's body's centre to that of the ground.

The orientation of an entity can be represented as an alignment between any one of its semi-axes and a suitably determined vector. Common expressions of orientation in English employ the verbs *face* and *turn*. Either of the two methods of defining vectors can be used with these. With *face*, the tail of the vector is always the centre of the figure. If the vector is specified in terms of tail and head, the object of *face* designates the head, as in (29). *Turn* takes an oblique prepositional phrase describing the head or tail, with the complementary constituent of the vector being understood to lie in the centre of the figure, as in (30).

- (29) The chair is facing me/the door.
 (30) The chair is turned toward/away from me/the door.

If the method of specifying a vector in terms of tail and angle is chosen, either verb combines directly with a directional expression, as in (31). In this case, the figure is always centred on the tail.

(31) The chair is facing/turned right/uphill/downstream/(160°) SSE.

The default semi-axis of the figure for representations of orientation in English, Seri, and Yucatec is the front semi-axis. That is how such utterances as in (29)–(31) are understood, as illustrated in Figure 14.

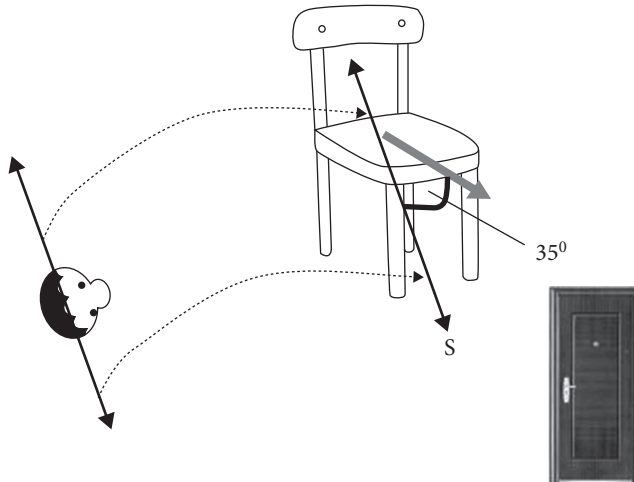


Figure 14. Chair, facing 160 SSE/right/the door

However, by specifying an appropriate part or feature of the object, any other unique semi-axis can be selected, as is the case in (32).

(32) The back/left of the chair is facing me/the door/right/uphill/downstream/(160°) SSE.

The angular-anchored and head-anchored types of FoRs can be characterised in terms of how their semi-axes, understood as vectors, are defined. In the case of the traditional angular-anchored type, the semi-axes are copied from those of the anchor through transposition or abstraction. The orientation of the semi-axes must be preserved in this process, so that they effectively behave like vectors defined as pairs of a place and an angle. In contrast, in the case of the head-anchored type proposed here, one semi-axis is constituted as a vector defined in terms of tail and head and the other semi-axes are derived from this base vector. The angular-anchored/head-anchored dichotomy needs no further justification: it follows from the fact that FoRs can be defined in terms of vectors in combination with the fact that vectors can be defined either in terms of tail and angle or in terms of tail and head. However, the existence of the dichotomy alone does not entail

that head-anchored orientation descriptions such as those in (29)–(30) or head-anchored locative descriptions such as those in (33), repeated from (3), indeed involve FoRs:

- (33) a. The ball is toward me with respect to the chair.
 b. The ball is on my side of the chair.

The claim that the interpretation of representations such as (29)–(30) and (33a) depends on FoRs may seem counter-intuitive, since they involve merely single vectors rather than entire coordinate systems. However, first of all, it is a general property of both orientation representations and locative representations that they require specifications of single vectors. Orientation representations use this vector to align a semi-axis of the figure with it, whereas place functions such as ‘in front of’ and ‘left of’ define regions as proximity zones with respect to it. Secondly, once a vector has been identified as one semi-axis of a coordinate system, all other semi-axes and therefore the FoR as a whole can be calculated from it. This could be interpreted to the effect that descriptions such as (29)–(30) and (33a) involve the information equivalent of a full FoR, but this FoR is not necessarily actually computed from the single specified vector. The situation is clearly different in (33b), which introduces a partitioning of space along a secondary axis (or rather a plane projected from it) through the centre of the chair that is orthogonal to the vector pointing to the speaker from the chair, as illustrated in Figure 15.

