Uniformity and variation in Tseltal reference frame use

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Abstract
Tseltal (Mayan) speakers have been described as favoring absolute frames of reference (FoRs) in spatial language and cognition, relying on a rich meronymic system in intrinsic descriptions (Levinson 1994), and making no more than marginal use of relative FoRs (Levinson 2003; Brown 2006). We present the results of a new referential communication task conducted in three Tseltal communities. The data show an overall preference for object-centered and landmark-based descriptions over absolute ones, which may be task-specific. The use of absolute FoRs varied drastically across the communities in correlation with the salience of topographic features. We argue that this variation does not represent evidence for environmental determinism of FoR use as proposed by Li & Gleitman 2002, but merely for environmental constraints on FoR use. These constraints derive from more general cognitive principles. We also consider evidence of change in FoR use due to contact with Spanish, as some speakers are introducing relative uses of 'left' and 'right'.

Keywords: Tseltal, frames of reference, space, semantic typology

1. Introduction[1]

Frames of Reference (FoRs) are coordinate systems used encode the location or direction of motion of a **figure** entity with respect to some reference entity or **ground** (Talmy 2000) or the orientation of the figure. Levinson (2003) distinguishes three types of FoRs: **intrinsic** FoRs exploit inherent asymmetries of the ground object itself to project regions of space, as in 'The cat is behind the house' in the observer-independent sense of 'behind'. The other two types of FoRs involve a third element besides figure and ground: **relative** FoRs involve the identification of regions around a ground object according to an observer's viewpoint, as in 'The cat is behind the house' under the interpretation in which 'behind' selects the region at the far side from the observer. Finally, **absolute** FoRs identify regions around the ground entity based on fixed bearings, independently of both the ground and the observer, as in 'The cat is north of the house.' This tripartite classification is currently being discussed, and further distinctions are proposed below, especially a landmark-based type of FoR, involving a landmark external to the ground entity as in 'The cat is toward the tree from the house.'

Spatial FoRs have aroused a renewed interest in recent years through the discovery of two important facts. On the one hand, speech communities show variation in their preferences in FoR

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[1] The following abbreviations are used in this paper: ABS: personal absolutive affix; CL: clitic; DIR: directional particle; PERF: perfect aspect; PL: plural; POS: possessive affix; PREP: generic preposition.

use, for instance speakers of Dutch or English prefer relative and intrinsic FoRs, whereas speakers of Guugu Yimithirr (Pama Nyungan, Australia) use exclusively absolute FoRs and speakers of Yucatec (Mayan) use all three types on a daily basis (Pederson *et al.* 1998; Levinson 2003; Majid *et al*. 2004; Levinson & Wilkins 2006; Bohnemeyer & Stolz 2006; Bohnemeyer, this issue; *inter alia*). In addition, people have been found to display an alignment between their preferred FoR when speaking and when memorizing and reasoning about spatial arrays: for example, Guugu Yimithirr not only habitually speak in terms of absolute cardinal directions but also memorize scenes the same way, whereas English speakers favor a relative viewpoint for both speaking and thinking about space. This alignment between the type of FoRs used in language and internal cognition is necessitated by the lack of intertranslatability across FoRs: one cannot report a configuration in a different FoR than that in which one remembers it, unless further contextual information allows one to recode it. But what determines, then, which FoRs a particular population prefers in any given context of use? The members of the former Cognitive Anthropology Research Group at the Max Planck Institute for Psycholinguistics have advanced the case that language, along with other observable behaviors, may be a driving force in population preferences for FoR selection (Levinson 1996, 2003; Pederson *et al.* 1998, Levinson *et al.* 2002; Levinson & Wilkins 2006; Majid *et al.* 2004), This entails a causal effect from language on thought - a "Whorfian" effect. The rationale of this relativistic hypothesis is this: given that there is more variation in FoR use across populations than within, the question is how do children learn what FoRs are preferred in their community? The answer, according to the relativistic view, is that they infer this from observable behavior, such as speech, gesture, and any other cultural practices that can be directly observed (as opposed to internal practices of thinking). Each population's pattern of FoR use represents a cultural *habitus* of that community, and language is the primary vehicle through which this habitus is transferred across generations.

This line of research has provoked much controversy. Adopting an opposing view, Li & Gleitman (2002) and others have argued that all spatial FoRs are universally available to human beings independently of their language. On this position, the population-specific preferences both in terms of linguistic and non-linguistic behavior do not represent elements of culture-specific knowledge (cultural *habitus* of referential practice), but instead are determined entirely in terms of literacy, education, topography, and population geography (including the distribution of a population over the area they inhabit and their prevailing settlement types). Accordingly, although correlations may exist between language and cognition, there is no causation from the former to the latter (see also Bloom & Keil 2001).

Data from Tenejapan Tseltal (Mayan, Mexico) have been in the center of this controversy. Tenejapan Tseltal has been described as a language where absolute FoRs are dominant in spatial descriptions and spatial reasoning (Brown & Levinson 1992, 1993; Levinson 1996 and 2003; Brown 2006; *inter alia*). Specifically, Tenejapans rely on an 'up'-'down' system, whose axis is abstracted from the general slope of the terrain. In several publications, Brown and Levinson show that this axis is pervasively used absolutely, meaning independently of the local relief, at all scales, including in manipulable space, although the same terms 'up' and 'down' also have non-absolute uses in reference to the actual local slope and absolute ones in the vertical 'anchored' (see §3) to the Earth's field of gravity, among others; see §4 below).

Under Li & Gleitman's view, the Tenejapan absolute system would be an effect of their living in the mountains in a relatively small and cohesive speech community. Any such society, under the same circumstances, would thus be predicted to use a similar absolute system (Li & Gleitman 2002).

A recurrent problem in this controversy has been the lack of agreement about the very terms of the debate: categories of analysis of FoRs, as used on the two sides of the debate, do not

match. Li & Gleitman (2002) and other publications following the same line (Li, Abarbanell & Papafragou 2005, Abarbanell 2007) rely on a classification widely used in the psychological literature, which distinguishes among egocentric (or 'viewer-centered'), intrinsic (or 'object-centered'), and geocentric (or 'environment-centered') frames (see also, e.g., Carlson-Radvansky & Irwin 1993; Wassman & Dasen 1998). The basis of this distinction is what Danziger (2010) calls the **anchor** of the frame: some entity or environmental feature which defines the axes of the coordinate system. In egocentric representations, the anchor is the body of an observer. In intrinsic representations, the ground functions as anchor, and in geocentric ones, some environmental entity or feature does. The members of the former Cognitive Anthropology Research Group at the Max Planck Institute for Psycholinguistics have developed a different classification on the basis of evidence from language typology (henceforth, the 'Nijmegen classification'; Levinson 1996, 2003; cf. also Pederson 2003 and Danziger 2010 for proposed refinements). These two classifications are often misunderstood as terminological variants; they in fact group FoRs quite differently. The relative type of the Nijmegen classification singles out exclusively those egocentric representations in which the ground is distinct from the observer's body. 'The ball is left of the chair' is relative on the Nijmegen classification, but 'The ball is left of me' is intrinsic. And absolute type of the Nijmegen classification includes only those geocentric frames whose axes are abstracted from some environmental gradient or feature and provide bearings treated as fixed throughout the totality of space. So 'The ball is uphill of the chair' counts as absolute if 'uphill' is understood to denote an abstract direction vector that remains constant regardless of the actual location of ground or observer vis-à-vis the hill, and as intrinsic otherwise. Any frame that is neither relative nor absolute is classified as intrinsic. This classification is justified by crosslinguistic evidence: while all languages have both egocentric and geocentric frames, many languages lack relative frames, absolute frames, or both (Pederson *et al.* 1998, Levinson 2003, Levinson & Wilkins 2006).

The first goal of this paper is to clarify in which sense the absolute use of 'up' and 'down' in Tseltal can be said to be influenced by environmental factors. We show that this system, in the way it is used in different communities, is constrained by the local topography, in the sense that the frequency of use of the 'up'/'down' terms depends on the location and orientation of each community with respect a salient mountain slope that may serve as the anchor of the system. The 'up'/'down' system is also "calibrated" to the local topography in the sense that the inclination of the slope, where one is present, determines the orientation of the central axis of the 'up'/'down' system. . We argue that such environmental constraints on the use of geocentric FoRs are special cases of more general principles that govern the accuracy of any FoR use. Such constraints neither support nor contradict the environmental determinism of FoR selection hypothesized by Li & Gleitman.

The second goal of this paper is to evaluate the extent of uniformity and variation in the use of relative FoRs. Previous accounts suggest that Tenejapans frequently rely on intrinsic FoRs, based on a productive meronymy (Levinson 1994), but that they almost never use relative FoRs, whereby an observer projects their own left, right, back or front onto a ground object to locate a figure (Brown & Levinson 1992, Brown 2006). However, we present evidence of increased use of relative FoRs especially among younger speakers. While the available data do not allow to conclusively distinguish between bilingualism in Spanish and the non-linguistic factors of literacy and education as possible causes of the apparent spread of relative reference, there is an apparent connection between relative interpretations and the use of Spanish loan words which hints at bilingualism as the decisive factor. This outcome would be in line with the relativistic hypothesis that language may be a factor influencing FoR use.

This study is based on data collected in three places from two Tseltal speaking regions: Tenejapa and neighboring Oxchuc. These data are of three kinds: the results from a linguistic task called "Ball & Chair", fully described below, sessions of elicitation on spatial language and orientation, and direct observation and interactions in the field.

