

---

## Geocentric Gestural Deixis among Yucatec Maya (Quintana Roo, México)

---

**Olivier Le Guen**, *Northwestern University, USA*, olivierleguen@free.fr

Fieldwork conducted among the Yucatec Maya of Mexico reveals that this group preferentially uses a geocentric frame of reference in both linguistic and non-linguistic tasks. Contrary to other cultural groups (such as the Guugu Yimithir of Australia or Tzeltal of México), this frame does not seem to rely on the use of specific spatial terms (such as cardinal directions for instance). Because linguistic evidence is not sufficient to determine which frame of reference is used, attention to gestural deixis is particularly relevant. Using a comparative French example, we present a method of analysis for gestural deixis and show that Yucatec speakers, both children and adults, rely primarily on a geocentric frame of reference in giving spatial indications of directions.

The data presented in this chapter<sup>1</sup> were collected among the Yucatec Maya, an ethnic group defined by linguistic criteria, who mainly live in Mexico's Yucatán Peninsula. The village where the fieldwork was done is situated in the state of Quintana Roo in the so-called "Zona Maya". This area has preserved many aspects of traditional Maya life, and the Yucatec Maya language is still widely spoken, although most of population knows some Spanish (but only the adult men are fluent). The terrain of their environment is primarily a tropical forest flat land devoid of high hills and mountains.

This study follows up on findings from previous research (Le Guen, 2006), which examined the Frame of Reference preferentially used by the Yucatec Maya in linguistic and non-linguistic tasks. In the literature, it is usually considered that there are three main Frames of Reference (or FoR) encoding angular information that are available for making localizations in space (Levinson, 2003; Tversky, 1998, for a review): the intrinsic, the egocentric and the geocentric frame of reference. In the *intrinsic* frame of reference, locations are represented in relation to an object's intrinsic properties (front, back, sides). In an *egocentric* FoR, the relations between objects are specified from the individual point of view, in relation to his left, right front or back. Finally, the *geocentric* frame of reference specifies position in terms of fixed angles extrinsic to the objects whose spatial relation is being described. This latter corresponds in many societies to cardinal directions, and often involves a conceptual 'slope' (an uphill/downhill opposition for instance).

Tasks developed by the Max Planck Institute of Psycholinguistic team led by Stephen Levinson were used to determine if, under a 180° rotation, subjects rely on their own point of view (using an egocentric FoR) or on external features of the environment (using a geocentric FoR) (Brown & Levinson, 1993; Levinson, 2003). In the Le Guen 2006 study, fifty-seven subjects were tested, ranging in age from 4 to more than 30 years. The results for the non-linguistic task reveal a large preference for a geocentric FoR. These tasks were followed by a linguistic knowledge evaluation conducted to evaluate subjects' comprehension of specific spatial lexical items corresponding to different FoR, mainly egocentric and geocentric. Sixty-seven subjects were asked to move a toy man on a labyrinth given directions such as: "turn right, go south, go in the direction of the house of Ricardo," etc. Comparing the results of these two tasks shows that the Yucatec Maya rely on a non-linguistic geocentric FoR but (1) with the exception of adult males, they do not necessarily master specialized vocabulary for it, such as

---

<sup>1</sup> I would like to thank Douglas Médin, Richard Carter, Erin Leddon, Sonya Sachdeva and Pierre Dasen and his team for helping me in revising this paper. I am also grateful to the anonymous reviewers for their comments on this paper.

cardinal direction words, and (2) they do have cognitive geocentric perception of their environment, but they only rely particularly on landmarks and other features of the environment.

This chapter aims to illustrate the difference in the cognitive representation of space between egocentric and geocentric coders and how, among Yucatec Maya, the use of the geocentric FoR is not sustained by language, by presenting qualitative data from quasi-experiments. One way to determine the preferred cognitive FoR reference used by people is by studying their gestural deixis in direction giving. Gesture in spatial indications must rely on only one specific FoR (intrinsic, egocentric or geocentric) to be decoded by a listener in order for him/her to find his/her way correctly. French and Maya examples will be analyzed along with how the Yucatec Maya use a geocentric representation of space despite the lack of verbal clues in their speech. The implications in respect to the Whorfian hypothesis (Whorf, 1956) will also be discussed in conclusion.

### The French example

The brief demonstration below illustrates how gesture is used in an egocentric FoR, using the example of a French native speaker giving directions. In a real-life situation, we asked a French native speaker to direct us to the Boulevard St. Michel from the Place de la Sorbonne in Paris. Her answer was as follows: *“First, go straight and then turn to the right.”* This speech determines two different segments with three particles, A-B and B-C, where B is the street corner. The Place de la Sorbonne corresponds to point A and Boulevard St. Germain corresponds to point C (Figure 1).

