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Language, Culture and Spatial Cognition: Bringing anthropology to the table

Abstract: Languages vary in their semantic partitioning of the world. This has led to speculation that language might shape basic cognitive processes. Spatial cognition has been an area of research in which linguistic relativity — the effect of language on thought — has both been proposed and rejected. Prior studies have been inconclusive, lacking experimental rigor or appropriate research design. Lacking detailed ethnographic knowledge as well as failing to pay attention to intralanguage variations, these studies often fall short of defining an appropriate concept of language, culture, and cognition. Our study constitutes the first research exploring (1) individuals speaking different languages yet living (for generations) in the same immediate environment and (2) systematic intralanguage variation. Results show that language does not shape spatial cognition and plays at best the secondary role of foregrounding alternative possibilities for encoding spatial arrangements.

1. Introduction

Languages vary in their semantic partitioning of the world. From the vantage point of an English speaker, Tzotzil Maya, one of the languages

explored in this study, shows several peculiarities,[1] such as lacking categorical terms for "animals" or "plants," and using the term *yax* for the colors described in English as "blue," "green," and "gray". While these differences are not disputed, the important question has been whether or not such linguistic differences have implications for how humans think about the world. Said differently, *do Tzotzil Maya and English speakers differ in how they think about animals, plants or colors*? Abstractly, answering this question in the positive is known as either the Sapir-Whorf hypothesis or Linguistic Relativity (Sapir 1921; Whorf 1956; Gumperz & Levinson 1996; Hunt & Agnoli 1991; Kay & Kempton 1984; Lucy 1997; Levinson 2003:18; Martin 1986).

Challenges to the idea of linguistic relativity arise from fields such as Psychology, Linguistics and Anthropology, yet conclusive evidence has often been missing. On one hand Psychologists tell us that language cannot be the vehicle for thought (see Pinker 1994). On the other hand Linguists and Anthropologists question the very construct of language as an independent variable (see for example Fromkin et al. 2003).

Still, interest in the overall idea has never ceased. In fact, interest in psycholinguistic phenomena seems to be greater than ever. Such interest is high because the consequences for the nature of human thought are considerable; if language impacts thought then many assumed cognitive universals could no longer be taken for granted, and child development would be constrained and shaped by the language one acquired. This, then, would have serious consequences for our understanding of cultural processes, in that it would be much more dependent on language than previously thought.

The relation of spatial language and cognition is one of the better-documented domains for which linguistic relativity has both been claimed and rejected. Levinson and colleagues (Levinson et al. 2002; Levinson 2003) have postulated the existence of three spatial frameworks that humans employ in order to reference objects in space. These are (1) the Relative Spatial Reference System (RSRS), with the speaker as reference point ("The ball is to the left of Bill", from the speaker's viewpoint); (2) the Intrinsic Spatial Reference System (ISRS), with intrinsic features of objects providing the features of the spatial description ("The ball is to Joe's right"); and (3) the Absolute Spatial Reference System (ASRS) ("the ball is to the north of Bill"). According to these re-

searchers the three spatial reference systems are not equally distributed across languages, a fact that has led to speculations about possible linguistic impacts on human spatial cognition.

Scholars like Levinson (2001) have argued that it might be interesting to look at languages that do not use the RSRS, and that lack terms (or their use) such as "left," or "right side". The existence of such languages might be surprising to the average English speaker in and of themselves. In fact, the idea that a language inevitably makes use of egocentric, person-based coordinates goes at least back to Kant (1768).

Noticing that languages vary in the way they encode spatial relations, (with some lacking certain spatial expressions), Levinson and collaborators hypothesized that linguistic differences would affect how spatial constellations are encoded in memory (Levinson 2003).[2] To show this, they designed a set of rotation tasks (Brown & Levinson 1992, 1993), one of which we employed in the current studies, albeit with minor modifications. In Figure 1, each participant (#1) is presented with three items on a stimuli table. After memorizing the items, the participant is turned 180°(now #2) and asked to (a) pick the three (out of five) items observed on the stimuli table and (b) arrange them on the recall table. Big circles in Figure 1 indicate the participant (before and after rotation) while arrows describe the direction the participant is facing (before and after rotation). The two recall tables describe two different types of responses. Recall 1 depicts the normal response of a person applying the relative frame of reference (RSRS). After the rotation, the stimuli items maintain their relative position with respect to the participant but change their absolute position (here North/South). Recall 2 describes the normal response pattern of a person applying what could be the absolute frame of reference (ASRS). After rotation the dark/light circles maintain their absolute position (North/South), yet change their position relative to the participant. According to Levinson and colleagues (Levinson et al. 2002), Tzeltal almost always encode spatial referents using ASRS (Recall 2). Spanish (like English), on the other hand, makes heavy use of RSRS (Recall 1). When presented with this task, Tzeltal Maya speakers arranged the items as depicted on recall 2. In comparison, Dutch students arranged items according to recall table 1.