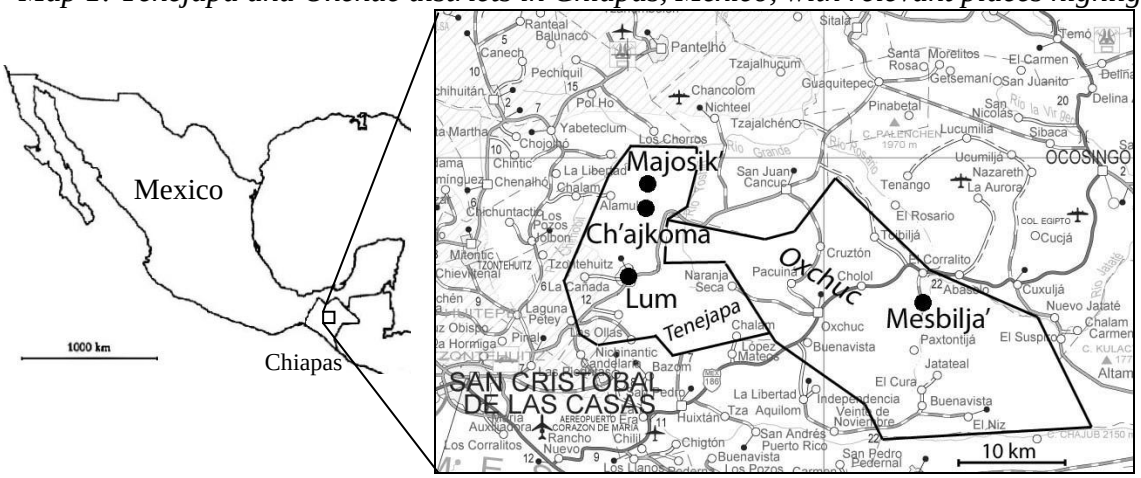
This paper is organized as follows: in §2, we present the speech communities under study with their geographical environment; in §3, we comment on the classification of FoRs used in this study; in §4, we summarize what we know about Tseltal absolute FoRs from Brown and Levinson's work; in §5, we present the Ball & Chair task, the main source of linguistic data for this study, and explain how we coded those data; in §6, we discuss the quantitative data from each of the three places where the task was conducted, and finally in §7, we draw some conclusions.

2. Setting the scene: Tseltal, Tenejapa and Oxchuc

Tseltal is a western Mayan language spoken in southeastern Mexico in the state of Chiapas, bordering on Guatemala, by more than 300,000 people. It is mildly polysynthetic, head-marking, verb-initial (VOS), with sets of pronominal affixes cross-referencing core arguments on the verb and possessors on the noun. Tseltal is especially known in the linguistic literature for its "highly developed linguistic resources for handling spatial concepts", like positional roots, directional particles, shape-referencing numeral classifiers, etc. (Brown 2006:230).

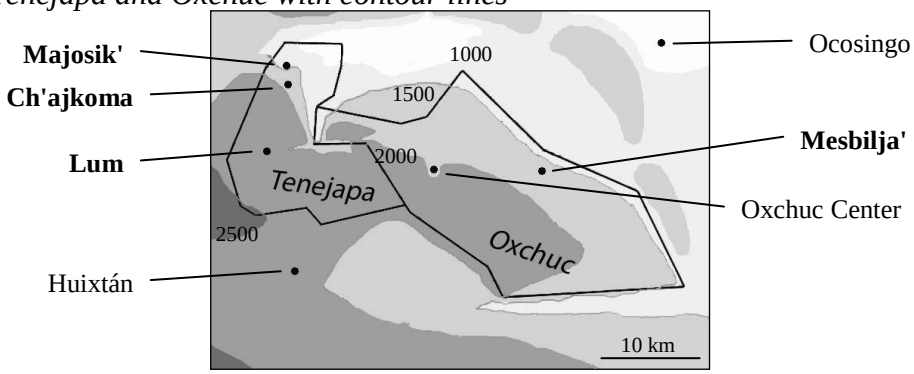
Tseltal has moderate dialectal variation, with three approximate zones: north, center and south. The two dialectal forms that concern us here are both from the central zone: Tenejapa and Oxchuc, which correspond broadly to two counties (called *municipios* 'municipalities' in Mexico), as represented in map 1. Although perceptively different in several linguistic features (some morphological and lexical differences), mutual intelligibility is not an issue at all.

Map 1: Tenejapa and Oxchuc districts in Chiapas, Mexico, with relevant places highlighted



Tenejapa and Oxchuc share a hilly and wooded landscape, which is characteristic of the whole region called Altos, with an altitude ranging from approximately 900m to 2,500m. In Tenejapa, the incline of the terrain is quite uniform, with altitude decreasing as one goes north or east, whereas in Oxchuc the relief is a little bit more complex. Map 2 illustrates the regional elevation with contour lines indicating 1000, 1500, 2000 and 2500m above sea level.

Map 2: Tenejapa and Oxchuc with contour lines



Tseltal as a language is not acutely endangered in Tenejapa and Oxchuc. However, in these counties, as in the whole state, we observe in recent times a quick rise in bilingualism and literacy in Spanish, along with strong socioeconomic changes linked to globalization (migration, decline of the farming economy, etc.), which entail increasing disruption in the inter-generational transfer of cultural and linguistic knowledge and practices, as over time more young people move away from the traditional way of life and get more acculturated within Mexican Mestizo society.

This article presents data collected by the first author in three Tseltal communities. The first of these is Ch'ajkoma, a small rural community situated in the northern part of Tenejapa, very close to Majosik' where Penelope Brown and Stephen Levinson worked for years (cf. below). The second is the town of Tenejapa, the municipal capital of Tenejapa county, which is situated at the bottom of a valley in the center of the county. As compared with the other communities, it can be considered urbanized; following Tenejapan usage, it is referred to as *Lum* in the following. The third and last community is Mesbilja', a small rural community in the Oxchuc county situated along a narrow river that winds northwards between hills.

3. FoRs classification

As stated above, there is no universally accepted classification of possible FoRs. We introduced the tripartite Nijmegen classification (Levinson 1996, 2003) in §1. Absolute FoRs rely on abstract bearings such as 'south'/'north'/'east'/'west'; relative FoRs on a projection of bodily coordinates of the observer onto a reference entity (in locative and motion descriptions), and object-centered intrinsic FoRs on the intrinsic axes of the reference entity itself. Object-centered and relative FoRs are used to interpret spatial relators such as 'left'/'right'/'front'/ 'back'. The crucial difference between relative and object-centered FoRs is that the former involve a projection from the anchor (see §1), the observer's body, onto the ground, whereas in the case of the latter, the anchor is the ground itself. Following this logic, 'The cat is on my left' is interpreted intrinsically (there are only two entities: the ground object, which is the speaker's body, and the figure, which is the cat). Expressing leftness in a relative FoR necessarily involves another entity, as in 'The cat is on the left of the tree (from my perspective).' Here, the left side of the observer is projected onto the ground (the tree) to define a region. It follows from the above that there cannot be any expression that has relative interpretations, but no object-centered ones.

Beyond these three basic FoR categories, additional finer distinctions can be drawn. Whether these new categories are subdivisions of categories the Nijmegen typology or full FoRs on their own is a matter for debate. In this work, we keep all the categories but one as used by Brown & Levinson (2009) in a detailed study of FoR acquisition in Tseltal. These categories are presented in Table 1 together with the results of a study called 'Farm Animal Interactional Games,' in which pairs of Tseltal speakers interacted to reproduce arrays of toy animals. The authors also

present data from children, but as we only focus on adults in this study, the child language data are ignored here.

Table 1: FoR categories and frequency of use among adults in Tseltal (Brown & Levinson 2009:458)

deictic	absolute	intrinsic	landmark	sunrise-sunset	relative	Total
30%	14%	22%	25%	8%	1%	1682

As can be seen, the authors added three categories to the three basic ones: deictic, landmark and sunrise-sunset. Deictic concerns here the use of directional particles ('coming'/'going') in spatial descriptions. We ignore this category in the rest of this study, because deictic terms do not *per se* require FoRs for their interpretation.

'Landmark' refers to the use of ad-hoc situational landmarks for localization or direction, as in 'The bottle is toward the door from the chair.' The place of landmarks in the classification of FoRs is still under debate. In the Nijmegen classification, the use of a landmark to locate a figure from the perspective of a ground is treated as a kind of intrinsic description, because both the ground object and the landmark (the chair and the door in the preceding example) together can be seen as a complex array with reference to some parts of which the figure is located; this is the position defended by Levinson (2003) (see also Brown & Levinson 2009:456). In contrast, in the egocentric-intrinsic-geocentric classification widely used by psychologists (see §1), including by Li & Gleitman (2002), a landmark-based description is treated as geocentric on a par with an absolute description, insofar as it relies on environmental clues external to the observer and external to the ground itself. Essentially, the larger and farther away a landmark is, the more its use as an anchor in a spatial coordinate system resembles that of an absolute system, since the angle it will form with any potential ground will basically be the same as long as one does not travel too far away.

The sunrise-sunset category corresponds to references to the points on the horizon where the sun rises and sets. According to Brown & Levinson (2009:457), "these are intermediate between absolute and landmark terms; they provide geocentric directions but these are tied to specific mountains and are subject to significant solstitial variation, unlike the true absolute terms". In this study, we maintain both 'landmark' and 'sunrise-sunset' as distinct FoR categories, besides absolute, relative and intrinsic.