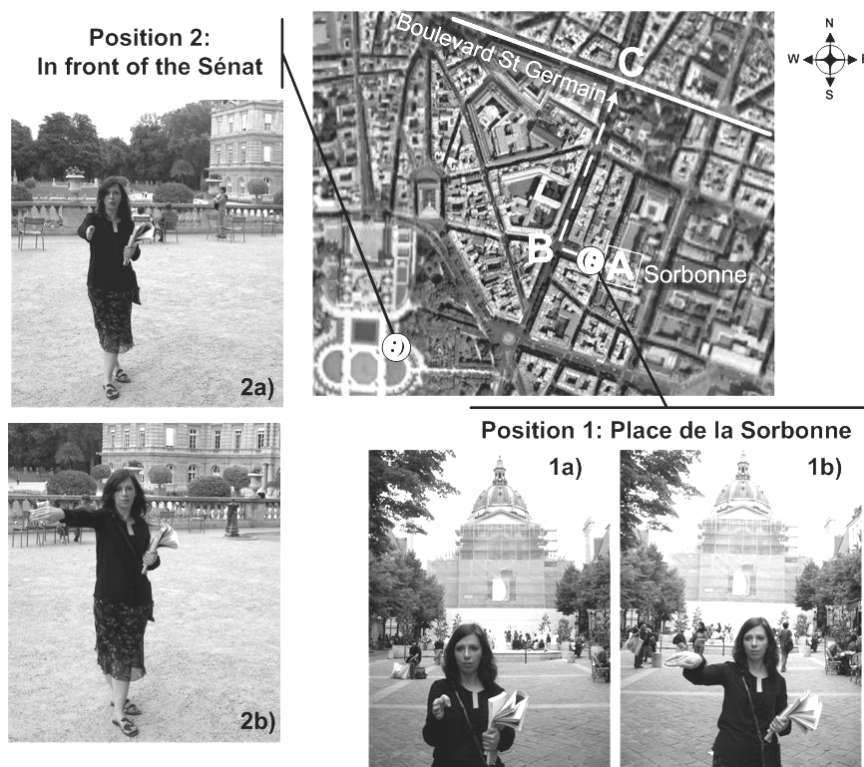
In order to compare the consistency of her gestural and verbal indications, the same French speaker-respondent was interviewed at another location as well. In Position 1 (as explained in the previous paragraph), she was directly in front of the Place de la Sorbonne facing west, and the Sorbonne is at her back. In Position 2, she was standing in front of the Sénat, a few hundred meters away from the first position. This time, she was facing the opposite direction (east).

In Position 1, her position was equal to the “origo<sub>0</sub>”, which is point A, the departure point of the indicated path. Her gestures are shown in Figure 1 (photographs 1a and 1b): she stretches out her arm in front of her to indicate segment A to B (1a) and then indicates her own right to symbolize the segment B to C (1b). In doing this, she imagines herself at point B (the street corner). Note that her gestures, in Position 1, are matching to the real word configuration (i.e., the orientation of the street).

In Position 2, she was standing in a different place from point A (the departure point). So, to indicate the same path, she had to project herself from her current location back to the Place de la Sorbonne, as if it were to her back. In doing this she created a new indexical origo (origo<sub>1</sub> = Point A). Her directions and gestures thus have now to be understood in the context of this projected point and not her actual position. In other words, she imagines herself looking at the street, the Sorbonne at her back. To understand correctly her direction giving, an interlocutor will also have to imagine himself/herself at this place and, in a sense, “looking through her eyes”. From point B, she does the same thing, but imagining herself at point B. In Position 2 (Figure 1, photographs 2a and 2b), she stretches out her arm in front of her and then indicates (in her speech and with her gesture) to her own right, exactly as she did when at Position 1. In the two positions, she relied on her own point of view. This example illustrates her consistent use of an egocentric frame of reference in her speech and her gestures.

These observations suggest: a) there are linguistic clues in the use of the egocentric frame of reference, b) these linguistic indications are consistent with egocentric gestures, c) these gestures are always performed in the frontal zone of the body, and d) because, she is, in the Position 2 relying on her point of view, orientation to the real world is not respected when “origo<sub>1</sub>” is different from speaker position. That means that, in Position 1, she stretches her arm

towards the north for indicating the segment B to C (where C is indeed north of B). But she stretches her arm toward the south in the Position 2 for indicating the same segment. Nevertheless, this is not a problem because an interlocutor who also uses an egocentric FoR will not consider this gesture as indicating south, but a right turn.