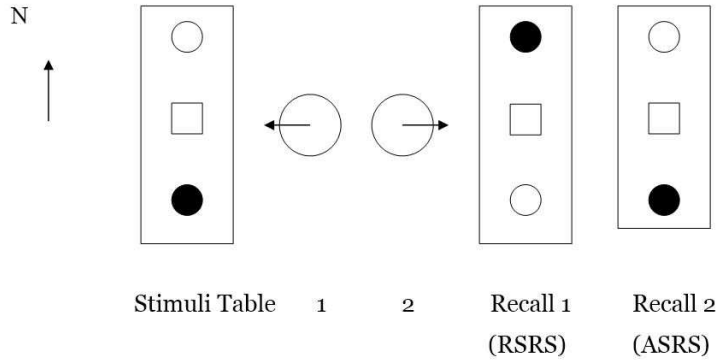

Figure 1: Setup of the rotation task.

Data such as these have been interpreted in line with the linguistic relativity theory, a claim that has not gone uncontested. Li & Gleitman (2002) for example proposed that the observed correlations might be due to experimental conditions rather than language effects. They conducted three variations of this task showing that U.S. college students use different systems of spatial references depending on the experimental setting. When a salient and easily recognizable university building was in sight of the participants (or identical rubber ducks were located at one end of the stimuli and recall tables), student participants would usually align the items relative to this building (or the rubber duck). The researchers took this as evidence that environmental cues – not language – trigger the use of spatial reference systems. This criticism points at the need for tighter-controlled cross-language experiments; however Li and Gleitman's work introduced new problems. Their data only deal with English speakers, and English in fact encodes all three frames of spatial reference. Even more problematic is the fact that they misconstrue what they describe as ASRS; when students use the University building (or the rubber duck) as reference points it remains unclear whether they employ the ASRS or what Levinson et al. describe as ISRS. While Levinson et al. point at these shortcomings in their direct reply (2002), they fail to address several other important problems of their work:

First, most (if not all) cross-language experiments potentially con-

found language differences with their experimental environments (different landmarks and cues available in different locations), as implicitly argued by Li & Gleitman (2002). Second, previous research not only treats language as an independent variable, but also treats language differences (between, say, Dutch students and Tzeltal Maya) as if they were the only distinguishing variable between two groups (see Medin et al. 2002; Ross 2004 for a similar point in cross-cultural studies). The average Tzeltal Maya interviewed by Levinson and colleagues, however, was probably much older, had less formal education and was much less affluent than the average U.S. or Dutch student used as the comparative sample. They probably also had much more knowledge about their immediate environment, including knowledge, for example, of where the sun rises/sets, where landscape features are located, etc. These factors are not independent variables themselves and not all of them might be directly related to spatial cognition, yet they illustrate that the applied experimental practices confound language with an extremely large number of other (potentially important) factors. Said differently, the rigor that psycholinguists usually apply to produce tightly controlled experiments was absent when it came to the selection of participants and the overall ethnographic setting. Interestingly, Levinson himself (somewhat) acknowledges this fact, when he relates that among the Guugu Yimithirr (a small Australian aboriginal group from North Queensland) research "focused primarily on older people with a long association with the community, who were acknowledged to have special cultural competence" (2003:114). One could hardly say the same with respect to U.S. or Dutch students, who usually provided the comparison sample.

