Spatial reference frames in language, culture, and cognition

- two central questions
  - what is the role of culture in cognition?
  - does speaking particular languages influence the way the speakers think?
- a domain in which to look for answers: spatial frames of reference

Spatial reference frames in language, culture, and cognition (cont.)

- projective – framework-dependent
  - the place function returns a region defined in a coordinate system centered on the reference entity
  - the axes of the coordinate system are derived from an anchor
    - in intrinsic frames, the anchor is the reference entity
    - in relative frames, it is the body of an observer
    - in absolute frames, it is some environmental entity/feature

Figure 2. The three types of spatial FoRs distinguished in Levinson 1996, 2003

Spatial reference frames in language, culture, and cognition (cont.)

- alternative classifications and subtypes

Figure 3. Reference frame types and their classification (A - 'away from', B - 'back', D - 'downriver', F - 'front', L - 'left', R - 'right', T - 'toward', U - 'upriver'); Bohnemeyer & Levinson ms.

Synopsis

- spatial reference frames in language, culture, and cognition
- MesoSpace: team, goals, tools
- the Ball & Chair study
- the distribution of the response variables
- the impact of the predictor variables
- discussion and future prospects
Spatial reference frames in language, culture, and cognition (cont.)

- finding: a great deal of crosslinguistic variation
  - in terms of both availability and preferences

- two competing interpretations
  - Innatist interpretation (Li & Gleitman 2002; Li et al. 2011; inter alia)
    - innate knowledge of all FoR types
    - variation only in usage preferences
    - variation caused by adaptation to the environment - topography, population geography, education, literacy
    - language plays no role in the cultural transmission of practices of spatial reference
  - Neo-Whorfian interpretation (Levinson 1996, 2003; Pederson et al. 1998; inter alia)
    - knowledge of some FoR types is culturally transmitted
    - language plays a key role in the cultural transmission of practices of spatial reference
    - the adaptation to the environment happens at the phylogenetic level, not at the ontogenetic level

Table 1. Animals-in-a-Row in Levinson 2003: the large sample

<table>
<thead>
<tr>
<th>Linguistically Absolute</th>
<th>English, Dutch, Japanese, Aztecan</th>
<th>Prediction: Non-verbal coding will be absolute</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relative</td>
<td>Predominant</td>
<td>Predominant</td>
</tr>
</tbody>
</table>

MesoSpace: team, goals, tools

- NSF award BCS-0723694
  *Spatial language and cognition in Mesoamerica*

- MesoSpace aims to contribute to the debate from two angles
  - we are working on a series of studies that pit linguistic against non-linguistic predictors
    * in reference frame use across languages
  - we are also investigating a possible lexico-syntactic factor that may bias speakers against relative FoRs
    * namely the productive use of shape-based meronyms in the representation of space

Synopsis

- spatial reference frames in language, culture, and cognition
- MesoSpace: team, goals, tools
  - the Ball & Chair study
  - the distribution of the response variables
  - the impact of the predictor variables
  - discussion and future prospects

MesoSpace: team, goals, tools (cont.)

- 14 Mesoamerican (MA) languages
  - Mayan
    * Chol (J.-J. Vázquez)
    * K’ani’oj (E. Mateo)
    * Tseltal (several variants; G. Pollan)
    * Yucatec (J. Bohmeyer)
  - Mixe-Zoquean
    * Ayutla Mixe (R. Romero)
    * Soconusco Mixe (G. Gutierrez)
    * Tecpatán Zoque (R. Zamora)
  - Oto-Manguean
    * Isthmus Zapotec (G. Pérez)
    * Otomi (N. Hernández, S. Hernández, E. Palancar)
  - Huave (S. Herrera)
  - Purépecha (A. Capistrán)
  - Totonac-Tepelahua
    * Huehuetla Tepelahua (S. Smythe)
  - Uto-Aztecan
    * Papago Nowat (V. Peralta)
Reference frames in Mesoamerica: Linguistic and nonlinguistic factors