**Figure 1.** French directions giving.

### Maya gestural deixis

In order to compare French and Yucatec gestural deixis, we asked Yucatec Maya speakers to indicate a path similar to that illustrated in the French example above. The two speakers interviewed were in different positions, and both were at different locations from the departure point. In this case, the position of the speaker is considered, for each of them, as  $origo_0$ , and the departure point A is “ $origo_1$ ”. They thus face the same task as the French speaker when she is in position two<sup>2</sup>. The question asked was “how can one go from the church to the house of X?”.

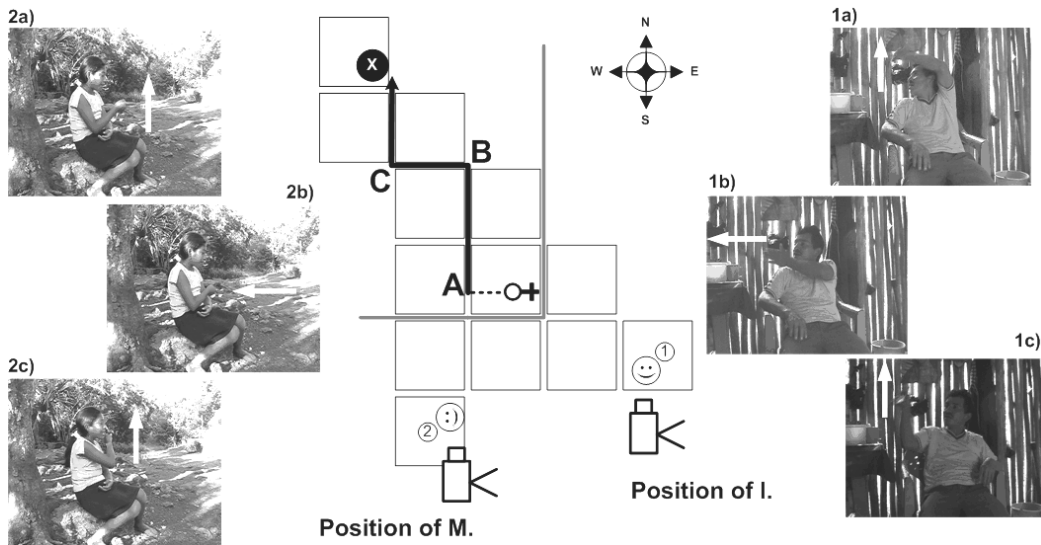
This path has three segments A to B; B to C, and C to the house of X<sup>3</sup>. An adult male (I.)<sup>4</sup>, was interviewed facing south, and a 10 years old girl (M.) was asked to indicate the same path but facing east. The camera was always facing north. If they were both relying on a

<sup>2</sup> The first task is not illustrated here because Yucatec Maya, like in probably most of the cultures, make gesture in conformity with the world orientation when they indicate a path that start from where they currently stand (i.e., when the departure point correspond to  $origo_0$ ).

<sup>3</sup> The purpose of this task is to see what FoR Yucatec Maya will rely on for indication of directions using gestures. Furthermore, other examples show that Yucatec Maya use the same non linguistic geocentric FoR in a systematic way. Other data from Le Guen (2006) show that the number of segments does not interfere with the choice of the FoR.

<sup>4</sup> To remain anonymous, all the names of the participants are here presented only with their initial.

egocentric FoR in the direction giving (basing their indication on their point of view, like in the French example) their gesture should be similar. But this is not the case. Their gestures are not identical.



**Figure 2.** Yucatec directions giving.

An examination of the participants' gestures (Figure 2) indicating the segment from A to B reveals that they both indicate the same direction: south to north. But their gestures are different: the man uses a front-back gesture, and the young girl uses a frontal right-left gesture. Again for the B to C segment, they both indicate an east-west direction but use different gestures: the man uses a frontal left to right gesture, and the girl a front-back gesture. Finally, for the C to X segment, they both use the same gestures used for the first A-B segment.

The verbal indications of the Maya participants are not informative about the FoR they rely on. The verbal indications of I. and M. are thus complemented by gestures to indicate direction. I. verbal indications go as follow: "you take the street like *this straight* (gesture 1 - segment A-B). When you get to the corner of P.'s house, you take the street *like that* (gesture 2 - segment B-C), and then you take again the street *like that* (gesture 3 - segment B-C)"<sup>5</sup>. M. verbal indications are also elusive: "you should go *like that* (gesture 1 - segment A-B), you go *like that* (gesture 2 - segment B-C), and *go like that* in order to get there (gesture 3 - segment B-C)"<sup>6</sup>.