This focus on more "traditional" individuals opens the question as to whether less culturally competent individuals would be less likely to demonstrate the language effects the researchers argue for. If so, one could hardly speak of a language effect at all. Second, these studies explore the effects of speech as independent of other accompanying means of communication such as gesture, assuming that language can express everything without the need for other semiotic means. For example, Le Guen has shown that for Yukatec Maya speech and gesture combine to form a communicative act that provides the necessary information without all the necessary frames of reference being present

in speech alone (Le Guen 2011). Third, knowledge and use of specific spatial language is not necessarily evenly distributed within a speech community. Again, Le Guen found that Yukatec Maya men know the meaning of left / right terms and the cardinal directions much more accurately than women (2011:915). Fourth, the researchers paid no attention to the stimuli used in the experiments, assuming the process of encoding spatial arrangements to be an abstract problem, independent of what is encoded. Fifth and finally, for the most part these studies are devoid of important ethnographic information. For example, it remains an open question whether the Tzeltal Maya use a truly absolute frame of spatial reference (Levinson et al. 2002), or whether these "absolute directions" (translated as "up" and "down") refer to culturally salient – yet far away – regions. If so, their use would represent an ISRS rather than an ASRS. This is the case in neighboring San Andrés Larraínzar, a Tzotzil Maya community. Here, "hot-land", *kixin osil*, is used to designate the hot lowland areas (also referred to as down / low) where people used to travel in search of temporary work on coffee plantations (Ross 1997). Polian & Bohnemeyer (2011) recently showed Tzeltal Maya to be much less consistent in terms of their preference for the ASRS as described by Levinson and colleagues.

To be clear, none of these points directly refutes the purported linguistic relativity effects. However, together they show that the data so far are, at best, inconclusive and problematic. In order to mediate the discussed problems we propose a somewhat different approach: we conducted cross-language comparisons within one environmental setting, pairing them with systematic exploration of intralanguage differences. We furthermore paired experimental tasks with ethnographic research, the project itself being part of a long-term research endeavor in the community. Intralanguage differences are important for several reasons. First, as mentioned above, knowledge and use of spatial language is not necessarily equally distributed in a community (Le Guen 2011; Polian & Bohnemeyer 2011). Second, in related research we have documented widespread cultural changes in the community that might affect spatial cognition yet are not necessarily reflected in language use (such as agricultural practices and mobility; see Shenton et al. 2011). Third, exploring intralanguage differences avoids some of the above sampling problems, tying the participants and hence the interpreta-

tion of the findings much more directly to their ethnographic environment. As a result such an approach seems to be much more powerful for understanding underlying causal relationships (see Ross 2004 for cross-cultural versus within group comparative studies). Fourth and finally, meta-analyses conducted by Levinson's research group of their own data found as yet unexplainable intralanguage differences of spatial cognition (see below).

2. ETHNOGRAPHIC BACKGROUND

Our studies took place in the Tzotzil Maya municipality of Chenalhó, a Tzotzil Maya community of Chiapas, Mexico. Chenalhó is adjacent to the Tzeltal community of Tenejapa, where some of the original studies on language and spatial cognition were conducted. The municipality consists of a town center (henceforth cabecera) and several communities, up to 3 hours away (by car). Approximately 36,000 people live in the municipality. Of the 3,000 living in the cabecera approximately 200 are Spanish-speaking Mestizos who have lived in this locality for several generations. As in other municipalities Chenalhó's cabecera is a place of increasing western modernity (Blaser 2010). Small-scale commerce, offices, as well as employment in construction and the service sector now shape its economy. It is here that the only *preparatoria* (high school) in the municipality is located and the only location in which secondary school education is becoming normalized for children. In fact, many families have moved here from their natal hamlets to pursue a different life for themselves and their children. This has led to internal migration and a resulting distribution of individuals based on their goals and aspirations. To say it differently: the cabecera has become a harbor for individuals with goals and aspirations usually in line with what can be described as western modernity. Individual goals and plans override commitments to the community and gainful employment is usually preferred to ownership of land and agricultural work. In contrast, people in outlying hamlets depend by and large on agriculture. Slash and burn mixed-corn cultivation is the main subsistence activity mixed into, or today even replaced by, the cash cropping of coffee or fruit trees, or cattle husbandry. It is here that goals and aspirations get mixed up. While some of the members of the hamlets prefer living by

and from their agricultural fields, others simply can not afford to move to the center town.

These differences in values and economic activity have not only been described as representing different steps in a process of "modernization," but stand in a complex relationship to activity toward, interest in, and expertise regarding environmental knowledge among both adults and children (Shenton et al., 2011). In the cabecera, knowledge of local ecology is limited. Children rarely work in the fields or visit the forest to play, collect firewood, or do other chores. Instead soccer, basketball, TV, and videogames are important activities (for both Tzotzil Maya and Ladino children). Children from poorer households also work as domestic helpers or street vendors.