To our knowledge, the data in Table 1 represent the first quantitative data ever published on FoR use in Tseltal. In their previous accounts cited above, Brown and Levinson routinely assert dominance of absolute and, at very close range, intrinsic reference and an absence of relative FoRs. A representative quote follows:

> "The intrinsic uses are very constrained, as Tzeltal speakers prefer to use body-part expressions when figure and ground are in contact or at least in close proximity. In the case where figure and ground are more widely separated in space, Tzeltal speakers use an absolute frame of reference to describe the angle at which the figure lies from the ground." (Brown 2006: 263)

The data in Table 1 paint a much more differentiated picture. According to this picture, while the marginal status of relative FoRs is confirmed, object-centered intrinsic and especially landmark-based frames were actually used more frequently than absolute frames during the Farm Animal Interactional Games, at least by adult speakers. Brown and Levinson explain this apparent discrepancy with reference to a putative task-specific effect. The niceties of the Farm

Animal Interactional Games motivate a greater degree of precision in spatial reference than what the 'up'/'down' system affords:

> "The explanation for the increase of landmark specifications is clear enough. Adults are attempting a level of precision that cannot be communicated by the abstract absolute system alone, which only divides directions into four 90-degree quadrants. To give more precise angles, local landmarks can be brought into play, so one can say in effect 'heading southward, toward Red Cliffs,' now precise to, say, 20 degrees of arc. Caring about precision and having the inventive means to produce it are what mark fully adult speech." (Brown & Levinson 2009: 460)

Striking support for the assumption of task-specificity comes from the fact that the absolute 'up'/'down' system was used vastly more frequently by children of all four age groups recruited for the study (5-7, 8-10, 11-13, 14-16) than by adults. Among the children, the absolute system was indeed the dominant one. In the data from the three Tseltal communities we present below, a similar preference for object-centered and landmark-based FoRs over absolute ones manifests itself. We tacitly conjecture that this preference may likewise be task-specific. The first author conducted a second study with the same speakers. This was likewise a referential communication task, but one that targeted labels for object parts, not spatial relators and FoRs. The data collected in the course of this second study are still being processed and analyzed. Impressionistically, however, the use of the 'up'/'down' system was more frequent during this task.

In the next section, we describe the use of FoRs in Tseltal in more detail, focusing especially on absolute FoRs.

4. FoRs in Tseltal

During the 90's, Brown and Levinson conducted a series of investigations on spatial language and reasoning in Tseltal, mainly in the Majosik' community in the northern lowlands of the Tenejapa district (see maps 1 and 2).[2] They showed that in Tseltal, absolute FoRs are predominant in locative descriptions when figure and ground are not adjacent. In cases in which figure and ground are adjacent, Tenejapans use intrinsic FoRs, relying on a productive meronymic system which identifies parts of the objects according to their internal geometry (Levinson 1994): from those parts, whose name is selected among a restricted set of body part terms, a region can be projected to locate a figure close to that part of the ground. For example, someone located at the intrinsic front of a car would be said to be 'at the car's head', etc.

Brown and Levinson also showed that Tenejapans hardly use relative FoRs at all. Tseltal does have terms for 'left' and 'right', but these are restricted to naming the left and right hand respectively, and there is no projective use of these terms altogether. On the other hand, there are marginal uses of 'back' under relative interpretations, with ground objects that lack intrinsic backs. This explains the very low frequency of relative FoRs (1%) in Table 1 above.

The type of FoR that has attracted most attention in Tseltal is the absolute one, which is primarily based on the terms for 'up' and 'down', *ajk'ol* and *alan*, and other associated linguistic devices (verbs for 'go up' and 'go down', relational nouns 'on top of' and 'below', etc.). These terms are not exclusively bound to an absolute interpretation. Brown & Levinson (1993) show that *ajk'ol* and *alan* have no less than five different kinds of interpretations, summarized in (1).

[2] See Brown and Levinson (1992, 1993, 2000, 2009); Brown (1994, 2001, 2006); Levinson (1994, 1996, 2003); Levinson and Brown (1994); Levinson *et al.* (2002). In this article I use the abbreviated mention of "Brown and Levinson" to refer to this whole group of publications.

(1) *Ajk'ol* ‘up’ and *alan* ‘down’ can be interpreted with reference to:

a) The absolute vertical axis (linked to gravity). According to Brown & Levinson, this use is marginal in Majosik' with respect to other uses.

b) On any arbitrary slope, *ajk'ol* designates the upper part and *alan* the lower part, independently of the absolute orientation of the slope. The terms are also used in reference to spatial regions projected from these parts and to the directions ‘uphill’ and ‘downhill’ with respect to the slope. This is the family of geomorphic uses of the terms.

c) The absolute directions 345° NNW (*alan*) and 165°SSE (*ajk’ol*), as located on a compass, and/or quadrants formed around these points on the horizon. These directions are abstracted from the dominant orientation of the terrain around Majosik' (and in general in the Tenejapa municipality), which slopes down steeply from south to north. The difference with respect to (b) is that in this case, *alan* and *ajk'ol* do not refer to the local inclination, but to a "conceptual slope" independent of the local terrain, so they can be used in the horizontal. This is the *horizontal absolute* use of *alan* and *ajk'ol*, as opposed to the *vertical absolute*, as in (a).

d) The relative distance of two places in front of an observer: *alan* ‘down’ can refer to a place closer to the observer and *ajk'ol* ‘up’ to a place further away. This can be interpreted as an effect of the two-dimensional projection of the three-dimensional visual field on the retina: closer points appear lower on the retina, more distant points appear higher.

e) Place names: Tenejapan territory is divided into two halves, a northern/lower/hotter part named *alan* or *alan k'inal* (*k'inal* means 'space') and a southern/higher/colder part named *ajk'ol* or *ajk'ol k'inal*. Thus, going *alan* or *ajk'ol* can mean 'going to the lower/higher region of Tenejapa regardless of the compass direction the figure moves in.

Brown and Levinson gloss *ajk'ol* and *alan* as 'uphill' and 'downhill' instead of just ‘up’ and ‘down’, arguing that their primary meanings are not related to verticality, but to (actual or abstracted) inclination of land. We instead assume that, at least on a broader pan-dialectal level, the basic meaning of the terms is the vertical one, reflected in the glosses ‘up’/‘down’ used in this article. The geomorphic uses of the terms and the uses describing distance in the visual field are but special cases of the vertical sense, whereas the absolute horizontal uses are metonymic extensions.

Brown and Levinson show two fundamental properties of how people use the absolute axis: on the one hand, it is used as a spatial reference not only at a large-scale (geographic) level, but also at a manipulable level, even for locating a tiny object with respect to another object in manipulable space. For example, if a bottle is placed north of a chair in the horizontal, even without visual access to the dominant slope (say, inside a house without windows), its location can be expressed as 'down of the chair', and indeed that would be a common way of locating it. This means people are constantly aware of the absolute ‘up’/’down’ axis at every moment and in every place.

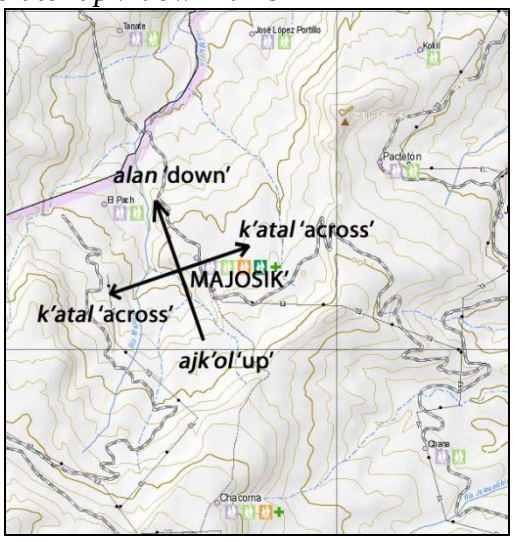
On the other hand, the use of this axis does not depend on people being in Majosik': as they travel to other places, with different hills and slopes, they carry with them the same axis and are still capable of communicating successfully among themselves, locating things as ‘up’(SSE) and ‘down’ (NNW) with respect to a ground object. This last property is crucially what makes this system truly absolute, and not landmark-based: the dominant slope is abstracted as a "conceptual slope", present at every moment and every place in the memory of the speakers.

Brown and Levinson (1992:596; 1993:64) show that geomorphic reference to an actual slope (b), in situations in which such a slope is saliently present, preempts the horizontal use of the

terms. In contrast, in the absence of an actual slope, the absolute interpretation (c) preempts all other senses. The uses counted as ‘absolute’ in Table 1 above are strictly speaking undifferentiated in terms of whether they involve absolute or geomorphic FoRs, since these two interpretations cannot easily be distinguished in a place like Majosik’. We follow this same practice below, i.e., we do not distinguish between absolute horizontal and geomorphic uses of *ajk’ol* and *alan*, but instead treat all uses of the system in reference to our stimuli as absolute.

Map 3 superimposes the absolute ‘up’/‘down’ axis onto a topographic map of the Majosik' area. The contour lines show the alignment with the actual slope of the local relief. Orthogonal to the ‘up’/’down’ axis, another axis gives an 'across' direction, which is expressed as *k'atal* 'lying crosswise' or *ta jejch* 'on the (other) side'; this last axis can mean either (roughly) ‘eastward’ or (roughly) ‘westward’. In the vertical uses of the system, *k'atal* is interpreted as 'horizontal' (neither up nor down).

Map 3: Majosik' and the absolute ‘up’/’down’ axis



Besides showing the predominance of absolute FoRs in the linguistic use of FoRs, Brown and Levinson further conducted non-linguistic experiments that revealed that Tenejapans tend to resolve spatial tasks by also using an absolute FoR. That is, when asked to memorize a spatial array in front of them and then reproduce it under 180° rotation, they would not reproduce the array egocentrically, that is, maintaining the orientation of the array with respect to their own left or right sides, as most Dutch, Japanese, and speakers of other predominantly relative languages have been shown to do (Pederson *et al*. 1998). They would instead maintain the same absolute orientation of the array (say, northwards, southwards, etc.). The authors argued language to be a determining factor in this aligned use of FoRs in linguistic and non-linguistic behavior, a Whorfian effect by which language influences cognition, as discussed in §1.