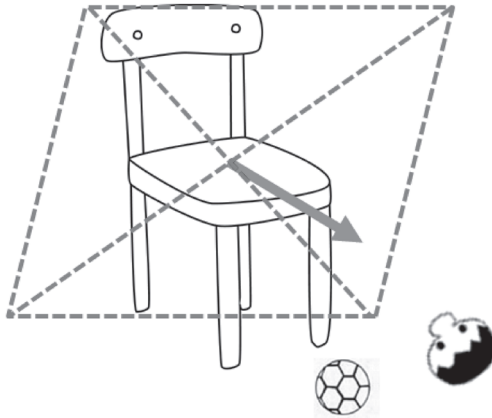


Figure 15. Vector partitioning space in head-anchored locative description

Descriptions of the kind instantiated by (33a), too, have interpretations under which the ball is not merely located *on* the vector, but in an area near it, analogous

to the interpretation of locative descriptions in angular-anchored FoRs as discussed above. Consider (34), a Yucatec description of Figure 16.

- (34) *T-u=tséel túun te=x-ts'íik, t-u=x-ts'íik máak=e' tí'*
 YUC PREP-A3=side then PREP:DET=F-left PREP-A3=F-left person=D3 there
yàan hun-p'èel bòolai', náats' y=iknal y=òok
 EXIST(B3SG) one-CL.IN ball=D4 near(B3SG) A3=at A3=leg/foot
xan, mas chan=kàabal xan, mas chan=kàabal
 also SUP DIM=low(B3SG) also SUP DIM=low(B3SG)
t-ak=tòoh-il-o'n.
 PREP:A1PL=straight-REL-1PL
 'On the side, then, on the left, on a person's left, there is a ball, near one of its legs again, a littler lower again, a little lower **in our direction.**'



Figure 16. B&C photograph 3-4 described in (34)

The phrase in boldface, *tak tòohilo'n* 'in our direction', is true of the ball in this case even though the ball is not located on the vector pointing from the centre of the chair toward the observer, but sideways of it. It designates the entire front region of the chair, just like the relator 'in front of' interpreted in a relative FoR.

With representations of orientation, such effects do not occur, since orientation functions designate vectors, not regions. However, there is another way in which head-anchored representations – of location and orientation alike – resemble angular-anchored representations: they are “perspectival”, i.e. their interpretation depends on a perspective. But there is a fundamental difference between the two types in how this perspective manifests itself: the truth conditions of angular-anchored representations depend on the orientation of the anchor, but not on its

location, whereas the truth conditions of head-anchored descriptions conversely depend on the location of the anchor, but not on its orientation. Consider, for illustration, the angular-anchored locative descriptions in (35):

- (35) a. The ball is left/in front of the chair.
- b. The ball is uphill from the chair.

The truth of (35a) depends, under the egocentric/relative interpretation, on the orientation of the observer vis-à-vis the chair and, under the object-centred interpretation, on the orientation of the chair. In the egocentric/relative interpretation, the truth of the representation changes as the observer's body rotates, while rotation of the chair does not affect it. In the object-centred interpretation, it is the inverse: it is in this case a rotation of the chair around its top-down axis that affects the truth conditions of the description. In contrast, changes to the location of the anchor – the body of the observer under the relative interpretation and the chair under the intrinsic one – have, at least in first approximation, no impact on the truth of the representation. This holds with the general proviso that relative FoRs tend to presuppose that the observer is facing the ground, and changes of the observer's position that affect the satisfaction of this presupposition may thus indirectly affect the truth conditions of the description. The same holds for (35b): its truth conditions are affected by the orientation of the hill, but not by the location of the hill. In this case, too, there is an independent constraint that muddies the waters somewhat. Imagine moving the hill from a location in which (35b) is true to the other side of the configuration of the ball and chair. Even if the direction vector from the ball to the chair that was identified as 'uphill' previously remains the same, it is likely that the configuration of ball and chair is now closer to a different slope of the hill and the vector will therefore be labelled 'downhill' (see Section 1).

The principal dependence of angular-anchored FoRs on the orientation of the anchor also holds for orientation descriptions such as that in (36):

- (36) The chair is facing left/uphill.

In Levinson (2003: 50–53), orientation dependence is in fact used as a diagnostic for distinguishing relative, intrinsic, and absolute FoRs. However, on closer inspection, the dependence on the orientation of the ground that Levinson considers a diagnostic of the intrinsic type in fact holds for object-centred FoRs only, but not for head-anchored intrinsic descriptions such as those in (37):

- (37) a. The ball is toward me/the door from the chair.
- b. The chair is facing me/the door.

In these cases, it is changes in the location of the anchor that affect the truth of the representation, whereas they are completely insensitive to the rotation of the anchor. This difference in the behaviour of angular-anchored and head-anchored FoRs follows straightforwardly from the difference in how their axes are constituted. The axes of angular-anchored FoRs are derived from those of the anchor through transposition or abstraction. As a result, the FoR rotates with the axes of the anchor. In contrast, head-anchored FoRs are calculated based on vectors defined in terms of their head and tail coordinates. The region occupied by the anchor characterises one of these two places. Consequently, the (semi-)axis of the FoR thus constituted changes with the location of the anchor, whereas its orientation plays no role.