3. THE CASE OF TZOTZIL MAYA AND SPANISH

In debates over linguistic relativity, Tzotzil Maya is often considered to be a language that defaults to an absolute reference system (De Leon 1994)[3], as it supposedly lacks expressions for left and right. This is inaccurate, however, because a clear distinction is made between the "left hand" *tz'et k'om'* and the right hand *batz'i k'om'* (Laughlin 1975). In fact, in our studies 6-year old children were able to distinguish and correctly name their right and left hands or feet. The following spatial terms can be found in Tzotzil Maya:

Ta is a general spatial preposition that can be translated into English as "among, as, at, before, behind, by, from, in, to" (ibid.). In combination with the word *pat*, "human back," *ta pat* signifies "behind" (ibid.), yet can only be used when the reference object has a clear front and back (the ball is in the back of the house but NOT the ball is behind the bucket). Similarly, *ichonil* signifies "in front of, the front side, opposite" (*ta k-ichon* = in front of me) (ibid.) with the reference object having a clear front/back. In our studies, participants described a ball in front of a bucket as *ta xokon* "at its side." While in English "behind the house" usually refers to an object that is "on the other side of the house" – from the perspective of the speaker, *ta s-pat na* in Tzotzil, refers to the back of the house independent of the speaker's position.[4]

These descriptions show a clear preference for ISRS in Tzotzil Maya, basically resembling what Levinson describes for the closely related

Tzeltal Maya (2003:93).

The most important spatial axis in Chenalhó is the distinction between the areas of sunrise (*lo'kem' jtotik*, "our emerging father") and sunset[5] (*batem' jtotik*, *"our waning father"*[6]). The orthogonal of this axis is linguistically unmarked; instead both North and South are called xokon vinajel, the sides of the heavens. As East and West, North and South are not points but areas (sides), together describing the square shape of the traditional Mesoamerican world. In neighboring Chamula the two sides of heaven are distinguished between left and right, determined from the perspective of the sun facing the earth as it rises (from east to west) (personal communication Gary Gossen). This sunrise/sunset distinction plays a role when building houses, but also in seating arrangements of honored guests on official occasions. Here seating is arranged with decreasing seniority from east to west. The fact that the sun in Tzotzil is referred to as our father *j-tot* makes the spatial reference also a religious reference point.

In contrast Spanish encodes spatial representations much like English, i.e. it predominantly encodes the relative reference frame in the description of spatial referents. However, Ladinos in Chenalhó make ample reference to the sunrise and sunset when describing general directions.

The interweaving of space and cosmology is not unique to Tzotzil Maya, but has also been described for speakers of Yukatec Maya (Hanks 1990; Le Guen 2011). According to Hanks, Yucatec Maya encodes two types of spatial frames. The first is based on the cardinal points and is invoked mainly for ritual purposes. Each direction is associated with "winds" or "spirits," and their qualities depend on their provenance and carry moral connotations (e.g., "west" contains malevolent spirits). This "cardinal-place" frame can be transposed into what Hanks calls a "cardinal-direction" frame, which is a coordinate system a speaker uses to refer to the spatial relationships between objects. While Hanks describes the fact that Yucatec Maya uses the absolute frame of reference to refer to spatial relationships, he does not attribute a causal role to language.

Overall, the similarities with Tzotzil Maya are striking. Here the movement of the sun – associated with the highest god - sets the frame for a spatial perception that not only guides ritual practices (from seating orders on a bench to the alignment of a traditional house or a grave), but potentially also human spatial reasoning.

This brief ethnographic discussion should make two points clear. First, we cannot treat spatial encoding as an abstract reasoning process independent of *what is encoded*. Depending on the context people might use different frames of reference. Second, numerous extra-linguistic factors exist that could account for the fact that Tzotzil Maya default to what appears as ASRS, none of which being a result of language structure or use.

Of course, providing possible alternative accounts does not refute a theory. We conducted a set of formal studies, which we present below. All interviews with indigenous participants were carried out in Tzotzil Maya by either the first author or indigenous collaborators.