In contrast to the French, these observations suggest: a) there are no linguistic clues in the Maya participants' speech to determine what FoR is being used, b) the gestures used by the Maya are not restricted to being performed in the frontal zone and can be performed to the back and c) despite the fact that they have different orientations and they stand in places distinct from the origin of the indicated path, I. and M.'s gestures are consistent with the layout of the object in the world and, as a consequence, they are not identical. This is exactly the opposite of what was observed with the French speaker when she was in Position 2. Yucatec Maya speakers rely on a different frame of reference in their gestural indication: a geocentric frame based on the orientation of the real world.

<sup>5</sup> *Ka'ch'a'ik e kaaye' bey toha'* (gesture 1). *Ken k'uchkech tu'eskina tunayle P., kach'a'ik beya'* (gesture 2), (...) *ken ts'o'ke' kaka'ach'a'ik ti' beya'* (gesture 3).

<sup>6</sup> *Ken xi'ikech beya'* (gesture 1), *kabin beya'* (gesture 2), *bey kabin yóola k'uche'* (gesture 3).

The data presented here are an illustration of a general tendency among Yucatec Maya. Several quasi-experiments were run and systematically analyzed with twenty participants, children and adults (male and female), involving tasks such as the one presented here but also pointing to one referent inside the village or pointing at surrounding villages. We also recorded and analyze several natural direction giving between speakers that show an identical pattern (details and analyses can be found in Le Guen, 2006).

### The alignment of the FoRs

We now turn to an analysis of how different linguistic frames of reference can be used at the same time. As evident in the French example, the French speaker uses the same egocentric frame of reference in her speech and her gesture. So when she says “*turn to the right*”, she moves her arm to the right. One problem with the Yucatec speakers is that they either do not use specific cues in their speech, only saying for example “this way, that way” or, more confusingly, they can use different speech cues that do not belong to the same linguistic frame of reference. Nevertheless, considering the untranslatability between frames of reference, speakers from every community must, in their gesture, use a consistent FoR (either intrinsic, egocentric or geocentric). In other words, if one decodes the same gestural indication giving using an egocentric FoR or a geocentric FoR, one will not get at the same place! In the following examples, we will show, from the analysis of their gestures, how Yucatec speakers rely on a non-linguistic geocentric FoR and how they, in the end, align all the different linguistic FoRs on a geocentric one.

### Example with geocentric and egocentric FoR

In speech direction giving, geocentric and egocentric frames of reference may be used simultaneously, but they should not be used simultaneously in gesture. The experimenter (O.) asked DC, a forty-five years old man, if he could give him directions to the old pillar in an abandoned village. DC complements his verbal indications with gestures for the different segments. The following is a transcript of his directions:

O: *awóohláa' te' Sahkabch'e'en tu'ux yàan le okom, le úuchbem 'okomo'? Tu'ux k'abèet inbin yóos inkaxtik.*

Do you know in Sahkabchen where the pillar is, the old pillar? Where do I need to go to find it?

DC: *kabin te' ... te' karetèera.*

You take the ... the road [**gesture 1 (=d1)**]

*Kak'uchul tukrusèero, katséele'.*

(when) you get to the crossroad, you turn. [**gesture 2 (=d2)**]

*Kak'uchul yi'nal e ch'e'eno' kabin te' tubèelilo'.*

(when) you get to the well, you take “its” path. [**gesture 3 (=d3)**]

*Ka k'uch te' tu'ux yàan le ... ubèel sàay,*

(when) you get where there is... the path of the *sàay* ant, [**iconic gesture (=ant path)**]

*kaka'a'òokol beya'.*

You enter once more like this. [**gesture 4 (=d4)**]

*(...)Kab... kana'akal yok' hump'e' bu'tun beya' he'ex ana'aka' beya'*

you go up on a hillock like this

*kaka'achìinil beya', hach bey ti'a' ti'yàani'!*

and your turn once more like this, this is exactly where the pillar is!