As mentioned earlier, this last claim regarding Tseltal has been controversial: another group of linguists and psychologists (Li & Gleitman 2002; Li 2002; Li, Abarbanell & Papafragou 2005; Abarbanell 2007, *inter alia*) have dismissed such a kind of direct connection between language and cognition, arguing instead for a view in which both linguistic and cognitive styles are shaped exclusively by non-linguistic factors - literacy, education, topography, and population geography: "the presence of supralinguistic cultural differences ... predict both the favored linguistic terminology and the spatial reasoning patterns" (Li & Gleitman 2002: 288). Of particular interest for our purposes is the claim that the use of geocentric FoRs may be conditioned by an interaction of topography and population geography. Geomorphic and landmark-based systems can be used

in a uniform manner only up to a certain level of distance from the landscape entity or feature that serves as the anchor. This predicts that reliance on such systems is restricted to small communities that live in close proximity of the topographic cue. Consequently, "a single factor − geographical cohesion in community life − plays a major role in predicting why social groups develop preferences in their everyday terminology for referring to regions and directions in space" (*ibid.*, p. 287). This was rejected by Levinson and collaborators, countering that such environmental restrictions do not extend to true absolute systems abstracted from geomorphic ones, as is the case with the 'up'/'down' system in Majosik': "landmark cues do not play any special role in absolute systems like the Tzeltal ... system." (Levinson *et al*. 2002: 182). As we show below, this statement is clearly too bold: both the frequency of use of the *ajk'ol-alan* system and the orientation of its axes vary strongly across Tseltal communities, evidently dependent on the local topography. So the use of geocentric FoRs is indeed constrained by the environment, and we argue that something similar in fact holds for all types of FoRs. However, such constraints must not be confused with determinants. The environment may limit the accuracy with which particular types of FoRs can be used in particular contexts; but there is no evidence that it may *cause* the use of certain kinds of FoRs as opposed to others, as it would have to if Li & Gleitman's attempt to leverage it into an argument against the possibility of linguistic influences were to succeed.

In addition to assessing the role of the environment as a constraint on the use of absolute FoRs in Tseltal,we consider the linguistic variable bilingualism and the non-linguistic variables literacy and education as competing possible explanans of an increased use of relative FoRs in our data compared to those in Table 1.

5. The task and the coding of the data

As part of the MesoSpace project (cf. O'Meara & Pérez Báez, this issue), the first author conducted a series of tasks in Ch'ajkoma, Lum, and Mesbilja' in order to get comparable results, both for internal comparison between Tseltal communities and between Tseltal and other Mesoamerican languages. In this article, we report only the results of the Ball & Chair task (henceforth B&C). In this task, two speakers are seated together at a table, facing the same direction, with a screen between them preventing visual contact. On the table, two identical sets of twelve photographs featuring a chair and a ball in various configurations are arranged (see some examples of the photographs below). One of the two participants acts as the "director" and the other as the "matcher." The director picks up any one of the photographs and describes it, talking with the matcher until the matcher finds the matching photograph. Once all photographs have been matched, another set is presented. Four sets are successively laid on the table, 48 photographs in total.

B&C was applied to five pairs of speakers in both Ch'ajkoma and Lum, and to six pairs in Mesbilja'. Participants were all adult native speakers of Tseltal, women and men, living in the village where they participated in the task, most of them born there. Ages ranged from 17 to 57, with varying degrees of bilingualism in Spanish, literacy and schooling. All interactions with participants were in Tseltal.

All sessions were fully transcribed, and spatial descriptions involving FoRs were extracted and organized into two groups: descriptions which refer to the orientation of the chair and descriptions which refer to the location of the ball with respect to the chair. Each description was then analyzed in terms of the strategy it involves, taking into account the six categories presented in §3 above: absolute 'up'/'down', sunrise/sunset, relative, intrinsic and landmark. These of course do not exhaust all the types of strategies that occurred during the task: in particular, there were frequent uses of deixis (as in 'here', 'there', etc.), topological descriptions (as in 'on the chair',

'in between the legs', etc.), and vertical absolute FoRs (‘up’/‘down’ with respect to gravity) which are not relevant for the study at hand and are not dealt with in this article.

Absolute ‘up’/’down’

As described by Brown and Levinson, Tenejapa Tseltal, and also Mesbilja' Tseltal as we will see, use ‘up’ and ‘down’ terms for referring to absolute directions through abstraction of a dominant slope, which generally goes down northwards or eastwards in both Tenejapa and Oxchuc. This is how speakers can make sense of descriptions as in (2), where ‘up’/’down’ terms apply to a horizontal scene.

(2) a. ***koel*** *ay bel* *y-elaw* *te* *silla-e*
downwards is DIR 3POS-face the chair-CL
'The chair is facing downwards.'
b. *te* *pelota-e li'* *ay ta* ***ajk'ol***
the ball-CL here is PREP up
'The ball is up (with respect to the chair).'

Figure 1

As introduced in §4 above, this system relies first on the nouns *ajk'ol* ‘up’ and *alan* ‘down’. Other terms related to verticality are also used, like the two intransitive motion verbs *ko* 'go down' and *mo* 'go up', which appear as main predicates, auxiliaries, or directional particles (in a nominalized form *koel* and *moel*, respectively).

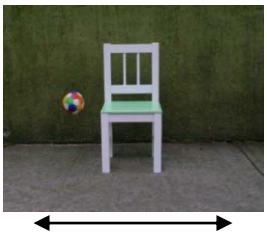
The system observed in Mesbilja', in Oxchuc county, is roughly the same except for the noun *ajk'ol* 'up', which does not exist as such and is only used as a possessed relational noun in a slightly changed formed: *y-ajk'l-al* 'on top of'. Instead of *ajk'ol*, people from Oxchuc generally use the positional stative form *kajal* 'above' (which is also a lesser used possibility in Tenejapa). *Alan* ‘down’, *ko* 'go down', and *mo* 'go up' are used in the same way as in Tenejapa.

Sunrise/Sunset

Reference to sunrise and sunset for spatial description is common in several Tseltal communities, including parts of Tenejapa and Oxchuc. Sunrise is expressed as *slok'ib k'aal* (literally, 'coming out of the sun') and sunset as *smalib k'aal* (literally, 'pouring of the sun'), with a possible contraction to *lok'ik'al* and *malik'al*, respectively. This use is illustrated in (3):

Figure 2

(3) *ta* *lok'ik'al* *ay* *me* *balon-e*
PREP sunrise is the ball-CL
'At (toward) sunrise is the ball.'



sunrise / sunset

We consider reference to sunrise/sunset as involving another kind of absolute FoR, which we keep separate from absolute ‘up’/’down’ because the latter is what mainly interests us here. Note that, as commented above in §3, Brown & Levinson (2009) consider this use as intermediate between absolute and landmark-based FoRs.

Relative FoRs

This type of FoR is defined by the projection of the observer's own asymmetries onto a ground object (in locative and motion descriptions; in orientation description, the frame is projected onto the figure itself) in order to establish projected areas in which to locate a figure, as in (4): the ball is located at the 'back' of the chair, although it can be seen that it is not the intrinsic back, but the area defined as being opposite to the speaker. We show below that this same relator can be interpreted within the intrinsic FoR (see (5) below).

(4) *ay p'ekel pelota ta* ***s-pat***
is lying ball PREP 3POS-back
'There is a ball behind it [the chair].'

Figure 3

Other expressions that were used relatively in the task include the terms for 'left' (*xin* in Tenejapa, *k'exen* in Oxchuc) and 'right' (*wa'el*), and several terms for 'side' (*xujk* or *ts'eel*). This contrasts with previous descriptions according to which there is no projective use of 'left' and 'right' in Tseltal altogether. We argue that there are reasons to think there has been a recent spreading of these relative uses in Tseltal due to contact with Spanish.

Intrinsic FoRs

In this type of FoR, the inherent asymmetries of a ground object are used to locate a figure projecting a region from a part of the ground, as in (5).

(5) *ay p'ekel pelota ta s-pat*
is lying ball PREP 3POS-back
'There is a ball behind it [the chair].'

Figure 4

Note that this description is identical to the relative description in (4). But here, it refers to the intrinsic back of the chair.

Another kind of intrinsic description relies on parts of the body of the speaker or the hearer, as in (6).

(6) *li' ay tal ta k-elaw-tik*
here is DIR PREP 1POS-face-PL
'It [the ball] is in front of us (*lit.*: in our face).'

Figure 5

Note that this description is not understood in a relative FoR, because there is no projection of the observer's bodily coordinates onto a ground object: the observer's body is the ground object itself. In other proposals, this would instantiate a distinct type of FoR: Li & Gleitman (2002) merge this kind of intrinsic reference based on the observer's bodily axes with the relative FoR into an

egocentric category, whereas Danziger (2010) analyses it as a new kind of FoR, called ‘direct’, distinct from both the intrinsic and the relative type. In order to allow comparisons with these other frameworks, we specify two subcategories of intrinsic: following Danziger's (2010) terminology, **object-centered** refers to intrinsic descriptions based on the chair, as in (5), whereas **direct** refers to intrinsic descriptions based on the body of the speaker, as in (6).

Landmark-based FoR
As explained in §3, this strategy corresponds to the use of ad-hoc landmarks for directions or location. A prototypical use of a landmark for B&C is illustrated in (7). The landmark *mukinal* 'the cemetery' was in the direction suggested by the position of the ball with respect to the chair in the actual situation of the recording.

(7) *jich p'ekel bel ta stojol* ***mukinal*** *i pelota-i*
thus lying DIR PREP towards cemetery the ball-CL
'The ball is placed towards the cemetery [with respect to the chair].'


Figure 6

Another kind of landmark used by almost all the participants was their own body: the orientation of the chair or the location of the ball was sometimes described as 'towards me', 'towards where we are', etc., as in (8).

(8) *li' ay tal y-elaw ta ba ay-otik-i*
here is DIR 3POS-face PREP where be-1PL.ABS-CL
'It [the chair] is facing towards here where we are.'


Figure 7

Technically, such uses of the bodies of speech act participants as landmarks satisfy Danziger’s definition of ‘direct’. For the concern of maintaining comparability with the proposals that would analyze (8) as instantiating a distinct type of FoR, the landmark category in the tables in §6 is broken down into two subcategories: "SAP" refers to the use of speech act participants' bodies as landmarks, as in (8), whereas "general" refers to the use of any other object in the world as a landmark, as in (7).

6. Results place by place

6.1. Ch'ajkoma

As described above, Ch'ajkoma is situated directly south and above Majosik' on the same slope: from the lowest houses of Ch'ajkoma one sees Majosik' a few hundred meters below. The expectation was then to obtain results similar to those of Brown and Levinson, as described in §3. B&C was applied to five pairs of speakers in Ch'ajkoma, whose characteristics are summarized in Table 2. Literacy means literacy in Spanish; although some people may have rudimentary literacy in Tseltal also, there is generally no functional literacy in Tseltal.

