Vectors and frames of reference: Evidence from Seri and Yucatec

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Abstract

We show that frames of reference (FoRs) play an equally important role in representations of the orientation of entities as they do in 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, a separate type of primitive conceptual function. Equipped with the notion of vectors, we introduce a distinction between two classes of FoRs: classical "angular-anchored" FoRs and the previously unrecognized "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-centered angular-anchored FoRs dominate in locative descriptions, but head-anchored FoRs dominate in orientation descriptions.

Keywords: Frames of reference, location, orientation, Seri, Yucatec

1 Introduction

In this paper 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 which 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 & Irwin 1993; Wassmann & Dasen 1998; Li & Gleitman 2002), a ternary classification among egocentric or viewer-centered, intrinsic or object-centered, and geocentric or environment-centered 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-centered 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 are 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-a-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-centered 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) are 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 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 which crosscuts 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-centered 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 summarizes the relationship between the three classifications:

Table 1. *Existing classifications of FoRs and anchoring type*

psych. classific-ation	Egocentric				object-centered		geocentric			
typological classific-ation	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)	*The ball is left/ in front of me*	*The ball is on my side of the chair*	*The ball is lef/in front of the chair*		*The ball is left/in front of the chair*		*The ball is uphill/downriver from the chair*	*The ball is toward the door/seaward from the chair*	*The ball is north of the chair*	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 crosslinguistic differences in terms of two factors: the preference for intrinsic FoRs in Seri and Yucatec combined with the (language-independent) unavailability of object-centered FoRs in orientation descriptions. En passant, we offer a reanalysis of Terrill & 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 crosslinguistic 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 12 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 & Wilkins 2006: 545-547.

Terrill & Burenhult 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 & Burenhult 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:

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*[1]

stand-NF 3SG.S-exist tree.F ART.SG.F 3SG.POSS-back-LOC

'The man is standing facing/towards the bush, the tree at his back' (Terrill & 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 & 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-centered 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 & 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); 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; 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; LOC – locative; M – masculine; N – neuter; NF – non-finite; NMLZ – nominalizer; NPP – non-past progressive; OBL – oblique; POSS – possessive; PL – plural; PREP – generic preposition; RC – relative clause; REAL – realis; REL – relational derivation/nominalizer; RES – resultative derivation; RP – recent past; SBJ – subject; SG – singular; SPEC – specifier; SR – switch reference; SUP – superlative; UNSPEC – unspecified.

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, & Verhelst 2006: 508)

6. *Nhenhe-le alturle-theke atne-rle.ne-me-rle…*

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 & 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') this direction "points to". In treating this as the prototype of representations of orientation, Terrill & Burenhult may be making a similar assumption as 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". 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 analyze (5) and (6) in this fashion. 'Left' and 'west' are inherently directional terms. Rather than to be defined as pointing towards some entity or place,[2] they name the axes of coordinate systems used in their turn to define places at which entities are located. 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 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 & 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 defense, 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.

[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).

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 labeling 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 & Burenhult's finding that in descriptions of the M&T pictures in Jahai and Lavukaleve, representations of orientation often seem to supplant representations of orientation entirely. We think that this is an artifact 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-centered descriptions on a ground which 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 which, like Jahai and Lavukaleve, favor intrinsic FoRs, following the Nijmegen classification of FoRs.

3 Data collection and methods

We ran the Ball & Chair (B&C) referential communication task (Bohnemeyer 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 12 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 & 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 12 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 northwestern 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 northwestern 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 Seri (Lewis 2009). The two Seri villages are located along the coast of the Sea of Cortez northwest 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 ms.; O'Meara ms.) and works that cover larger components of spatial reference (Bohnemeyer & 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 northwestern 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

[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*.

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 of 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 through 60s and five women in their late teens through 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 & 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 descriptions[4] of B&C photos for Seri. Nearly all of the descriptions encoded the location of the ball in the photos and around 80% 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 & 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% of the locative descriptions in Seri and 52.4% of the locative descriptions in Yucatec. Examples of topological descriptions in each of the languages are provided in (11) and (12), respectively.