*Yan atàal sut tumen táan bin beya' kusut ubey ta ... ta'èestel a... x-no'oh!*

you will arrive on the other way so it will be to your ...right! [**gesture 5 (=d5, toward East)**]

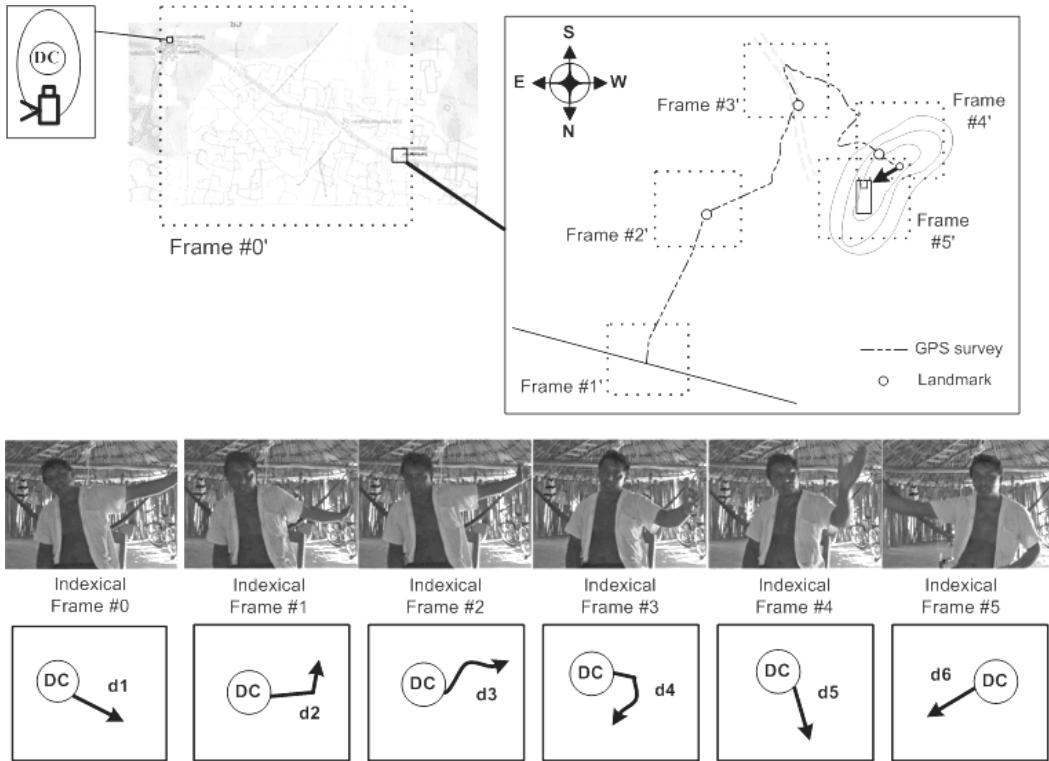
*(...) lak'in kuka'ap'a'ata' tech.*

It will be east from you.

DC used two indications belonging to two different FoRs: “to your right” (egocentric FoR) and “east from you” (geocentric FoR). Considering only the cues he gave in his speech, it is not possible to know on which FoR he was relying on.

To test the conformity of DC’s gestural indications with the real world orientation, they have been compared with a GPS survey. In Figure 3 we have reproduced the GPS survey

complemented by an official Mexican map of the village surrounding. The analytical method used is inspired by Haviland's lamination principle (Haviland, 1996, 2000).



**Figure 3.** DC's directions to the old pillar (note that north is reverse in the figure).

During this interview, DC and the interviewer were standing in the village. He was looking to the north and the video camera was facing south. The first gesture he makes indicates the direction of the abandoned village (d1) from his actual position. In this case, he does not actually create a new origo, because the origin of his indications is his own body (Frame #0). If we now focus on the zone of the abandoned village of Sahkabchen, we see that DC uses landmarks as new origos when he projects himself to determine different segments. The first origo<sub>(1)</sub> is the crossroad. His gesture indicates one segment with an east and a south direction which actually corresponds to real orientation of the path that one has to take from the crossroad. The second origo (O<sub>2</sub>) is the well; the direction indicated is south-west. The third gesture is an iconic gesture<sup>7</sup> to symbolize a new landmark: the path of the *sàay* ants that will be the third origo; the direction is now west to north. The fourth origo is the bottom of the hill; DC indicates a north-west direction rising-up. Finally, the fifth direction where the old pillar stands is, from the top of the hill, "to your right" but also "to the east".

These ways of giving directions beg the question: Do linguistic frames of reference really encode what speakers mean? Was DC using a geocentric or an egocentric FoR? Since the cues in his speech used are contradictory, they are not, by themselves, sufficient to know what FoR DC was relying on. He used "to your right" and "east". But if we take a careful look at the GPS survey, we can see that DC gestures always respect the orientation of the real world. Every time he projected himself to a new origo (landmark), the indexical frames he created were

<sup>7</sup> An iconic gesture is one that depicts a physical aspect of its referent.

always oriented with respect to the actual cardinal directions, and so were his gestures. In his speech, DC thus aligned the egocentric FoR on the geocentric one. In other words, when he stretched his arm to indicate the position of the pillar, it just happened that the pillar was on his right. But what he really meant in his indication was that the pillar stands east from one's position on the top of the hill. Let's suppose for a minute that he had come from the opposite direction so that, on the top of the hill the pillar was on his left, he would have stretched his arm in the same cardinal direction, towards the east. In the same condition, an egocentric coder would have made a gesture that indicate the left, not matter of the cardinal direction where the pillar stands from her/his position on the top of the hill<sup>8</sup>.