Table 2: Ball & Chair Participants in Ch'ajkoma

Pair	Speaker	Sex	Age	Bilingual	Literacy	Schooling
1	1	M	22	yes	yes	secondary school
	2	M	40	yes	some	some
2	3	M	48	yes	some	some
	4	F	44	no	some	some
3	5	F	30	yes	yes	primary school
	6	M	29	yes	yes	primary school
4	7	F	22	no	no	some
	8	M	24	yes	some	primary school
5	9	F	29	no	some	primary school
	10	M	29	yes	some	primary school

Quantitative results of the B&C task in Ch'ajkoma are presented in tables 3a and 3b. The numbers in table 3a refer to the number of photographs (among 48) for which the corresponding strategy was used (generally various strategies were used successively before the matcher found the photograph that the director was describing).

Table 3a: Strategies used for Ball & Chair in Ch'ajkoma (pair by pair)[3]

		absolute 'up'/'down'	sunrise sunset	rela-tive	intrin-sic	(o.-c. /direct)	land-mark	(general /SAP)	total
1	Orientation of Chair	5	1	4	0	(0/0)	23	(17/6)	33
	Location of Ball	0	0	9	30	(27/3)	4	(2/2)	43
2	Orientation of Chair	1	12	0	1	(0/1)	25	(21/4)	39
	Location of Ball	0	22	6	21	(21/0)	3	(2/1)	52
3	Orientation of Chair	1	20	0	0	(0/0)	22	(22/0)	43
	Location of Ball	0	13	3	28	(28/0)	0	(0/0)	44
4	Orientation of Chair	8	2	0	0	(0/0)	29	(24/5)	39
	Location of Ball	5	4	1	13	(13/0)	11	(7/4)	34
5	Orientation of Chair	20	0	0	5	(0/5)	20	(10/10)	45
	Location of Ball	12	0	1	17	(17/0)	13	(6/7)	43

Table 3b: Strategies used for Ball & Chair in Ch'ajkoma (summary)

	absolute 'up'/'down'	sunrise sunset	rela-tive	intrin-sic	(o.-c. /direct)	land-mark	(general /SAP)	total
Orientation of Chair	18%	18%	2%	3%	(0/3%)	60%	(47%/13%)	199
Location of Ball	8%	18%	9%	50%	(49%/1%)	14%	(8%/6%)	216

First of all, we can see that the participants from Ch'ajkoma used the absolute 'up'/'down' axis : all pairs used it at least once, but pair 4, and more markedly pair 5, used it much more frequently than the other pairs of speakers. All those absolute references were successful, in the sense that the matcher interpreted them correctly in terms of absolute directions, in spite of the potential ambiguity of 'up' and 'down' terms (cf. §4 above). This shows that the absolute 'up'/'down' axis belongs to the habitual resources of Ch'ajkoma speakers for describing spatial configurations at a scale within reach.

However, the sunrise/sunset axis was preferred by pairs 2 and 3 over the 'up'/'down' axis. This seems to indicate that the solar compass is also a common resource for establishing a coordinate system to be used in spatial descriptions in Ch'ajkoma.

[3] o.-c. = "object-centered", cf. preceding section on intrinsic FoR.

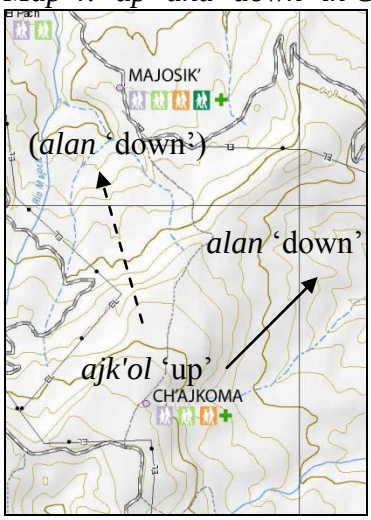
Going back to Table 3b, we observe that the main strategies used in the B&C task are the use of ad-hoc landmarks in describing the orientation of the chair (60%) and the intrinsic FoR in describing the location of the ball with respect to the chair (50%). That is, a prototypical expression for orienting the chair was 'its face is turned towards Majosik' / the car / here where we're sitting / etc.', and a frequent way of locating the ball was 'it is at the chair's side / back / face / etc.'

All these result are consistent with the results from Majosik' obtained by Brown and Levinson (2009), as presented in Table 1 above.

The frequencies of use within the individual categories are quite similar, despite the fact that they come from different tasks. In particular, landmark uses outnumber uses of the absolute 'up'/'down' axis in both places. The only perceptible differences are, on the one hand, the fact that absolute 'up'/'down' references outnumber references to the sun compass in Majosik', whereas it is the other way around in Ch'ajkoma. On the other hand, the relative FoR seems to be less marginal in Ch'ajkoma than in Majosik', a point we return to below.

Nevertheless, there is an important difference between Ch'ajkoma and Majosik' which needs highlighting: the orientation of the 'up'/'down' axis. Ch'ajkoma is situated on an edge, with a slope descending in NNW direction and another one descending in NE direction. As a matter of fact, there are two possible referents of *alan* 'down', as represented in Map 4. The north(west) *alan* (dotted arrow) manifests itself when people are on the north(west)-oriented slope − this is the expected predominance of the actual slope over the "conceptual slope" − but in all other contexts the dominant *alan* 'down' axis is northeast (≈45°) in Ch'ajkoma, with *ajk'ol* 'up' oriented southwest (≈225°), whereas in Majosik' the axis is 345°/165° for 'down' and 'up', respectively. Topography is thus crucially involved in defining the 'up'/'down' axis.

Map 4: 'up' and 'down' in Ch'ajkoma



Regarding the relative FoR, we observe in Table 3a that all pairs of speakers used at least one relative expression, but that pair 1 accounts for more than half of all of these expressions. Many of the relative expressions are of the kind 'at the back of the chair' meaning 'behind the chair from our perspective', as exemplified in (4) above. Several speakers also used *xujk* 'side' involving a relative FoR, as in (9), a possibility that had not been observed before in Tenejapa as far as we know, suggesting it could be a recent innovation.

(9) *tey ta [x]-xujk ay me balon-e*
there PREP 3POS-side is the ball-CL
'There at its side is the ball.'

Figure 8

What is referred to in (9) cannot be an intrinsic side of the chair. It is instead a side imposed by the observer's perspective on the ground, preempting in this case the intrinsic side.

Pair 1 is the only dyad where the speakers rely on terms for ‘left’ and ‘right’. Speaker 1 first introduces them into the interaction. He is 22 years old, fully bilingual and completed secondary school (which is conducted in Spanish). Speaker 2 is also quite fluent in Spanish, but with a much lower level of literacy and schooling. A careful examination of the data shows that speaker 2 aligns with speaker 1 and starts to also rely on the relative ‘left’ and ‘right’, although he only uses it as an ancillary option when absolute, intrinsic or landmark-based attempts failed. An example of the kind of relative use that shows up with pair 1 is given in (10).

(10) *ta j-wa'el-k'ab-tik wil-em moel jteb pelota-i*
PREP 1POS-right-hand-PL fly-PERF DIR a.little.bit ball-CL
'At our right hand the ball is flying a little bit.'

Figure 9

Two important things must be highlighted from this use of relative FoRs. On the one hand, it confirms that spontaneous projective uses of left and right do exist in Tenejapa Tseltal, a fact not registered before. On the other hand, it is reasonable to think that this is a recent innovation resulting from contact with Spanish given the fact that twenty years ago this kind of use was uncommon, as reported in the work of Brown and Levinson for the Majosik' community. Second, the diffusers of this phenomenon appear to be young bilingual speakers. At the same time, as native terms for left and right are used projectively, we observe the borrowing of the Spanish terms *izquierda* 'left' and *derecha* 'right' into Tseltal discourse: these were used twice during the task for pair 1.

But interestingly, the fact that speaker 2, who is older and less educated than speaker 1, easily adopts the relative strategy during the task in response to speaker 1's initiative shows that this represents no difficulty for him. This is consistent with the findings of Abarbanell (2007), who has shown that it is possible to induce and/or teach Tenejapan people to successfully use relative expressions in specific communication contexts. We take up this point again in §7 below.

6.2. Lum

The B&C task was applied to five pairs of speakers in Lum (the town of Tenejapa), as the data in Table 5 show. These are mostly female speakers, a little bit older than the Ch'ajkoma participants (median age = 35.5, as compared to 29 for Ch'ajkoma).