3.1. Task 1: Language Production.

Our first study targeted the default linguistic spatial frame of Tzotzil Maya for small-scale spatial arrangements. We grouped 116 Tzotzil Maya children into 58 pairs (42 pairs were interviewed in a rural hamlet, approximately 30 minutes away (by car) from the cabecera, where 16 pairs of children were tested). Children (between six and fourteen years old) were seated in pairs (< 1 year age difference) front to back. The child in the back was presented with three picture cards (a ball, a plate and a bucket) arranged in a line in front of her. She was asked to describe the scene verbally to the child sitting in front (who could not see the arrangement). The task of the child in the front was to recreate the scene based on the verbal instructions. Instructions provided by the child in the back were recorded and coded according to the use of RSRS, ISRS and ASRS. It is important to note that objects used as stimuli did not lend themselves to the use of an intrinsic frame (e.g. they lacked an identifiable front, back, or sides).

3.1.1. Results.

In total 62% of the responses included the use of RSRS (right / left from the speakers perspective); 20% used an ISRS (mainly in relation to landmarks like buildings, mountains etc.) and only 18% of the directions provided used an ASRS (sunrise / sunset). No child in the

cabecera used the ASRS in her description.

Clearly then, Tzotzil Maya children have ready linguistic access to the RSRS. In fact the ASRS is employed significantly less often and only by children in the rural hamlet.

3.2. Task 2: Spatial Arrangements Under Rotation: Animals-in-a-Row.

We already described the general set up of this task above (see figure 1). It is important to note that participants were never asked explicitly to remember the spatial arrangements on the stimuli table. Items on the stimuli table were lined up to face the participant. After the rotation, participants were asked to pick the three objects they had seen before (out of five objects) and arrange them on the recall table. Both the item arrangements and their orientations (facing the participant or not) were recorded. After arranging the items on the recall table, adult participants were asked whether an alternative manner of arranging the items existed. This question targeted potentially viable though less salient manners of spatial encoding. Participants were 117 Tzotzil Maya children (79 from a rural hamlet and 31 from the cabecera, ranging in age from five to seventeen years), 6 Ladino children (all approximately 10 years old), 35 adult Tzotzil Maya speakers (15 from the cabecera) and 37 adult Ladinos, who all had lived their entire lives in the municipality.

To be clear, in order to support the linguistic relativity hypothesis a large majority of the participants should use the RSRS when organizing the items on the recall table.

3.2.1. Results.

74% of the Tzotzil children in the center town and 85% of the children in the rural hamlet arranged the items on the recall according to what looks like ASRS. Both response rates are significantly above chance ($t=9.04$; $p<0.0001$). No differences with respect to age or gender were detected; the community level difference is marginally significant (ttest, $p=0.1$). All Mestizo children interviewed used RSRS when arranging the items on the recall table. All 20 Tzotzil adults from the outlying hamlet arranged the items according to ASRS, compared to 67% of the Tzotzil in the cabecera. This difference is significant (ttest; $p=0.004$); No difference was found between Tzotzil speakers living in the cabecera and their Spanish-speaking counterparts (57%). Furthermore, for Tzotzil speakers, self-reported Spanish language abilities did not predict the use of a specific spatial reference frame.[7]

No participant using the RSRS maintained the absolute orientation of the objects (e.g. facing away from EGO). Of the individuals using the ASRS, the participants in the rural hamlet were significantly more likely to maintain the absolute orientation of the objects than the Tzotzil participants in the cabecera (47% vs. 27%; ttest; $p= 0.01$).

Whether participants allowed for an alternative spatial arrangement was also not randomly distributed: only 25% of the individuals who originally used the RSRS allowed for an alternative arrangement (ASRS) when asked. In contrast, 83% of the individuals using the ASRS allowed for RSRS as an alternative. Finally, self-reported Spanish skills predicted a participants' willingness to allow the RSRS as an alternative spatial arrangement. For both children and adults the effect approaches statistical significance ($r=0.239$; $p=0.05$ for children; $r=0.258$; $p=0.067$ for adults).[8]

Results from the two tasks strongly suggest that language does not determine spatial cognition. To explore the stability of these findings, we probed whether the verbalization of spatial arrangements immediately prior to the rotation task would influence a speakers' performance in the rotation task. Said differently, we were interested whether verbal priming immediately before the rotation task (done by the participant herself) would influence task performance.

3.3. Task 3: Spatial Language Production and Spatial Arrangements under Rotation.

This task is basically the same as task 2. However, **immediately prior to the rotation** participants were asked to describe the location of each object on the stimuli table. Initial responses were coded as *relative, intrinsic or absolute*. We take the participants' description as a form of direct language priming; hence this task explores whether language priming influences performance in the rotation task. In all cases we asked whether an alternative description existed. Participants were 17 Tzotzil speaking adults from the municipality town center.