### Example with intrinsic FoR and geocentric gesture

Another example of alignment of frames of reference regards the situation when only the intrinsic FoR is linguistically salient. Two adults, (I.) and his wife (S.), were asked by the experimenter (O.) "where the Nance tree<sup>9</sup> is in relation to the house". The two objects (the tree and the house) are located in the field they own in the forest several kilometers to the north from where they were standing in the village.

The directions given by S. were:

O.: *tu'ux yàan le naho' ti' le màata', ti' le chi'o'?*

Where is the house to the Nance tree?

S.: *bey yanik e chi'a' .. e naha', ...*

The Nance tree ... h'm the **house** is like this [gesture 1 in Figure 4],

S.: *tàanil ti' beya' ti' yàan le chi'o'.*

In front of it like this, there is the **Nance tree** [gesture 2 in Figure 5]



**Figure 4.** S. indicating the position of the house.



**Figure 5.** S. indicating the position of the Nance tree.

In her response, S. used iconic gestures to symbolize the tree and the house. She only used a linguistic intrinsic FoR to say that the tree is "in front of" the house. Her husband (I.) indicates the same object configuration in the following way:

O.: *e'esten tu'ux yàan le màata' ti' .. le màata' chi' ti' le naho'!*

Show me where is the Nance tree ... the Nance tree to the house!

I.: *le naho' bey yàanika'*

the **house** is like this [gesture 1 in Figure 6],

<sup>8</sup> The French speaker, in the first example, uses the same egocentric gesture ("to the right") in position 2 to indicate the position of the Blvd St Germain, pointing to the south, despite the fact that the boulevard is north of her.

<sup>9</sup> *Byrsonima craassifolia*.

I.: *le chi'o' bey bey làado' ti' yàaniki'*.

the **Nance tree** is on this side like that, there it is [gesture 2 in Figure 7].



**Figure 6.** I. indicating the position of the house.



**Figure 7.** I. indicating the position of the Nance tree.

Contrary to his wife, I. did not use iconic gestures, but he rather used pointing gestures avoiding any speech cues corresponding to an intrinsic, egocentric or geocentric FoR. He only used deictic terms (“like this, like that, there”). But considering the layout of the object in the real world reveals that, in both cases, their gestures were consistent with the actual location of the tree standing north of the house.

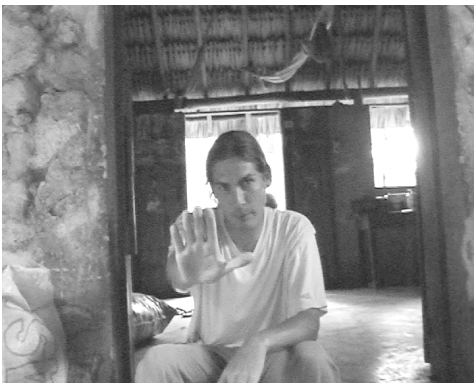
Even though their gestures situated the tree “to the north of” the house, I. and S. never actually said this, and only used a linguistic intrinsic FoR (“in front of”) or deictic expressions. But since both are looking to the west, their gestures could be only coincidental with the location of the objects. In order to “challenge” I.’s representation of the location of the Nance tree, he was further asked to listen to the interviewer’s directions given through “free oriented” gestures. In this case, the FoR used would be intrinsic, considering only the intrinsic orientation of the house and its relation to the tree, but not corresponding to the layout of the house and the tree in the real world. In order to do so, I. was asked to take the video camera and film the interviewer sitting in front of him.

O.: *wáa kinwa'ik tech* : “*tèene'*, *ich nah yàanen*,

If I say to you “I’m in the house,

*táan inpaktik umàatasil chí', beya', bey bàanta' (...)* *bey bàanta'ila''*.”

I’m looking at the Nance tree, like this, this way (...) it is in **this direction**” [gesture in Figure 8].