Table 5: Ball & Chair Participants in Lum

Pair	Speaker	Sex	Age	Bilingual	Literacy	Schooling
1	1	M	57	no	no	none
	2	F	53	no	no	none
2	3	F	26	yes	no	none
	4	M	56	yes	no	some
3	5	F	21	yes	yes	secondary school
	6	F	21	yes	yes	high school
4	7	F	29	yes	some	primary school
	8	F	33	yes	some	primary school
5	9	F	54	no	no	none
	10	F	38	no	no	some

Quantitative results for Lum are presented in Tables 6a and 6b:

Table 6a: Strategies used for Ball & Chair in Lum (pair by pair)

		absolute 'up'/'down'	sunrise sunset	rela-tive	intrin-sic	(o.-c. /direct	land-mark	(general /SAP)	total
1	Orientation of Chair	1	0	0	0	(0/0)	42	(25/17)	43
	Location of Ball	0	0	0	16	(16/0)	21	(17/4)	37
2	Orientation of Chair	0	0	0	0	(0/0)	33	(26/7)	33
	Location of Ball	0	0	5	26	(25/1)	25	(24/1)	56
3	Orientation of Chair	1	0	0	0	(0/0)	42	(32/10)	43
	Location of Ball	0	0	7	24	(24/0)	16	(5/11)	47
4	Orientation of Chair	0	0	3	1	(0/1)	23	(9/14)	27
	Location of Ball	1	0	17	17	(15/2)	1	(0/1)	36
5	Orientation of Chair	0	0	0	1	(0/1)	45	(28/17)	46
	Location of Ball	0	0	2	20	(20/0)	19	(14/5)	41

Table 6b: Strategies used for Ball & Chair in Lum (summary)

	absolute 'up'/'down'	sunrise sunset	rela-tive	intrin-sic	(o.-c. /direct	land-mark	(general /SAP)	total
Orientation of Chair	1%	0	2%	1%	(0/1%)	96%	(62%/34%)	192
Location of Ball	0	0	14%	48%	(47%/1%)	38%	(28%/10%)	217

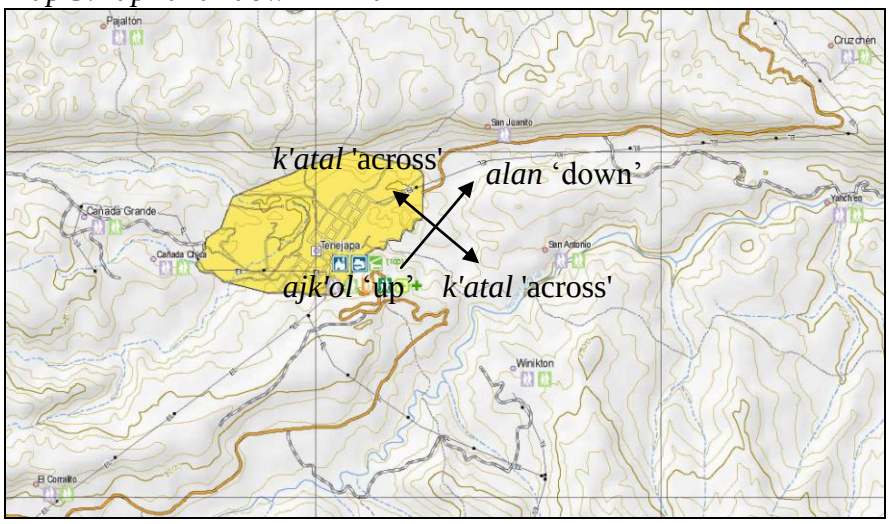
Before highlighting the discrepancies between the Lum and Ch'ajkoma data, we can see at first sight that there are consistencies between the two places. The main strategy for the orientation of the chair is also the use of a landmark-based FoR (although with a higher rate, as we discuss below), and the main strategy for the location of the ball is the intrinsic strategy, with a very similar frequency (48%, as compared with 50% in Ch'ajkoma). The use of relative FoRs is a little bit higher in Lum than in Ch'ajkoma for the location of the ball (14%, against 9% in Ch'ajkoma), and again a single pair accounts for more than half of all of the tokens.

The main surprise comes from the near complete absence of use of any absolute FoRs: the absolute 'up'/'down' axis is used no more than three times in the whole task, by three different pairs, and the sunrise/sunset axis does not show up at all. The contrast with Ch'ajkoma is significant: we are dealing here with two groups of people who speak the same dialect of the same language, and who both use absolute reference in their daily conversations, as we show below for Lum. But when speakers from the two communities solve a communicative task like B&C, a drastic difference emerges: Ch'ajkoma speakers rely on the 'up'/'down' and sunrise/sunset axes, whereas Lum speakers do not. Literacy and education cannot account for this

contrast, since they are higher among the Ch'ajkoma speakers we recruited than among the Lums speakers. It is not obvious that urbanization can account for the difference. Although it is true that Lum is slightly bigger (the 2005 population census shows a total of 1900 people in Lum, *vs.* 1413 in Ch'ajkoma) and has more urban-like concentrated housing with few green areas between houses, there are no drastic socioeconomic differences between the two places, as most people maintain similar farming activities. One interesting difference between the two communities that deserves further attention is the presence of 10% monolingual Spanish speakers. This could account for the slightly more frequent use of relative FoRs in Lum.

Additional studies the first author conducted in Lum show that people do use both the absolute 'up'/'down' and the sunrise/sunset axes; we focus here only on the former. In Lum, 'up' corresponds to southwest and 'down' to northeast, with the corresponding 'crosswise' axes, as presented in Map 5.

Map 5: 'up' and 'down' in Lum



This orientation of the axes is linked to topographic cues, although not as saliently as in Ch'ajkoma or Majosik'. Still, it follows the local (gentle) inclination of the land inside the village. The orientation of the streets, which form a grid oriented from southwest to northeast and from southeast to northwest, may also play a role in the exact orientation of the axes, as does the fact that the main road that crosses Lum and connects it to the upper and lower parts of Tenejapan territory is oriented in approximately a southwest to northeast direction. Nevertheless, other important topographical details contribute to making the 'up'/'down' axis less salient. Above all, directly north of Lum there is a huge cliff, which climbs up 300 meters almost vertically at some points. This means the absolute 'down' direction quickly implies going up as soon as one exits the village. The general land inclination from high south(west) to low north(east) is thus locally concealed from sight, and the only way of going really down out of that valley is eastwards (without a steep slope). There is then a complex of contradictory local clues which downgrades the salience of the absolute 'up'/'down' axis.

Even so, Lum speakers do use the absolute 'up'/'down' axis, but for more restricted purposes than people from northern Tenejapa: they mainly use it in expressions of motion − for instance following the main street northeastwards is commonly expressed as 'going down' − and for the respective location of places at geographic scale space, for instance, 'Balunk'anal (a village southwest of Lum) is up with respect to Lum' or 'Retiro (a village southeast of Lum) is crosswise with respect to Lum', etc. Locating where other people live is also typically done with an

indication of ‘up’ or ‘down’, as in 'Xun's house is downward (with respect to here or to another specific point)'. But what the B&C data teach us is that, contrary to what happens in the northern part of Tenejapa like in Ch'ajkoma or Majosik', the absolute ‘up’/’down’ axis is not completely adequate at a small scale level, that is, the level where objects like balls and chairs are manipulated. It seems reasonable to think that this is an effect of the low salience of this axis.

Aside from this effect on the use of the absolute FoR, the data from Ch'ajkoma and Lum are very consistent. In fact, the sum of absolute ‘up’/’down’, sunrise/sunset and landmark use remains constant in both places: for the orientation of chair, we have 18%+18%+60%=96% for Ch'ajkoma and 1%+0+96%=97% in Lum; for the location of the ball, we have 8%+18%+14%=40% in Ch'ajkoma and 0+0+38%=38% in Lum. This suggests that the inadequacy of the absolute axes for resolving this task in Lum is directly compensated by a more massive use of ad-hoc landmarks, and not, for instance, by an increase in the use of relative FoRs.

Turning now our attention to relative FoRs, we observe that four out of five pairs used them at least once. In three of these four pairs, we only find relative uses of the expressions *ta xujk* 'at its side' and *ta spat* 'at its back'. Pair 4 stands out by their more frequent use of relative FoRs, which accounts for 47% of their descriptions. Pair 4 is responsible for 59% of all relative uses in the overall results. These data show that this type is indeed one of the dominant strategies for these speakers.This is also the only pair of speakers who use ‘left’ and ‘right’ terms: of the twenty times pair 4 used relative FoRs, eighteen correspond to utterances involving ‘left’ and ‘right’, and of those, twelve were expressed with the borrowed Spanish terms *izquierda* and *derecha*. A similar spreading of the use of relative FoRs along with that of Spanish loan words is reported in Hernández-Green, Palancar, & Hernández, this issue, for San Ildefonso Tultepec Otomí.This points to language contact as the source of the apparent rise of relative reference in Tseltal. At the same time, the speakers of pair 4 are neither the youngest nor the most educated of all participants from Lum. In fact, the speakers of pair 3 are the most literate of all the Lum participants, yet their rate of use of the relative FoR is much lower and they did not use left or right even once. This suggests that bilingualism, a linguistic factor, may play a more important role in the use of relative FoRs than the non-linguistic factors education and literacy. A much larger population sample needs to be tested in order to verify these tendencies.

6.3. Mesbilja'

The B&C task was applied to six pairs of speakers in Mesbilja', in Oxchuc county, as summarized in Table 7. Their median age is 32.

Table 7: Ball & Chair Participants in Mesbilja'

Pair	Speaker	Sex	Age	Bilingual	Literacy	Schooling
1	1	M	56	yes	some	some
	2	F	23	yes	yes	secondary school
2	3	F	53	some	some	primary school
	4	F	34	yes	yes	primary school
3	5	F	47	no	no	some
	6	M	48	yes	some	primary school
4	7	F	23	yes	yes	high school
	8	M	30	yes	no	no
5	9	M	43	yes	yes	secondary school
	10	F	20	Yes	yes	high school
6	11	M	17	Yes	yes	secondary school
	12	M	18	Yes	yes	secondary school

Results for Mesbilja' are presented in Tables 8a and 8b:

Table 8a: Strategies used for Ball & Chair in Mesbilja' (pair by pair)

		absolute 'up'/'down'	sunrise sunset	rela-tive	intrin-sic	(o.-c. /direct)	land-mark	(general /SAP)	total
1	Orientation of Chair	0	0	0	7	(0/7)	38	(37/1)	45
	Location of Ball	0	0	4	22	(20/2)	7	(7/0)	33
2	Orientation of Chair	0	0	0	0	(0/0)	7	(5/2)	7
	Location of Ball	0	0	1	23	(19/4)	9	(8/1)	33
3	Orientation of Chair	6	0	0	5	(0/5)	28	(26/2)	39
	Location of Ball	16	0	0	14	(11/3)	7	(7/0)	37
4	Orientation of Chair	4	0	0	3	(0/3)	32	(26/6)	39
	Location of Ball	0	0	5	22	(18/4)	22	(12/10)	49
5	Orientation of Chair	12	8	0	1	(0/1)	34	(17/17)	55
	Location of Ball	4	2	3	18	(17/1)	21	(7/14)	48
6	Orientation of Chair	12	0	0	0	(0/0)	32	(21/11)	44
	Location of Ball	0	0	2	11	(10/1)	19	(8/11)	32

Table 8b: Strategies used for Ball & Chair in Mesbilja' (synthesis)

	absolute 'up'/'down'	sunrise sunset	rela-tive	intrin-sic	(o.-c. /direct)	land-mark	(general /SAP)	total
Orientation of Chair	15%	3%	0	7%	(0/7%)	75%	(58%/17%)	229
Location of Ball	9%	1%	6%	47%	(41%/6%)	37%	(21%/16%)	232

These results are overall very similar to the results of Ch'ajkoma and Lum: preponderance of landmark and intrinsic FoRs for the orientation of the chair and the location of the ball and low rate of relative FoRs. The use of the absolute 'up'/'down' axis is broadly similar to that of Ch'ajkoma (15% for descriptions of the orientation of the chair and 9% for descriptions of the location of the ball, as compared with 18% and 8%, respectively, in Ch'ajkoma).