11. (…) ***i-hiin*** ***hac*** *,* *ziix* *c-oqueht* *quij*

SEI 3.POSS-near DEF.ART.SG.LOC thing SBJ.NMLZ-bounce DEF.ART.SG.sit

i-ti *m-iij.*

3.POSS-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'éel 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-centered intrinsic FoRs. This type was instantiated by 19.9% of the locative descriptions in Seri and 50.2% of the locative descriptions in Yucatec.[5] Examples of this type are provided in (13) for Seri and in (14) for Yucatec.

13. (…) ***i-pac*** ***i-icp*** ***hac,*** *i-toaa* *i-icp*

SEI 3.POSS-back 3.POSS-side DEF.ART.SG.LOC 3.POSS-foot 3.POSS-side

hac *hi-ic* *c-aap* *cap*

DEF.ART.SG.LOC 1.POSS-side SBJ.NMLZ-stand DEF.ART.SG.stand

ha *ziix* *c-oqueht* *quij* *i-ti* *y-iij.*

FOC thing SBJ.NMLZ-bounce DEF.ART.SG.sit 3.POSS-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

[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.

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**'

Figure 3. *B&C photograph 2-11, described in (13)-(15)*

These object-centered 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 analyze these representations as covert orientation descriptions along the lines of Terrill & Burenhult's (2008) analysis of examples of the kind illustrated in (4).

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

15. *Ti'=pek-kun-a'n*

YUC PREP=lie.as.if.dropped-CAUS-RES(B3SG)

hun-p'éel *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*** ***i-icp*** ***hac,***

SEI 1.POSS-arm enormous DEF.ART.SG.UNSPEC 3.POSS-side DEF.ART.SG.LOC

ziix *c-oqueht* *quih* *hai* *cop* *ano*

thing SBJ.NMLZ-bounce DEF.ART.SG.UNSPEC wind DEF.ART.SG.stand 3.POSS.in

cola *t-iij,* *i-ti* *y-iij.*

up IRR.DEP-sit 3.POSS-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 & 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

[6] Cf. Tversky, Bauer Morrison, Franklin, & Bryant 1999 for a different, but related, three-way classification.

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: 127-34). 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% of the Yucatec locative descriptions and less than 1% of the Seri locative descriptions are of this type. The low number of occurrences of this type of description in Seri has 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).

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'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.'

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

Additionally, 19% of the Seri and 24.7% 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% of Seri locative descriptions and 10.8% 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.

18. (...) *cmaax ziix c-oqueht quij*

SEI now thing SBJ.NMLZ-bounce DEF.ART.SG.sit

hi-icp hac ah i-ic *m-iij.*

1.POSS-side DEF.ART.SG.LOC FOC 3.POSS-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-A1PL=straight-REL-B1PL thus how sit-EXFOC-B1PL

bèey=a', ti'=pek-a'n te=lu'mo' hun-p'éel 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-centered, witness the independence of their truth conditions regarding the orientation of the 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 *t-iij* *ma,* *haco* *mos* ***iglesia*** ***cop***

3.POSS-on REAL.DEP-sit SR already again church DEF.ART.SG.stand

i-icp ***hac*** *i-icp* *t-iij...*

3.POSS-side DEF.ART.SG.LOC 3.POSS-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-centered. Such head-anchored FoRs occur in 10.4% of the Yucatec descriptions locating the ball vis-à-vis the chair. 19 of the 24 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% of the Seri locative descriptions, with 29 of the 35 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).

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** (…)'

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

22. (…) *u=ho'l le=sìiya=o', estéen,*

YUC A3=head DET=chair=D2 HESIT

x-no'h ***súut-ul***

F-right(B3SG) turn\MIDDLE-INC(B3SG)

'(…) the backrest (lit. head) of the chair, it's **turned right**'

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

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

23. *Hehe i-ti iquiicolim quij cmaax*

wood 3.POSS-on OBL.NMLZ.ABS.POSS.sit.PL DEF.ART.SG.sit now

hi-nol ***aapjoj*** ***i-icp*** ***hac*** *i-iqui*

1.POSS-hand enormous.PL 3.POSS-side DEF.ART.SG.LOC 3.POSS-toward

t-iizc 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% of the Seri and 75.7% 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.