**Figure 8.** Intrinsic gesture.



This intrinsic gesture, considering the interviewer's position (toward the east), was not in conformity with the orientation of the tree and the house in the real world. I. accepted this utterance *per se*, but had one objection:

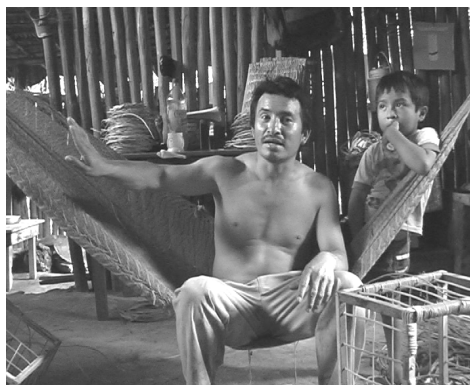
I.: *pero wáa e'esbil kamèetik ma' ma' bey bàanta'ila'*,

but if you indicate it (gesturally), no, it's not in this direction (**east**) [gesture 1 in figure 9]  
*bey bàanta'ila'*.

It is in this direction (**north**) [gesture 2 in Figure 10].



**Figure 9.** I.'s comprehension of the interviewer's gestural direction giving.



**Figure 10.** I.'s correction.

If I. had indeed accepted the intrinsic utterance, it makes no sense to him by itself. Gesture, the Yucatec Maya direction giving, must rely on a geocentric FoR. This is the reason why he corrected the interviewer's attempt. As the interviewer stretched his arm, he was innocently indicating the east. So I. tried to make clear that the Nance tree was not "east from" the house (Figure 9), but "north of" it (Figure 10). The interesting point here is that he never actually said it using the name of the cardinal direction, but only pointed to them gesturally.

### Conclusions

Examining French and Yucatec examples of giving directions demonstrates the importance of studying gestural deixis. Crucially, only considering a speaker's speech in the case of the Yucatec Maya is not sufficient to determine which FoR the speaker is relying on. The study of gestural deixis used to indicate directions, combined with the real world orientation of a GPS survey has allowed us to show that the cognitive maps of Yucatec Maya are in accordance with a non-linguistic geocentric FoR.

This study, along with experimental and ethnographical data collected among the Yucatec Maya (Le Guen 2006), might support a challenge to the Whorfian hypothesis recently reintroduced (Gumperz & Levinson, 1996; Lucy, 1992a, 1992b) and nuanced by some researches referring "moderate linguistic relativity"<sup>10</sup> (Mishra, Dasen, & Niraula, 2003; Wassmann & Dasen, 1998). Recent research by the Max Planck Institute for Psycholinguistics team studying spatial cognition (Brown, 2001; Brown et al., 1993, 2000; De León, 1994, 2001; Levinson, 1991a, 1991b, 1996, 2003; Levinson, Kita, Haun, & Rasch, 2002; Pederson, Danziger, Wilkins, Levinson, Kita, & Senft, 1998), has suggested that language (that is, the

<sup>10</sup> Wassmann and Dasen introduced the concept of "moderate linguistic relativity" based on the results of experiments (animals in a row and Steve's Maze) carried out in Bali. They indeed show a "moderate link between language specific verbal coding and the conceptual representation involved in solving non-verbal tasks" (1998: 706).

structure of a language crystallized in specific linguistic frames of reference) is a major influencing factor in spatial cognition. More precisely, these researchers claim that the dominant frame of reference used in a language affects cognition, so that verbal and non-verbal frames of reference are congruent.

Based on the data presented in this chapter, we see that the Whorfian hypothesis is not supported. On the contrary, Maya speakers use different linguistic Frames of Reference in speaking, but in gesturing, they align them with a geocentric, often non-linguistically salient, frame of reference. Indeed, this frame of spatial reference can sometimes even be masked by different linguistic FoR.

Although these differences in direction giving may appear superficial, they have profound implications for spatial cognition and memorizing processes. When a speaker is relying on an egocentric FoR, a listener should understand and remember his/her gestural indications as if he or she was looking “through the speaker’s eyes” at every segment. So when you get at point *x*, a left hand indication means that you should make a left turn. On the other hand, when a listener tries to decode gestural indications from a speaker that relies on a geocentric FoR, he/she must be aware that the orientation of the gestures correspond to layout of the object in the real world. So, in decoding geocentric gestures, you are not required to see through the speaker’s eyes. On the contrary, you have to remember that a left hand indication, pointing towards the east, at point *x*, does not mean a left turn: it means that you should go towards the east. This is true, no matter where you are looking at (or where the speaker was looking at when he/she gave his/her direction giving).

These differences have other deep implications on cognitive reasoning, especially in the way people take perspectives (see for instance the work of Danziger, 1998, 2001). In geocentric direction giving, information should be understood, memorized and updated without considering the person’s point of view or the objects’ intrinsic orientation, but the layout of the objects according to cardinal directions.