Nevertheless, there are also discrepancies between the data from Mesbilja' and Ch'ajkoma: all pairs in Ch'ajkoma relied on absolute strategies, be it the absolute 'up'/'down', the sunrise/sunset axis, or a mix of both. In contrast, two pairs of speakers in Mesbilja' (1 and 2) used absolute FoRs in the horizontal. As for the sunrise/sunset strategy, only one pair of Mesbilja' speakers used it (pair 5).

Another crucial phenomenon of Mesbilja' without parallel in Ch'ajkoma a high number misunderstandings in those four pairs of speakers that used the absolute 'up'/'down' axis. For example, in pairs 3, 4 and 5, all of which were mixed-gender dyads, the woman was the one using the absolute FoR, and the man did not interpret it correctly most of the time. The only pair managing an effective communication with the absolute type of FoR was pair 6, composed of two young men, suggesting that no hasty conclusion should be derived in terms of the factors of gender and age in the mastery of this FoR type.

The misunderstandings involving the 'up'/'down' absolute FoR cannot be explained by an ignorance of this type of FoR.Instead, the relative salience of the various possible interpretations of 'up' and 'down' are the issue: the speakers showing the misunderstandings favored a vertical interpretation of these terms, and were reluctant to apply them in that context to the absolute horizontal directions. For instance, in reaction to a description of photograph 3-11 in terms of 'the ball is up (with respect to the chair)', they would tend to select 3-8 instead.

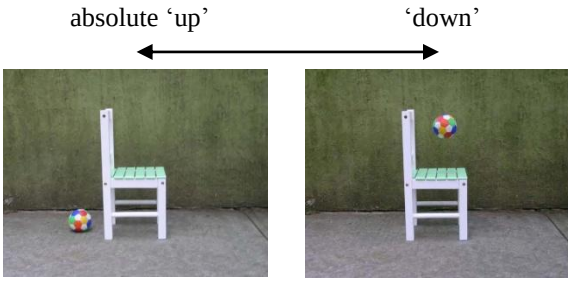
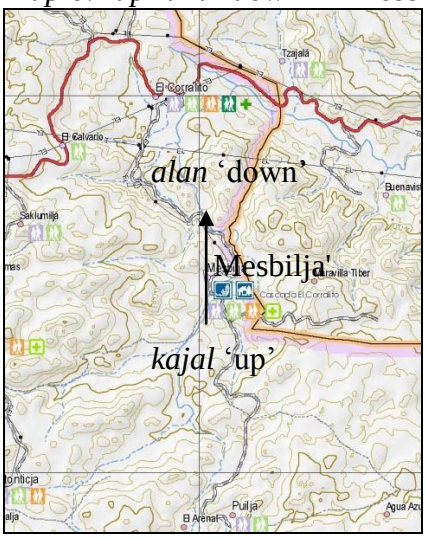


Figure 10

These same speakers would happily say 'I went down to the coffee plantation' or 'my house is up from here', referring respectively to a movement or a direction northward or southward on the flat terrain. Again, we're facing a problem in the application domain of the absolute ‘up’/’down’ axis: all speakers use it at a geographical level for motion and for locating places, but not all extend it to the small-scale level of the B&C task. These results are particularly surprising since the dyads in question consist of nuclear family members − pairs 3 and 4 are husband and wife, pair 5 is a father and his daughter.

As for the orientation of the ‘up’/’down’ axis in Mesbilja', it follows the local river drainage direction from south to north (see Map 6), so the axis closely aligns with local topography. We have not registered any crosswise axis as of now similar to the *k'atal* axis of Tenejapa. There is no unique dominant slope at a regional level around Mesbilja': east also goes down just passing the hill line, and going ten kilometers south one finds another downward slope descending south. This lack of uniformity is reflected in the lack of a shared conceptual slope at a regional level: there are locally defined ‘up’/’down’ axes usable for spatial communication in Oxchuc county, as in Mesbilja'; but there is no single system all communities in Oxchuc converge on, just as there is no such single standard in Tenejapa county.

Map 6: ‘up’ and ‘down’ in Mesbilja'



Finally, with respect to relative FoRs in Mesbilja', all pairs except for one use them at least once, but no pair relies heavily on them, unlike what was the case with one dyad each in Ch'ajkoma and Lum. Even among young bilingual and fully literate speakers, such as those of pair 6, the relative

type plays only a marginal role. Relatively interpreted expressions in Mesbilja' include 'at its back', 'at its side', and a few projective uses of ‘left’ and ‘right’, mainly involving autochthonous Tseltal terms.

7. Summary and discussion

In table 9 we present a summary of the results from the three places.

Table 9: Summary of the results of Ball & Chair in the three Tseltal communities:

		absolute ‘up’/’down’	sunrise sunset	rela-tive	intrin-sic	(o.-c. /direct)	land-mark	(general /SAP)	total
Ch'ajkoma (5 pairs)	Orientation of Chair	18%	18%	2%	3%	(3%/0)	60%	(47%/13%)	199
	Location of Ball	8%	18%	9%	50%	(49%/1%)	14%	(8%/6%)	216
Lum (5 pairs)	Orientation of Chair	1%	0	2%	1%	(0/1%)	96%	(62%/34%)	192
	Location of Ball	0	0	14%	47%	(47%/1%)	38%	(28%/10%)	217
Mesbilja' (6 pairs)	Orientation of Chair	15%	3%	0	7%	(0/7%)	75%	(58%/17%)	229
	Location of Ball	9%	1%	6%	47%	(41%/6%)	37%	(21%/16%)	232

B&C reveals a strong convergence in the three communities in terms of strategies used to solve this kind of spatial task. First of all, all three places converge in terms of favorite strategies. On the one hand, the orientation of the chair was predominantly described through the use of ad-hoc landmarks. On the other hand, to locate the ball with respect to the chair participants relied mostly on meronyms projecting regions from the parts of the chair, involving an intrinsic FoR. As discussed in §3, this prevalence of landmark-based and intrinsic FoRs over absolute ones confirms Brown & Levinson’s (2009) findings. We see no reason at this point not to go along with Brown and Levinson’s conjecture that this bias may be task-specific. If the need for great precision favors landmark-based over absolute FoRs, then such a need may well have driven the use of landmark-based frames in the B&C task given the high number and the sublety of the spatial contrasts in the B&C pictures.

All three groups show a low use of relative FoRs. The higher results in both Ch'ajkoma and Lum are in each case mainly attributable to a single pair of speakers, which shows that the use of this type of FoR is not uniform across the members of a community: certain speakers seem to act as diffusers of this pattern. There is also evidence that Spanish is exerting a strong influence in this diffusion, since the use of ‘left’ and ‘right’ for projecting spaces from the viewpoint of the observer is frequently done in connection with the loan words *izquierda* ‘left’ and *derecha* ‘right’, although Tseltal words for ‘right hand’ and ‘left hand’ also work. This influence manifests itself through bilingual, but not necessarily through the ones with the highest degree of literacy or schooling. But beyond the use of ‘left’ and ‘right’, which is the most significant sign of the spreading of relative FoRs in Tseltal, other terms seem to be extending their potential as relative relators: *spat* 'its back' and *xujk* / *sts'eel* 'its side'. Of these, only the first had been documented with relative interpretations in previous descriptions, and only as a marginal and secondary use. The B&C data speak of a much more regular use of these terms involving relative

interpretations. Our tentative conclusion is that the use of relative FoRs is generally on the rise among Tseltal speakers, and that this rise may be caused by a linguistic factor, language contact.

The main discrepancies between the three places have to do with the use of absolute FoRs based on the absolute 'up'/'down' and the sunrise/sunset axes. In each place, a different pattern of use of these axes was observed. In Ch'ajkoma, all pairs of speakers used at least one of these axes, and with most pairs it was one of the dominant strategies; the communication through this kind of FoR was effective. In Lum, we hardly observed any use of these axes at all: speakers did not rely on this strategy. As for Mesbilja', the absolute 'up'/'down' axis was used by four out of six pairs in a proportion similar to those of Ch'ajkoma, but in three of these four pairs, communication was not quite effective: one of the two speakers tended to interpret 'up' and 'down' in terms of the vertical axis instead of the absolute interpretation. Nevertheless, observation and interactions in the field outside of this task suggests that all speakers in both Lum and Mesbilja' do use the absolute 'up'/'down' axis for other purposes, such as in motion descriptions and descriptions of the location of objects in large-scale space. Variation is greatest smaller-scale locative descriptions. This kind of restriction on the use of the absolute FoR is quite common cross-linguistically. For example in the Australian language Jaminjung, the absolute FoR is said to be "predominantly for larger-scale geographic space, really only used in manipulable space for direction orientation of a featured figure, or motion" (Levinson & Wilkins 2006: 567). At a broader level, all languages that display frequent use of absolute FoRs in daily conversation show the kind of tendencies that we see at play here: they use the absolute FoR for orientation rather than for location, for motion rather than for static location, and to describe large-scale space rather than small-scale space (Levinson & Wilkins, 2006: 549). All of these tendencies are reflected in the B&C data as compared to general uses of the 'up'/'down' axis in Tseltal.