3.3.1. Results.

Of the four participants using the RSRS to describe arrangements on the stimuli table (three of whom rejected the notion of an alternative way to describe the arrangements), three arranged the items on the recall table based on what looks like ASRS. Despite the priming, only one of them used the RSRS. All of the six individuals describing the arrangement on the stimuli table using ASRS also arranged the items on the recall table as ASRS; all of them allowed for RSRS as an alternative arrangement.

Seven individuals used either a generic non-specific framework ("at the side") or numbered the items (first to last) in their initial description. All these individuals provided the RSRS as an alternative description, and all but one used the ASRS to arrange the items on the recall table. These data confirm the finding from task 1 that Tzotzil Maya speakers clearly have the RSRS linguistically available to them. The data confirm the previous finding that Tzotzil Maya speakers have several spatial frames in their linguistic repertoire. However, independent of direct linguistic priming the majority of our participants (here adult rural Tzotzil only) use the ASRS as the default way of arranging the items after rotation. This indicates the stability of our findings from task 2. Said differently, not even direct language priming impacts performance in the rotation task.

4. DISCUSSION AND CONCLUSION

Our data refute the conclusions of linguistic relativity on several counts. First, while Tzotzil Maya prefer the RSRS in language production (studies 1 & 3) the vast majority of both Tzotzil speaking adults and children defaulted to the ASRS in the non-linguistic task (study 2). Second, contrary to predictions based on standard accounts of the two languages, adult Tzotzil and Spanish speakers in the cabecera performed similarly in task 2. Third, we find significant intralanguage difference in performance (between the Tzotzil speaker from the cabecera and the rural hamlet) that are impossible to explain within the parameters of linguistic relativity. Instead, they seem to be related to different practices and values.[9] Fourth, performance on the rotation task didn't change even when individuals were linguistically primed with RSRS immediately before the task (task 3). The fact that in this latter task our participants

volunteered the "priming" suggests complete independence of the cognitive processes from linguistic encoding.

Rather than language difference we propose cultural differences – here an increase in western modernity and related ontological changes to account for the reported differences in spatial cognition. In broad strokes, we propose that increasing exposure to western modernity leads to a greater focus on the EGO and her goals and aspirations. These changes are clearly visible across members of the two communities (see Shenton et al. 2011 , Ross et al. n.d.). While more research is needed to show these causal links, we believe that our theoretical framework accommodates both our own data as well as findings from previous research – especially those aspects that could not be accounted for by the researchers' own theoretical models.

Recall that Levinson and colleagues did not simply select language speakers at random, but picked cultural experts, e.g. more traditionally oriented individuals in small-scale communities living in close interaction with their environment (2003:114). If we are correct in our interpretations, less traditional members of the societies studied might have exhibited very different patterns based on shifting values and ideas. In fact, a summary analysis of the different studies conducted by Levinson and colleagues indicates a similar trend to those found here. In a cross-language analysis, Majid and colleagues (2004) find a trend that urban communities are more likely to use RSRS than ASRS, independent of the language spoken. The researchers were not able to explain this aspect of their data, which obviously contradicts their argument regarding the role of language. Others have argued that a spatial orientation system and the language that goes with it adapt to the ecological conditions of either rural or urban life, arguing for a connection between RSRS and urban living (Mishra et al. 2003). However, it is not clear why the RSRS would be advantageous only in cities. This explanation also ignores the high computational costs involved in the use of ASRS, where one has to constantly calibrate her position and orientation. Furthermore, the cabecera in the present study compares to what have been termed "villages" in the studies mentioned above; with 3000 inhabitants it most definitely doesn't constitute an urban context to which spatial orientation systems and language might have to adjust. On the other hand, urbanism most likely is an expression of effects similar to

those presented in this paper. We argue that increasing urbanism is not only a matter of size (e.g., number of inhabitants), but reflects many concomitant changes related to values, epistemologies and ontological commitments. At this point we can only speculate that some of the differences reported in previous studies are related to what we termed here increasing "western modernization" and the concomitant loss of direct contact with the environment as well as changes in practices. In fact, these factors are likely also part of the very same causal chain that produced the cross-cultural findings reported by Levinson and his group: urban western students differing in the task performance from small-scale rural indigenous groups. More research is needed to understand the specific processes involved within each specific ethnographic setting.