24. *Hehe* *i-ti* *iquiicolim* *quij*

SEI wood 3.POSS-on OBL.NMLZ.ABS.POSS.sit.PL DEF.ART.SG.sit

hi-iqui ***t-ipac*** ***ma*** (…)

1.POSS-toward REAL.DEP-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 desribed 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% of the Seri descriptions and 10.1% of the Yucatec descriptions instantiate this type. Examples of such descriptions are provided in (26) and (27). 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* *iquiicolim* *quij*

SEI wood 3.POSS-on OBL.NMLZ.ABS.POSS.sit.PL DEF.ART.SG.sit

Xpanohax ***i-icp*** ***hac*** ***i-iqui***

Puerto.Libertad 3.POSS-side DEF.ART.SG.LOC 3.POSS-toward

t-iizc (…)

REAL.DEP.face

'The chair (lit. what one sits on) is **facing Puerto Libertad** (…)'

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

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

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

Summarizing, 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 & Burenhult's (2008) characterization. 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 ms. 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 Terrill & Burenhult observed was an artifact of the Men & 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 complementariness of FoRs and (head-anchored) orientation descriptions Terrill & 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 & Burenhult's analysis. However, head-anchored orientation descriptions are not universally dominant. English pilot data collected with the B&C task with four

[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 & Essegbey 2006).

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% of locative descriptions and 71.9% of orientation descriptions involve relative propositions), although here, too, the head-anchored strategy is much more frequent with orientation descriptions (31.9%) than with locative descriptions, where they did not in fact occur at all. [9]

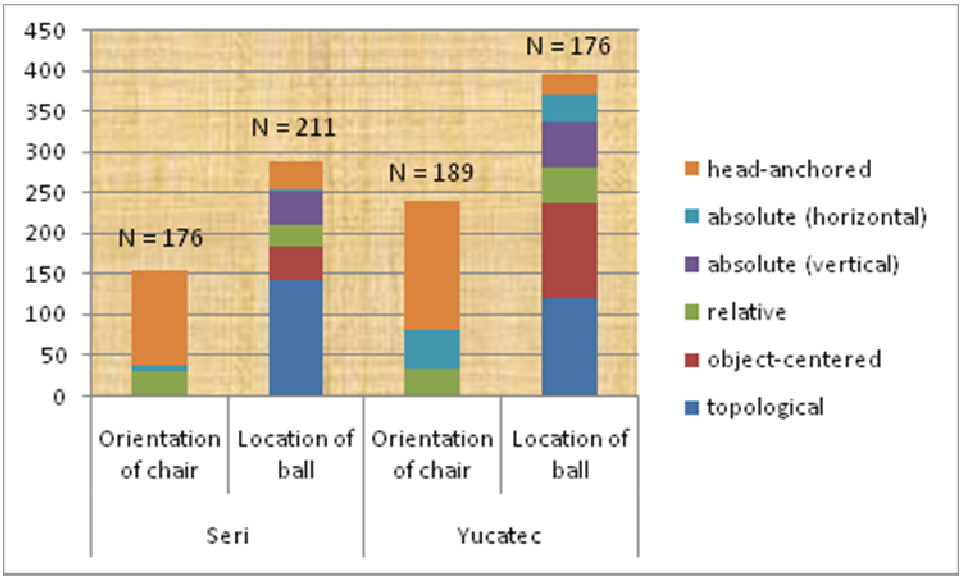

Figure 13. *FoR distribution in Seri and Yucatec locative and orientation descriptions (the number N at the top of the bars is the number of locative/orientation descriptions in the particular language; the y-axis gives the number of descriptions containing propositions encoded in a FoR of the particular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

[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.

relatively greater affinity of orientation descriptions to head-anchored FoRs compared to locative descriptions.

5 Frames of references 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 (cf. Bohnemeyer 2003; O'Keefe 1990, 1996, 2003; Zwarts 1997, 2003; Zwarts & 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 argument designates the head and tail, respectively, of sets of vectors. The second approach is instantiated by expressions such as *right*, *uphill*, *downstream*, and *(35°) 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/(35°) 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 centered on the referential ground in representations of location and the figure in representations of orientation and direction of motion. Each semiaxis can be represented as a vector whose tail is the origin of the FoR. In locative representations, the semiaxes define (cylindrical if the system includes only a single axis, cone-shaped otherwise) regions 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 semiaxis 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 semiaxis of the observer's body onto the ground by a vector from the observer's body's center to that of the ground.

