

Space in semantic typology: The MesoSpace project

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1. Semantic typology – Semantic typology is the crosslinguistic study of **semantic categorization** – the search for universals and dimensions of variation in the meanings expressed across languages. For example, suppose you see a bee flying into a house. A native speaker of Yucatec Maya might describe this event as follows:

- (1) Táantik uy=óok-ol hun-túul kàab ich le=nah=o'
RECENT it-enter-ASPECT one-CLASSIFIER.ANIMATE honeyin the=house=DEIXIS
'A bee just entered the house'

There is no reference to flying in (1). This could be added by expanding the sentence to include a second verb; but doing so would not be particularly idiomatic in Yucatec unless the speaker wanted to stress the fact that the bee flew instead of crawling into the house (Bohnemeyer & Stolz 2006). And the verb glossed 'enter' in (1) more literally means 'become inside'; (1) would also be true as a description of an event in which somebody placed a toy house over a motionless bee (Bohnemeyer in press). There is no equivalent of the English past tense in (1) (Bohnemeyer 2002). There is an expression of temporal immediacy; but this is compatible with any reference point in the past, present, or future - so (1) also translates 'A bee had just entered the house' and 'A bee will have just entered the house'. The bee is referred to using the word for honey in combination with the numeral "classifier" *túul* indicating that that which is counted is animate. Replacing *túul* with the generic classifier for inanimate entities would yield the translation of 'A beehive just entered the house' (Lucy 1992). The preposition *ich* 'in' selects the inside of the house as a point of reference, but does not indicate whether this place marks the endpoint of a motion event, as in this case, or the beginning ("A bee flew out of the house"), some point in between ("A bee flew through the house"), or the location of an entity ("There is a bee in the house") - all of these meanings can be expressed with the same preposition (Bohnemeyer 2007).

It appears, then, that the resources languages use to express the same idea can vary considerably. Even in contemporary linguistics there is widespread disagreement over the extent of this variation. Some view linguistic categorization as a mapping of a largely universal conceptual space into grammars and lexicons which vary only superficially across languages (e.g., Pinker 1994; Li & Gleitman 2002). Others assert that there is no crosslinguistic uniformity in linguistic categorization except perhaps at the most abstract levels of analysis (e.g., Levinson 2003; Evans & Levinson in press). The discrepancy between these positions is the result of sparseness of empirical evidence combined with the ideological struggle between universalists and relativists. Relativism is the idea that cognitive representations are to a significant extent culture-specific, learned, and social rather than individual. Conversely, universalism assumes that cognitive representations - or at least core components of them - are culture-independent and possibly innate. Thus the relativism-universalism debate is one contemporary manifestation of the age-old nature-nurture debate. Along with cognitive psychology and the study of linguistic and cognitive development, semantic typology opens one of the few empirical windows onto the relativism-universalism debate.

Languages are engines of symbolic representations. These allow people to "share" their cognitive representations – inferences, beliefs, emotions, desires, etc. - in ways that cognitive scientists have barely begun to understand. This amazing feat of sharing mental worlds in interaction makes human cognition far more social and cultural than any known form of animal cognition. A large portion of what we "know" or "assume" we do so neither on the basis of personal experience nor instinctively, because of something coded in our genes, but because this procedural knowledge is part of "our culture".¹ This

¹ Cultures are not countable entities. There is a single cultural network of humanity, a "cultural sphere" in analogy to the atmosphere, the biosphere, etc., and anything we metonymically refer to as a culture is a sub-network of it.

holds both for the categories expressed linguistically and for the categories of internal cognition. Cognition, *including* language, is to a very large extent a cultural phenomenon.

A precursor of semantic typology has been the research into the lexicalization of concepts of the natural world, in domains such as color, kinship, and ethnobiology, conducted by cognitive anthropologists and ethnosemanticists since the 1950s. Much of this work has been undertaken by proponents and opponents of the Linguistic Relativity Hypothesis (LRH), to lay the ground work for empirical tests of the LRH by charting the possibility space for “Whorfian” effects of language-specificity in nonlinguistic cognition. The LRH as one aspect of the overarching question of relativity: what aspects of language and internal cognition are universal and innate and what aspects are learned and culture-specific? Equally important is a second perspective motivating research in semantic typology: the search for universals and crosslinguistic variation in the principles governing the syntax-semantics interface. A methodological canon for semantic typology was developed in the 1990s by the members of the Language and Cognition (until 1997, Cognitive Anthropology) research group at the Max Planck Institute for Psycholinguistics. This method employs non-verbal stimuli such as pictures, videos, and toys to represent the conceptual distinctions of interest. Preferred descriptions and ranges of possible descriptions of these stimuli are collected in samples of unrelated and structurally broadly diverse languages with multiple speakers per language according to a standardized protocol.