Finally, our findings are also in line with recent findings by Li et al. (2011) and Polian & Bohnemeyer (2011) among Tzeltal Maya. While the former shows that Tzeltal Maya have no problem communicating spatial positions using "left" and "right," the latter indicates a high variance of the use of frames of spatial reference among different Tzeltal speakers. However, once more these researchers do not even try to explain the findings reported by Levinson et al. (2002), that is, the fact that in the rotation task these Tzeltal farmers resort to what looks like the ASRS. Our theoretical framework resolves the puzzle.

Conclusion

We have presented data that clearly reject the notion that language determines spatial cognition. We suggest that rather than language, specific cultural frameworks – defining the relation of the EGO with the wider environment – drive performance in non-verbal spatial tasks. As a result, the tasks do not elicit differences in abstract spatial cognition, but provide evidence for concrete spatial cognition embedded in specific cultural epistemologies and ontologies (Ross et al. 2007; Medin et al. 2006).

On this account, language and language use are not independent variables but are themselves shaped by ideology, experience and cultural change. Compared to previous research, our framework for analysis not only allows for within-group differences in task performance, but actually predicts such differences along the lines of what is usually

termed *western modernization* and experience-based differences.

To be sure, we do not argue for one specific set of beliefs to be encountered for all Tzotzil Maya, Tzeltal Maya, or the Guugu Yimithirr of Australia. Instead we argue for a more *generic relation* connecting individuals with their environment in ways substantially different from the average person in the USA or Western Europe, where egocentrically constructed space has a long history (Levinson 2003:9-10). Such a generic relation could be expressed in very different culture-specific beliefs, constituting fundamentally different orientations and conditions of being in the world, at least when compared to results based on the western undergraduate population.

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CORRECTION

14.05.2016 An earlier file version of this article was attributed to Volume 9 of the *Baltic International Yearbook of Cognition, Logic and Communication*. This error has now been corrected and the file reflects the correct publication date, December 2015, Volume 10. The contents of the article remain unchanged.

Notes

[1] Taking the vantage point of an English speaker (most often US undergraduate students) has become such a standard that we often forget the serious implications this assumption has for our theories (Henrich et al. 2010).

[2] Unfortunately researchers often are ambiguous whether they refer to the absence of a concept within a language or simply the lack of usage, its saliency, among the speakers of a language.

[3] See the debate between Bohnemeyer & Stolz (2006); Levinson (2003) and Le Guen (2009, 2011) for an illustration that assigning a "preferred frame of linguistic reference"

is anything but a straightforward task.

[4]The English back and front yard also refer to the back / front as a property of the house and not its location.

[5]These are areas oscillating between the solstices and not specific points.

[6]"Our father" refers to San Pedro, the highest god in the community - the sun. Alternative expressions are *lokem' k'ak'al* or *malem' k'ak'al*; emerging / waning heat / day.

[7]In a previous version of the task we interviewed bilingual Spanish / Tzotzil individuals in both languages (on different occasions), yet did not find any differences.

[8]The difference between the data for children and adults is the higher N for the former sample.

[9]It is important to note that if we had compared Spanish speakers of the cabecera to Tzotzil speakers from the rural hamlet we would have found a significant difference. This illustrates the above-discussed issues of sampling biases and confounding variables.

References

Blaser, M. 2010. *Storytelling Globalization from the Chaco and Beyond*. Duke University Press, Durham.

Bohnemeyer, J. & Stolz, C. 2006. 'Spatial reference in Yukatec Maya: A survey'. In S. Levinson & D. Wilkins (eds.) 'The grammar of space', 273–310. Cambridge.

Brown, P. & Levinson, S. 1992. '"Left" and "Right" in Tenejapa: investigating a linguistic conceptual gap'. *Zeitschrift fuer Phonetik, Sprachwissenschaft and Kommunikationsforschung* 45, no. 6: 590–611.

——. 1993. *Linguistic and non-lingustic coding of spatial arrays: exploration in Mayan cognition (Working paper No. 24*. Nijmegen: Cognitive Anthropology Research Group, Max Planck Institute for Psycholingistics.

De Leon, L. 1994. 'Exploration in the acquisition of location and trajectory in Tzotzil'.

Fromkin, V., Rodman, R. & Hyams, N. 2003. *An introduction to language*. Cengage Learning.

Gumperz, J. J. & Levinson, S. C. 1996. *Rethinking Linguistic Relativity: Studies in the Social and Cultural Fundations of Language (No.17)*. Cambridge University Press.