The orientation of an entity can be represented as an alignment between any one of its semiaxes 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 center 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 center 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 centered on the tail.

31. The chair is facing/turned right/uphill/downstream/(35°) SSE.

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

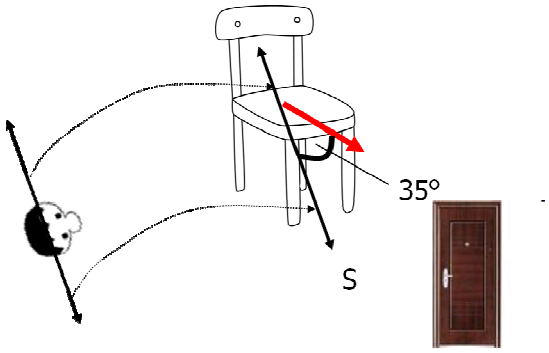

Figure 14. *Chair, facing 35 SSE/right/the door*

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

32. The back/left of the chair is facing me/the door/ right/uphill/downstream/(35°) SSE.

The angular-anchored and head-anchored types of FoRs can be characterized in terms of how their semiaxes, understood as vectors, are defined. In the case of the traditional angular-anchored type, the semiaxes are copied from those of the anchor

through transposition or abstraction. The orientation of the semiaxes 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 semiaxis is constituted as a vector defined in terms of tail and head and the other semiaxes 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 semiaxis 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 semiaxis of a coordinate system, all other semiaxes 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 center of the chair that is orthogonal to the vector pointing to the speaker from the chair, as illustrated in Figure 15:

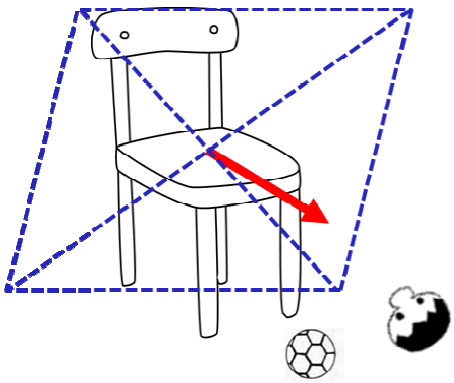

Figure 15. *Vector partitioning space in head-anchored locative description*

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'*

YUC PREP-A3=side then PREP:DET=F-left PREP-A3=F-left person=D3

ti' yàan hun-p'éel bòolai', náats' y=iknal

there EXIST(B3SG) one-CL.IN ball=D4 near(B3SG) A3=at

y=òok xan, mas chan=kàabal xan, mas chan=kàabal

A3=leg/foot 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 center 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-centered 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-centered 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 labeled 'downhill' (see section 1).

The principal dependence of angular-anchored FoRs on the orientation of the anchor also holds for orientation descriptions such as those 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 Levinson considers a diagnostic of the intrinsic type in fact holds for object-centered 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 behavior 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 characterizes 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 semiaxis of the figure. There are two ways to do this: by specifying the head (if the figure is centered on the tail;

if it is centered on the head, the tail needs to be specified) or by specifying an angle with respect to a semiaxis 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 semiaxis. 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 semiaxis 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 so much more important role in Seri and Yucatec orientation descriptions – occurring with 66.5% and 84.1% of them, respectively - than in English ones, where they are found a mere 31.9% 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 & 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-centered FoRs, is not available in orientation descriptions. In locative descriptions, such FoRs are centered on the ground, extending its geometrical axes out into surrounding space. In orientation descriptions, the origin of the FoR is the center 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-centered 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 & 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 semiaxis of the figure to be oriented. Vectors are conceptual primitives used to orient entities, direct their motion paths, and define their semiaxes 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 semiaxis of some FoR. This duality of strategies introduces

a previously unrecognized 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-centered FoRs. Object-centered FoRs are unavailable with orientation representations because entities cannot be oriented on themselves.

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