### References

- Brown, P. (2001). Learning to talk about motion Up and Down in Tzeltal. In M. Bowerman & S.C. Levinson (Eds.), *Language acquisition and conceptual development*, (pp. 512-544). Cambridge: Cambridge University Press.
- Brown, P., & Levinson, S.C. (1993). *Linguistic and nonlinguistic coding of spatial arrays: explorations in Mayan cognition*. Nijmegen: Cognitive Anthropology Research Group, Max Planck Institute.
- Brown, P., & Levinson, S. C. (2000). Frames of spatial reference and their acquisition in Tenejapan Tzeltal. In L. Nucci, G. Saxe, & E. Turiel (Eds.), *Culture, thought and development* (pp. 167-197). Mahwah, New Jersey: Lawrence Erlbaum Associates.
- Danziger, E. (1998). Getting here from there: The acquisition of "point of view" in Mopan Maya. *Ethos*, 1, 48-72.
- Danziger, E. (2001). *Relatively speaking: Language, Thought, and kinship among Mopan Maya*. Oxford: Oxford University Press.
- De León, L. (1994). Exploration in the acquisition of location and trajectory in Tzotzil. *Space in Mayan Languages, special issue of Linguistics*, 4-5, 857-884.
- De León, L. (2001). Finding the richest path: language and cognition in the acquisition of verticality in Tzotzil. In M. Bowerman & S. C. Levinson (Eds.), *Language acquisition and conceptual development* (pp. 544-566). Cambridge: Cambridge University Press.
- Gumperz, J. J., & Levinson, S. C. (1996). *Rethinking Linguistic Relativity*. Cambridge: Cambridge University Press.
- Haviland, J. B. (1996). Projections, transpositions, and relativity. In J. J. Gumperz, & S. C. Levinson (Eds.), *Rethinking Linguistic Relativity*, (pp. 271-323). Cambridge: Cambridge University Press.
- Haviland, J. B. (2000). Pointing, gesture spaces, and mental maps. In D. McNeill (Ed.), *Language and Gesture*. (pp. 13-46) Cambridge: Cambridge University Press.
- Le Guen, O. (2006). *L'organisation et l'apprentissage de l'espace chez les Mayas Yucatèques du Quintana Roo, Mexique, Unpublished Ph.D. Dissertation*. Université Paris X-Nanterre.

- Levinson, S.C. (2003). *Space in language and cognition: explorations in cognitive diversity*. Cambridge: Cambridge University Press.
- Levinson, S.C. (1991a). *Primer for the field investigation for spatial description and conception*. Nijmegen: Cognitive Anthropology Research Group, Max Planck Institute.
- Levinson, S.C. (1991b). *Relativity in spatial conception and description*. Nijmegen: Cognitive Anthropology Research Group, Max Planck Institute.
- Levinson, S.C. (1996). Relativity in spatial description and conception. In J. J. Gumperz & S. C. Levinson (Eds.), *Rethinking Linguistic Relativity* (pp. 177-202). Cambridge: Cambridge University Press.
- Levinson, S.C. (2003). *Space in language and cognition: explorations in cognitive diversity*. Cambridge: Cambridge University Press.
- Levinson, S. C., Kita, S., Haun, D. B. M., & Rasch, B. H. (2002). Returning the tables: Language affects spatial reasoning. *Cognition*, *84*, 155-188.
- Lucy, J.A. (1992a). *Grammatical Categories and Cognition: A Case of Study of the Linguistic Relativity Hypothesis*. Cambridge: Cambridge University Press.
- Lucy, J.A. (1992b). *Language Diversity and Thought: A Reformulation of the Linguistic Relativity Hypothesis*. Cambridge: Cambridge University Press.
- Mishra, R.C., Dasen, P., & Niraula, S. (2003). Ecology, Language, and Performance on Spatial Cognitive Tasks. *International Journal of Psychology* *38*, 366-383.
- Pederson, E., Danziger, E., Wilkins, D., Levinson, S., Kita, S., & Senft, G. (1998). Semantic Typology and Spatial Conceptualization. *Language*, *74*, 557-589.
- Tversky, B. (1998). Three dimensions of spatial cognition. In M. A. Conway, S. E. Gathercole & C. Cornoldi (Eds.), *Theories of Memory II* (pp. 259-275). Hove, East Sussex: Psychological Press.
- Wassmann, J., & Dasen, P. (1998). Balinese spatial orientation: some empirical evidence of moderate linguistic relativity. *Journal of Royal Anthropological Institute*, *4*, 689-711.
- Whorf, B. L. (1956). *Language, thought and reality*. Cambridge, MA: MIT Press.



**METHODOLOGY, STATISTICS, AND  
PSYCHOMETRICS**