Hanks, W. 1990. *Referential Practice: Language and Lived Space among the Maya*. Chicago: The University of Chicago Press.

Henrich, J., Heine, S. & Norenzayan, A. 2010. 'The weirdest people in the world?' *Behavioral and Brain Sciences* 33, no. 2–3: 61–83.

Hunt, E. & Agnoli, F. 1991. 'The Whorfian Hypothesis: A Cognitive Psychology Perspective'. *Psychological Review* 98: 377–389.

Kant, E. 1768. 'Von dem ersten Grunde des Unterschiedes der Gegenden im Raume. (On the first ground of the distinction of regions in space)'. In 'The philosophy of right and left: incongruent counterparts and the nature of space', 27–34. Dodrecht: Kluwer.

Kay, P. & Kempton, W. 1984. 'What is the Sapir-Whorf Hypothesis?' *American Anthropologist* 86: 65–78.

Laughlin, R. 1975. *The great Tzotzil Dictionary of San Lorenzo Zinacantan*. Washington, D. C.

Le Guen, O. 2009. 'Geocentric gestural deixis amon Yucatecan mayas (Quintana Roo, Mexico)'. In K. Mylonas (ed.) '18th IACCP book of selected congress papers', 123–136. Athens.

——. 2011. 'Speech and Gesture in Spatial Language and Cognition among the Yukatec Mayas'. *Cognitive Science* 35, no. 5: 905–938.

Levinson, S. 2001. 'Covariation between spatial language and cognition, and its implications for language learning'. In M. Bowerman & S. C. Levinson (eds.) 'Language acquisition and conceptual development', Cambridge: Cambridge University Press.

——. 2003. *Space in Language and Cognition*. Cambridge.

Levinson, S., Kota, S., Haun, B. M. & Rasch, B. 2002. 'Returning the tables: language affects spatial reasoning'. *Cognition* 84: 155–188.

Li, P. & Gleitman, L. 2002. 'Turning the tables: language and spatial reasoning'. *Cognition* 83: 265–294.

Li, P., Abarbanell, L., Gleitman, L. & Papafragou, A. 2011. 'Spatial reasoning in Tenejapan Mayans'. *Cognition* 120, no. 1: 33–53.

Lucy, J. 1997. 'Linguistic Relativity'. *Annual Review of Anthropology* 26: 291–312.

Majid, A., Bowerman, M., Kita, S., Haun, D. & Levinson, S. 2004. 'Can language restructure cognition? The case for space'. *Trends in Cognitive Sciences* 8, no. 3: 108–114.

Martin, L. 1986. '"Eskimo words for snow": A case study in the genesis and decay of an Anthropological Example'. *American Anthropologist* 88: 418–423.

Medin, D., Ross, N., Atran, S., Burnett, R. & Blok, S. 2002. 'Categorization and reasoning in relation to culture and expertise'. *The Psychology of Learning and Motivation* 41: 1–41.

Medin, D., Ross, N. & Cox, D. 2006. *Culture and Resource Conflict: Whymishr meanings matter*. Russel Sage Foundation, New York.

Mishra, R., Dasen, P. & Niraula, S. 2003. 'Ecology, language, and performance on spatial cognitive tasks'. *International Journal of Psychology* 38, no. 6: 366–383.

Pinker, S. 1994. *The Language Instinct*. New York.

Polian, G. & Bohnemeyer, J. 2011. 'Uniformity and Variation in Tseltal Reference Frame Use'. *Language Sciences* 33, no. 6: 868–891.

Ross, N. 1997. *Nutz' Lok'el li Kaxlane – Die Vertreibung der Ladinos aus San Andrés Larraínzar, Chiapas, Mexico*. Lit Verlag.

——. 2004. *Culture and Cognition: Implications for Theory and Methods*. Thousand Oaks.

Ross, N., Medin, D. & Cox, D. 2007. 'Epistemological models and culture conflict: Menominee and Euro-American hunters in Wisconsin'. *Ethos* 35, no. 4: 478–515.

Sapir, E. 1921. *Language: An introduction to the study of speech*. New York.

Shenton, J., Ross, N., Kohut, M. & Waxman, S. 2011. 'Folk Botany and Knowledge Devolution: Modernization and intra-community variability in the acquisition of folkbiological knowledge'. *Ethos* 39, no. 3: 349–367.

Whorf, B. 1956. *Language, thought, and reality*. New York.