January 4th, 2013

Synopsis

- spatial reference frames in language, culture, and cognition
- MesoSpace: team, goals, tools
  - the Ball & Chair study
  - the distribution of the response variables
  - the impact of the predictor variables
  - discussion and future prospects

The Ball & Chair study

- our tool for studying the use of FoRs in discourse
  - a referential communication task: Ball & Chair (B&C)
    - replacing Men & Tree (M&T) in Pederson et al (1998) etc.
    - B&C allows us to discover selection preferences for any of the FoR types
      - at the in-door scale
      - M&T may for various reasons depress the use of intrinsic FoRs

- these are all the languages of the MesoSpace sample
  - data from five dyads of participants per variety are included in the analysis
  - except for the case of
    - Mexican Spanish, where up to now only the data from three of the five dyads have been coded
    - Istmo Zapotec, where we have data from six dyads
  - responses are accompanied by the researchers’ estimates of the participants’
    - level of education
    - frequency of use of Spanish (as first or second language)
    - frequency of reading and writing

- the data set of the present study
  - B&C data from 11 varieties
    - 6 Mesoamerican languages
      - Yucatec Maya (J. Bohnemeyer)
      - Ayutla Mixe (R. Romero)
      - San Idefonso Tulepec Otomi (N. Hernández, S. Hernández, E. Palancar)
      - Purépecha (or Tarascan; A. Capistrán)
      - Chacoma Tzeltal (G. Polian)
      - Juchitán (Isthmus) Zapotec (G. Pérez)
    - 2 non-Mesoamerican indigenous languages
      - Seri (C. O’Meara)
      - Sumu-Mayangna (A. Egleston, E. Benedicto, Mayangna Yulbarangyang Balna)
    - 3 varieties of Spanish
      - from Barcelona (A. Egleston), Mexico (R. Romero), and Nicaragua (A. Egleston)

- coding
  - we coded descriptions of the location of the ball
    - distinguishing among eight categories (see Figure 3 above)
      - allocentric intrinsic
      - egocentric intrinsic (‘direct’; Danziger 2010)
      - egocentric extrinsic = relative
      - intrinsic and relative aligned (Carlson-Radvansky & Irvin 1993)
      - geocentric (= geomorphic, landmark-based, or absolute)
      - vertical absolute
      - vertical absolute and intrinsic aligned (Carlson-Radvansky & Irvin 1993)
      - topological (no reference frame involved; Piaget & Inhelder 1956)
The Ball & Chair study (cont.)

- all of the languages in the sample have the lexical and grammatical resources for using all FoR types
  - in no case does the grammar or lexicon of the language constrain the use of particular frame types
  - reference frames are semantic patterns
    • which are only indirectly related to particular lexical items

- The Ball is in front of the chair
- The ball is left of the chair

> Figure 14. Truth conditions of intrinsic and relative descriptions of Ball & Chair 3.9 (left) and 3.12

The Ball & Chair study (cont.)

- the similarity matrix
  - for each participant, we calculated a set of eight frequencies
  - these sets can be interpreted as points in an octodimensional space
  - the distances between the points represent the similarity across the participants’ responses
  - we calculated the distances in the ‘Manhattan’ metric
    • where the distance between two points is the sum of the differences of the coordinates
  - we can use this similarity measure to analyze
    • how the responses cluster
    • which factors predict the similarity between participants

Synopsis

- spatial reference frames in language, culture, and cognition
- MesoSpace: team, goals, tools
- the Ball & Chair study
- the distribution of the response variables
- the impact of the predictor variables
- discussion and future prospects

The Ball & Chair study (cont.)

- a given speech community’s preferences for using particular frame types are strictly a matter of usage
- the question the studies reported here address is this:
  • does the frame use of individual speakers/dyads reflect the practices of the community
  - and those of communities whose languages they use as L2 speakers
  • or does it depend exclusively on the speaker’s level of education and literacy?