We can now proceed to offer explanations for the distributions observed in the previous section. First, why is it that head-anchored FoRs are more common in orientation descriptions than in locative descriptions, in English, Jahai, Lavukaleve, Seri, Yucatec, and quite possibly universally? The answer appears to be that orientation descriptions require the specification of a vector that determines a semi-axis of the figure. There are two ways to do this: by specifying the head (if the figure is centred on the tail; if it is centred on the head, the tail needs to be specified) or by specifying an angle with respect to a semi-axis of some coordinate system projected onto the figure. The first solution, which produces head-anchored descriptions, seems conceptually simpler and therefore more efficient than the second, which yields angular-anchored descriptions. (However, that head-anchored orientation descriptions do not require the transposition of a system of axes onto the figure does not mean that calculating a vector to orient an entity does not *constitute* a coordinate system – we have argued above that it does.) In contrast, to locate the figure, a region containing the place occupied by it needs to be calculated. As discussed above, this region is defined in terms of proximity to a semi-axis. The head-anchored strategy at the very least offers no context-independent advantages over the angular-anchored strategy in this case. At a more abstract level, orientation and locative representations emerge as constituted by inverse operations: orientation representations require a place (the head or tail) in order to specify a vector, whereas locative representations require a vector (the semi-axis of a coordinate system) to specify a place (the region in which the figure is located).

The second distributional puzzle we would like to address is why the head-anchored strategy plays a much more important role in Seri and Yucatec orientation descriptions – occurring with 66.5 per cent and 84.1 per cent of them, respectively – than in English ones, where they are found a mere 31.9 per cent of the time. This, we submit, is due to a combination of two factors. First of all,

Seri and Yucatec, like Jahai and Lavukaleve according to Terrill and Burenhult's (2008) data, but unlike English, are languages in which the use of intrinsic FoRs, following the typological classification, dominates overall over that of absolute and relative FoRs. And secondly, the most important intrinsic strategy in locative descriptions, the use of object-centred FoRs, is not available in orientation descriptions. In locative descriptions, such FoRs are centred on the ground, extending its geometrical axes out into surrounding space. In orientation descriptions, the origin of the FoR is the centre of the figure – the very entity whose orientation is at issue. It is impossible to compute a FoR for the orientation of the figure from its own geometry, since that would amount to orienting the figure with respect to itself, something that cannot be done – orientation requires an extrinsic anchor. Given the general preference for an intrinsic solution, the absence of the object-centred option renders the head-anchored strategies the most prominent ones for Seri and Yucatec (and presumably also for Jahai and Lavukaleve) speakers.

6. Conclusion

Location and orientation are orthogonal spatial properties of entities. Both seem to be universally represented in language and cognition, and representations of both may depend on frames of reference (FoRs) for their interpretation. This parallelism discourages both the view of orientation as an alternative to FoR-dependent locative descriptions (Terrill and Burenhult 2008) and, at a more fundamental level, the idea that orientation is cognitively encoded in terms of metaphorical motion paths (Jackendoff 1983). Orientation is represented in terms of a vector aligning with one semi-axis of the figure to be oriented. Vectors are conceptual primitives used to orient entities, direct their motion paths, and define their semi-axes and those of FoRs. Vectors are cognitively encoded either as ordered pairs of head and tail regions or as ordered pairs of a tail region and an angle with respect to a semi-axis of some FoR. This duality of strategies introduces a previously unrecognised dichotomy in FoR types in terms of how they are constituted: angular-anchored FoRs copy and extend the axes of the anchor. The truth conditions of representations interpreted in such FoRs therefore depend on the orientation of the anchor, but not (in first approximation) on its location. In contrast, head-anchored FoRs are calculated from a single vector whose head or tail region is occupied by the anchor. The truth conditions of representations interpreted in such FoRs depend on the location of the anchor, but not on its orientation. Head-anchored strategies seem to universally play a more prominent role in orientation

representations than in locative representations because they offer a simpler solution to the determination of orientation vectors than angular-anchored strategies. In languages such as Seri and Yucatec, in which the use of intrinsic FoRs is more common than that of absolute or relative FoRs, head-anchored strategies dominate in orientation descriptions due to the absence of the most important intrinsic strategy for locative representations, the use of object-centred FoRs. Object-centred FoRs are unavailable with orientation representations because entities cannot be oriented on themselves.

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