2. The Levinson-Gleitman debate - A growing controversy has arisen around the demonstration in Levinson (1996, 2003) and Pederson et al. 1998 of a robust crosslinguistic alignment of the spatial frames of reference (FoRs) used in language, recall memory, and spatial inferences. FoRs are coordinate systems used to identify places (in the sense of regions) and directions, often with respect to some reference entity or “ground”. Three types of FoRs are distinguished in language use and internal cognition (Levelt 1984, 1989; Carlson-Radvansky & Irwin 1993; Levinson 1996, 2003): “intrinsic” or object-centered systems, where the geometric or functional structure of the ground itself is projected onto space (as when a tree closest to the intrinsic front of a house is referred to as being in front of the house); “relative” or observer-centered systems, where the geometrical/functional structure of the viewer’s body is projected onto the ground (as when a tree in the line of vision between speaker and house is referred to as being in front of the house while the speaker is in fact facing the side or back of the house); and “absolute” systems, which are projected onto the ground without a unique vantage point from which they are projected (e.g., if a tree is north of the house, it is so regardless of where the observer is positioned or how the house is oriented). Intrinsic and absolute FoRs may be grouped as “allocentric” against “egocentric”, i.e., observer-based/relative FoRs.

Pederson et al. 1998 show that speakers of a language that prefers relative FoRs in a given domain will also rely on relative FoRs in memory and inferences in the same domain, whereas speakers of a language that employs absolute FoRs in the same domain will encode states of affairs in this domain in absolute terms in memory and derive placement inferences based on absolute FoRs. These findings are consistent with a relativistic interpretation according to which FoR selection in language determines FoR selection in internal cognition. However, Li and Gleitman (2002) propose an alternative interpretation. They suggest that everybody independently of population is always capable of using any FoR (absent some impairment). The alignment of FoR selection in discourse and internal cognition observed by Levinson, Pederson, and colleagues is really the result of cultural factors such as literacy, education, and the adaptation to topography and ecology driving FoR selection in both discourse and internal cognition. To support this interpretation, they carried out experiments with American college students in a bid to show that FoR preferences in recall memory are easily mutable. With a little tweaking of contextual factors, American college students can be made to perform just like Tenejapan peasants. The authors replicated one of the designs used by Pederson and colleagues in which participants memorize an array of toy animals and then reproduce it after undergoing 180-degree rotation. Li & Gleitman introduced a

new condition employing an ad-hoc landmark (a toy duck pond). This induced a shift in the participants' recall memory strategy that the authors interpret as evidence for employment of an absolute FoR. The authors reason that if American college students can be induced to perform like the Tenejapan Tzeltal speakers described in Levinson (1996, 2003) and Pederson et al. 1998, the crosslinguistic differences found in these studies may be no more than shallow artifacts of environmental conditions and cultural factors. However, Levinson 2003 and Levinson et al. 2002 demonstrate that the experimental results of Li & Gleitman 2002 do not in fact straightforwardly support the authors' conclusions. Replication of the duck-pond condition under 90-degree, rather than 180-degree, rotation shows clearly that the landmark-based frame projected from the toy duck pond is an intrinsic, not an absolute, FoR. Li and Gleitman failed to properly distinguish between landmark-based (geomorphic) and absolute FoRs. Consequently, they did not, in fact, demonstrate that Westerners can be easily induced to perform like Tenejapans. Similarly, Li, Abarbanell, & Papafragou 2005 report what they argue to be evidence of egocentric FoRs in recall memory used by Tenejapan participants in their experiments. In one of these experiments, participants had to reproduce the orientation of a playing card after having rotated 180 degrees. The original card was concealed in a box which was given to the participants prior to rotation. In a "geocentric" condition, the box with the card would not change orientation while the participants rotated, whereas in the "egocentric" condition, it would rotate with the participants. It was found that the difference between the conditions had no significant effect, which the authors present as evidence that the use of egocentric and allocentric FoRs in recall memory is equally natural to Tenejapans. However, a FoR in which the observer's body serves as both "anchor" (the basis for the definition of the axes of the coordinate system or for the definition of its quadrants in terms of places they contain) and ground is, in fact, an intrinsic, not a relative, FoR in terms of Levinson's classification. Danziger (in press) proposes the term "direct" FoR for this special instance of the intrinsic type. Like true relative FoRs, direct FoRs are egocentric. However, they lack the key ingredient of relative FoRs – the projection of the geometry of the observer's body onto an external ground. The following examples illustrate the difference; (2) is direct, (3) relative:

(2) *The cup is on my left*

(3) *The cup is left of the ball*

There are no serious doubts that the use of direct FoRs is universal. The use of relative FoRs, however, is not. Thus, just as Li & Gleitman did not actually demonstrate that Euroamericans are easily induced to perform like Tenejapans, so Li, Abarbanell, & Papafragou did not actually demonstrate that Tenejapans are easily induced to perform like Westerners.