More importantly, we observed differences in the application domains of absolute FoRs in three places so close to each other: Ch'ajkoma, where absolute FoRs are used for B&C, is only 7 kilometers away on a straight line from Lum (or twenty minutes away by road), where absolute FoRs seem much less adequate in manipulable space. Both places are part of the same county, where a single dialect is spoken. As for Mesbilja', it is 27 kilometers away on a straight line from both Ch'ajkoma and Lum, and the variety of Tseltal spoken there is only slightly different from Tenejapa Tseltal. Remarkably, members of the same household do not use the absolute type of FoR with the same frequency in Mesbilja'.

Variation in the same language in the use of FoRs has been documented, for example between urban Tamils, who prefer relative FoRs, and rural Tamils, who favor absolute FoRs (Pederson *et al*. 1998:583, reporting Pederson 1993). But minor variation between individuals as displayed by Tseltal is more similar to the gender specialization reported for Yucatec in Bohnemeyer & Stolz (2006), where men rely on the cardinal axes whereas women do not. This gender bias is reportedly related to differences in cultural practices: the four edges of *milpa* slash-and-burn gardens are customarily aligned according to cardinal directions, and so are the walls of houses. So the activities of making a *milpa* and building a house, which are quite common in the male domain, but rare in the female, require familiarity with the cardinal directions (Le Guen 2006; Bohnemeyer, this issue).

For Tseltal, it appears that at least part of these discrepancies can be related to geographical issues. The higher or lower salience of the 'up'/'down' axis in terms of the local slope is most likely a determining factor in the propensity of use of this axis in different contexts. For instance, the low salience of the axis in Lum, where the dominant slope at the regional level is concealed by local topography, correlates with the fact that people seem reluctant to use 'up' and 'down' at a small spatialscale, contrary to what happens in northern Tenejapa, in Majosik' or Ch'ajkoma,

where the slope is very salient and people readily use absolute ‘up’ and ‘down’ at any scale. Likewise, the lack of regional uniformity of the terrain and the elevation in the Oxchuc region could play a role in the lack of agreement between Mesbilja' inhabitants about what the exact application domain of the absolute ‘up’/’down’ axis is. We could say that topography constrains the frequency of use of the absolute ‘up’/‘down’ system: the more salient the presence of one single mountain slope is in a given local as unique anchor of geocentric FoRs, the more likely FoRs anchored to this slope are used in this local. This appears to be but a special case of any kind of FoR, which may be formulated as in (11):

(11) **Salient anchorage constraint:** The accuracy and unambiguousness of spatial reference in a given FoR in any given context is a function of the extent to which the axes of that FoR can be unambiguously determined in that context and the location/motion of the figure with respect to the ground (in locative/motion descriptions; the orientation of the figure in orientation descriptions) aligns with these axes.

This constraint entails, for example, that the location of the ball is harder to describe in object-centered terms in Figure 9 above, where it is at roughly a 45° angle with respect to both the front-back axis and the left-right axis of the chair, than in Figure 8, where it is right on the front-back axis. Similarly, (11) causes speakers of English and Japanese to project relative FoRs much more readily onto grounds that are straight ahead in their field of vision than onto grounds that are sideways from or behind them. It also explains why left-right confusion is much more common than front-back confusion among relative speakers and thinkers. Tseltal speakers are more likely to apply the ‘up’/‘down’ system to figure-ground configurations that align with the ‘up’/‘down’ axis than to those that fall on the undifferentiated ‘across’ axis, let alone to those that fall on neither (Brown 2006: 267). Principle (11) explains this. And, as mentioned in §4, geomorphic uses of the terms – i.e., uses dependent on an actual local mountain slope as anchor - to the extent that they are possible in a given community, preempt absolute uses – (11) likely accounts for this distribution as well. This means that in every community in which there is a salient unique mountain slope, geomorphic usage anchored to this slope preempts absolute use. In theory, this does not necessarily prevent the various communities from converging on a single absolute system. As Levinson (2003: 225-243) demonstrates, based on data from three predominantly relative and three predominantly absolute populations including Tejenapans of Majosik’, collected by a number of researchers, speakers of absolute languages have vastly superior ‘dead-reckoning’ skills compared to speakers of relative languages, meaning they are much more adept at mentally tracking their bearings as they change place and orientation. However, in order for all Tseltal communities to adopt an absolute system anchored not with respect of their local topography, but with respect to that of one single other community, that “model” community would have to combine the presence of a unique salient mountain slope with an enormous amount of cultural prestige throughout the Tseltal area – and in actual fact, there is no such community. And given this lack of a single uniform absolute FoR accessible for all Tseltal speakers, speakers in communities that lack a unique salient mountain slope, such as Lum and Mesbilja’, will not use the ‘up’/‘down’ system much at all except in the vertical, as predicted by (11), and as borne out in the data presented above.

We have shown that local topography also “calibrates” the orientation of the ‘up’/’down’ axis. This fact is very clear if one compares data from Majosik' and Ch'ajkoma, two immediately neighboring communities: the former displays a south/north axis, whereas the latter shows a dominant southwest/northeast axis. Likewise, Mesbilja' speakers in Oxchuc who do use the

absolute ‘up’/’down’ in B&C consistently agree on a south/north orientation, following drainage direction in their valley. Again, (11) readily accounts for this variation.

The picture that emerges from those facts is a topographic constraint of the ‘up’/’down’ axis, very similar to that observed in other regions of the world.[4] Brown & Levinson (1993:52) themselves give a hint of this fact when they report the visit to Majosik’ by a Tenejapan from another community, where the slope fall eastwards and northwards: that visitor consequently “claimed ‘downhill’ was further east than our folk [i.e., people from Majosik’] will allow.” This fact led the authors to remark that: "familiarity with a particular territory may, at least for some individuals, be essential to exact use of the ['up'/'down' system]". As a matter of fact, we now can claim that this link to a particular territory is not merely a fact of "some individuals", but rather must be taken as the rule for all Tseltal speakers.

However, while (11) explains why topography, in connection with population geography, constrains the use of geocentric FoRs, this constraint does not support the environmental determinism Li & Gleitman 2002 propose. Li & Gleitman’s aim is to discourage the view that styles of cognition, such as adeptness at using one kind of FoR instead of another, may be learned cultural *habitus* transferred across generations through speech, gesture, and other observable cultural practices. For this position to be viable, they have to maintain that language *cannot* influence FoR selection. Environmental influences can only serve as evidence against linguistic influences if it can be shown that environmental factors determine FoR use independently of language. Li & Gleitman’s position predicts, for example, that if one were to discover somewhere in the Rocky Mountains an English-speaking community in a place whose topography is an exact mirror image of that of Majosik’, then – all else being equal - those English speakers should use the terms *up* and *down* in the same way the inhabitants of Majosik’ use *ajk’ol* and *alan*, and those English speakers would show the same linguistic and cognitive bias in favor of absolute FoRs. This kind of environmental determinism entails that any population that has a suitable feature in its local environment exploits it for modeling FoRs on it – which is clearly not the case for most English-speaking riverine or mountainous (etc.) communities. Anthropologists have long ago stopped trying to find strong determinants for a group’s spiritual or cosmological beliefs. Similarly, linguists are unable to strictly predict on cultural and environmental grounds what kind of color term system, demonstrative system, or tense-mood-aspect system a given language has. There appears to be no reason to assume that the relation between environmental factors and FoR use in language and cognition is any more direct. And the indirect, constraining role of topography and population geography confirmed in the present study in no way precludes language from playing a key role in guiding the acquisition of culture-specific styles of referential practice.

8. Conclusions

What had been described as one of the best documented cases of a language with a dominant absolute FoR, upon the collection and analysis of new data, revealed a situation more complex than previously thought. We knew from Brown and Levinson's work that speakers from a particular Tenejapan community, Majosik', relied heavily on absolute FoRs based on an ‘up’/’down’ axis both in talking and in thinking about space. A broader inspection including communities close to and farther away from Majosik' shows that the frequency of use of the ‘up’ and ‘down’ terms varies considerably. Their use can even be completely absent in a community.

[4] This panorama in particular is reminiscent of the case of Bali island, as described by Wassmann and Dasen (1998), where the up/down axis shifts as one goes around the island according to the direction of the central mountain range.

And in communities in which it is present, it is calibrated to local topography, which influences the exact orientation of the axis and the range of application it will have. What remains constant among different places is the geomorphic interpretation of 'up' and 'down' with reference to any local slope or to the gravitational vertical, which correspond to their primary meaning. Tseltal as a whole looks then more similar to Balinese (Wassmann and Dasen 1998) or Jaminjung (Schultze-Berndt 2006) than a strongly absolute language like Guugu Yimithirr (Haviland 1993, 1998; Levinson 2003).

We have argued that the observed constraints in terms of topography and population geography on the use of geocentric FoRs are a special case of a more general principle, the salient anchorage constraint, which constrains the use of all types of FoRs. The existence of such constraints neither contradicts nor supports the environmental determinism of FoR use proposed by Li & Gleitman 2002. Such constraints determine the relative accuracy of spatial descriptions in one type of FoR vs. another, but they do not cause speakers or thinkers to select one kind of frame as opposed to another independently of language and culture.

Through the results of the B&C task, we have shown in this paper that, besides discrepancies in the use of absolute FoRs, Tseltal is very consistent in terms of other spatial strategies: orientation information is mainly coded by means of landmarks, and location in close contiguity to a featured ground is mainly coded within intrinsic FoRs.

Nevertheless, a tendency observed in the data is the spreading of the use of relative FoRs through contact with Spanish and schooling. Projective uses of left and right, either with borrowed Spanish words or in Tseltal, manifested themselves in all three Tseltal communities. It should be noted however that the increased use of relative FoRs does not necessarily imply a decrease of the use of absolute FoRs in the discourse of young people, several of whom appear to be at ease with both strategies.

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