3. The MesoSpace Project – The Mesoamerican (MA) linguistic and cultural area provides a unique opportunity to improve our understanding of language and culture as factors in determining the use of FoRs in internal cognition. It puts us in a position to study populations that are closely matched in terms of their environment, modes of production, and literacy, with language being the potential major differentiating factor – the position of Li & Gleitman would seem to predict that language should not be able to make a fundamental difference in cognitive performance here. We have, moreover, for the first time possible linguistic predictors of FoR preferences in language, and may thus be able to pit these against other cultural factors to see just how autonomous FoR choices in language use really are. Lastly, we have the ability to study, in some communities, monolingual and bilingual speakers of the same language. On the interpretation of Levinson (1996, 2003) and Pederson et al. 1998, bilingualism is expected to critically affect FoR selection (in both language and cognition); on the position of Li & Gleitman, it is not.

The project *Spatial language and cognition in Mesoamerica* ("MesoSpace" for short; NSF Award # BCS-0723694) is investigating the representation of spatial information in 15 indigenous languages of Mexico, Guatemala, and Nicaragua. MesoSpace is the largest effort in semantic typology funded by the

National Science Foundation since the World Color Survey in the 1970s. The project focuses on two unusual traits of spatial reference in Mesoamerican languages: i) the widespread absence or paucity of use of relative FoRs and ii) the highly productive use of 'meronymic' terminologies for object parts and spatial regions based primarily on object geometry.

Meronyms are terms that describe entities as parts of larger entities. Terms for parts of the human body are perhaps universally the prototypical meronyms. From the perspective of the available literature on the typology of spatial descriptions, MA meronymies are unusual in two respects: first, they represent perhaps the most important resource for the expression of place functions (Jackendoff 1983) in many MA languages – in particular, in languages without spatial case markers and with few or no adpositions. Examples (4) (from Juchiteco Zapotec) and (5) (from Yucatec Maya) illustrate:

(4) Dxi!'ba=be* i^ke yoo
 mounted=it head house
 'He's on top of the house'

(5) ...h-tàal u=balak' y=óok'ol le=pak'=o'
 PERFECTIVE-come(it) it=roll it=top the=brickwork=DEIXIS
 '...it came rolling on/over the wall'

Secondly, MA meronyms are unusually productive, often apparently being extended to novel entities in a transparent and compositional manner, not unlike adpositions in other languages (but, unlike these, describing object parts, not abstract spatial relations). Two different proposals have been advanced to account for the productivity of MA meronymies. MacLaury 1989 describes seven high-frequency meronyms of Ayoquesco Zapotec as body part terms that are metaphorically extended to other entities by a generalized global analogical mapping process with the structure of an erect human body as its source domain and the structure of the entity described by the possessor of the meronym in its actual orientation as the target domain. This mapping is orientation-sensitive: the highest part of the object becomes the metaphorical 'head' and the lowest part the 'buttocks' or 'feet', depending on its shape. The assignment of 'front', 'back', and 'side' terms appears to depend both on the shapes of the parts of the object and on the perspective of the observer. In contrast, Levinson 1994 describes meronym assignment in Tenejapan Tzeltal as governed, not by a metaphorical mapping process, but by an algorithm that takes as input the visually segmented outline of the possessor entity and labels parts on the basis of their shape and the axis of the possessor they occur on – whether these are human, animal, or plant body parts or parts of inanimate objects.

The MesoSpace team of researchers is examining the conceptual basis for meronym assignment, testing predictions derived from the global-analogy account proposed by MacLaury for Zapotec and the shape-analytical algorithm proposed by Levinson for Tzeltal in their field languages. The overarching hypothesis informing MesoSpace is the idea that the availability of productive geometric meronymies may disfavor the use of relative frames of reference in both language and internal cognition. If confirmed, this “meronymy-allocentrism pattern” would represent evidence for a purely linguistic determinant of reference frame selection.

4. Evidence from Yucatec – At the time of writing, only the Yucatec data collected for the MesoSpace project have been fully analyzed. Yucatec, like Tzeltal and Zapotec - and unlike Indo-European languages such as English and Spanish - has a productive strategy for labeling object parts on the basis of their shape and position in the object's axial structure. The Yucatec system combines traits of Tzeltal and Zapotec meronymy, but is best described as a third type of system. Yucatec meronymy involves a critical distinction between three semi-autonomous subsystems which does not appear to exist in the other two languages: there are subsystems for the labeling of surfaces, volumes, and curvature extremes (edges, corners, tips, etc.). Evidence from a referential communication task involving 'novel' objects culturally unfamiliar to Mayan people and Westerners alike shows that only the subsystems for surface

and curvature extreme naming are fully productive. Volume naming shares many traits with the algorithm described by Levinson: volume meronyms are assigned independently of the object's canonical or actual orientation, independently of its overall structure except for the determination of the largest volume (a flashlight can be viewed as a 'leg' with a 'head' on one end and an 'asshole' on the other), and non-uniquely (objects can have multiple 'heads' etc.). Yet, strikingly, volume labeling is not only much more restricted with unfamiliar objects compared to surface and 'extreme' labeling, but is also frequently explicitly metaphorical (as suggested by the use of similes and hedges), which surface and extreme labeling never is. Surface labeling, unlike volume and extreme labeling, is orientation-dependent. The assignment of 'top' and 'bottom' surfaces depends on the object's canonical orientation, not on its actual orientation as in Zapotec. The evidence from Yucatec supports the view, advocated in Pérez Báez & Bohnemeyer 2008, that global analogical mapping as in Zapotec and assignment based on shape-analytical algorithms as in Tzeltal are not incompatible, contrary to Levinson 1994, 2003. Additional data supports the hypothesis that productive shape-based meronymies disfavor the use of relative frames of reference. This evidence comes from a second referential communication task, one involving four sets of 12 pictures each featuring a ball in various locations vis-à-vis a chair. The frame of reference Yucatec speakers use most frequently when describing the location of the ball in order to distinguish and match the pictures is the intrinsic frame of reference. This confirms a conjecture in Bohnemeyer & Stolz 2006. For reference to the orientation of the chair, direct FoRs (see section 2 above; e.g., (6)) and FoRs based on landmarks (e.g., (7)) dominate.

(6) *The chair is facing us*

(7) *The chair is turned towards the door*

All other team members can at present report only tendencies on the basis of already coded subsamples of their data. The corresponding preliminary results suggest that the use of relative frames of reference is dispreferred throughout Mesoamerica, as predicted. This pattern appears to extend to the two indigenous control languages of the sample, spoken north (Seri) and south (Mayangna) of the MA area, suggesting that it may not be a feature of the Mesoamerican sprachbund (Campbell, Kaufman, & Smith Stark 1986). First reports of data collected with the Novel Objects tasks indicate that, as predicted, meronyms appear to play a prominent role in identifying the parts of the Novel Objects throughout the MA sample and also in the control language Mayangna, but not in the control language Seri spoken north of the MA area.

5. The meronymy-allocentrism pattern – Why might the availability of a productive geometrically based meronymy in a language bias its speakers against the use of relative FoRs? A partial hypothetical account might be constructed as follows:

- In MA languages, representations of locations that are interpretable in relative FoRs tend to involve meronyms as expressions of place functions.
- These meronyms can always be interpreted intrinsically as well.
- Due to the pervasive use of meronyms in MA discourse and the dependence of their application on the geometry of the semantic² possessor, speakers of MA languages are accustomed to paying attention to the geometry of the ground when encoding place functions.
- The relative use of meronyms involves projection of the geometry of the anchor – the observer's body – onto the ground. This projection “overrides” the geometry of the ground, the semantic possessor of the meronym. The habit of assigning meronyms based on an analysis of the

² Meronyms are not always relational nouns. They often surface incorporated into the verb or ground-denoting nominal. In some MA languages, these incorporation/compounding strategies are preferred over possessive constructions with meronyms.

geometry of the semantic possessor biases speakers against this override, thus favoring the intrinsic interpretation of the meronym.

- FoRs involved in the interpretation of place functions whose encoding does not employ meronyms are not affected by this tendency. This holds for example for geomorphic/geocentric systems and/or landmark-based systems and direct systems such as those illustrated in (6)-(7) above.

6. Conclusions - The hypothesis that productive geometrical meronymies disfavor the use of relative frames of reference ties in with one of the foundational questions of cognitive science, the language-and-thought complex. If confirmed, the meronymy-allocentrism pattern would suggest that the availability of productive geometrical meronymies is a purely linguistic factor driving biases in frames-of-reference usage in language and internal cognition.

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