The Ball & Chair study (cont.)

- the similarity matrix (cont.)
  - innovation
    • previous multivariate analyses in semantic typology construct similarity matrices over the stimulus items
      - cf. Levinson & Meira 2003; Majid et al 2008
    • in contrast, our approach treats the (dyads of) participants as statistical units
      • this allows us to treat language as a direct predictor variable

The distribution of the response variables

- how do the participants’ responses cluster?
  - MDS analysis shows two broad groups
    • cf. Schiffman et al 1981

> Figure 15. MDS plot
• a strong correlation emerges between the dimension of the MDS plot and the use of geocentric frames
  » Spearman’s Rho 0.95
  – and weaker negative correlation between the first dimension and the use of relative frames
  » Spearman’s Rho -0.8
• the second dimension shows a weak correlation with the frequency of topological descriptions
  » Spearman’s Rho 0.79

Figure 16. Correlations between the dimensions of the MDS plot and the frequency of geocentric (left), relative (center), and topological (right) descriptions.

• discussion
  – the MDS and Neighbor-net analyses show
    • that the participants differentiated themselves most strongly in their use of relative, geocentric, and topological descriptions
  – the question now: which factors predict which of these strategies a speaker/dyad selects?
    • candidate predictor variables:
      1. L1
      2. L2 (… Ln)
      3. literacy
      4. education
      5. topography
      6. population geography
    • the linear regression we present in the following tests (1) – (4)

The impact of the predictor variables
• to analyze the role of the predictor variables we conducted several linear regression analyses
• we tested separate models for the strongest differentiating response variables
  – the use of relative and geocentric frames
• we tested these models for two sets of populations
  – on all 11 populations
    • with the predictor variables areal-linguistic affiliation (see below!), literacy, and education
  – on the speakers of the indigenous languages only
    • now including the L2 use of Spanish as a predictor variable

The impact of the predictor variables (cont.)
• the areal-linguistic affiliation variable
  – our dataset includes too many individual languages for a parsimonious model
  – therefore, we grouped the languages according to areal-linguistic affiliation
    • yielding a three-level variable for the 11-populations models
      – languages of the Mesoamerican sprachbund, Spanish, and the two non-Mesoamerican indigenous languages
    • and a two-level variable for the models that include the responses from the speakers of the indigenous languages only
      – Mesoamerican sprachbund languages vs. non-Mesoamerican indigenous languages (Seri and Sumu)

The impact of the predictor variables (cont.)
• the areal-linguistic affiliation variable (cont.)
  – the Mesoamerican linguistic area
    • cf. Campbell 1979; Campbell et al 1986

Figure 18. Mesoamerican language map (contemporary distribution)
source: http://en.wikipedia.org/wiki/Image:Mesoamericanlanguages.png; lines showing approximate boundaries of Mesoamerican area added by the authors
The impact of the predictor variables (cont.)

• implementation
  – we used generalized linear mixed-effects models
    • implemented using the ARM package in R (Gelman et al 2012)
  – ‘mixed-effects’ models b/c they include random nested
    intercepts for individual languages and dyads
    – in addition to the ‘fixed’ effects of the predictor variables
    and an invariable intercept
  • to avoid over-fitting or lack of independence
  – the probability of a given dyad using any of the eight
    response categories to describe a particular picture
  • is independent of the probability of them using any other type
    of frame to describe the same picture

• findings I: GEO, L1-Spanish speakers incl.
  – the fitted geocentric model revealed linguistic affiliation
    and literacy, but not education, as significant
  • there was no effect from membership in the MA sprachbund

• findings II: REL, L1-Spanish speakers incl.
  – the fitted relative model revealed linguistic affiliation
    as the sole significant factor
  • there was no evidence of an areal effect

• findings III: GEO, L1-Spanish speakers excl.
  – the fitted geocentric model showed
    literacy as the sole significant factor

The impact of the predictor variables (cont.)

• findings IV: REL, L1-Spanish speakers excl.
  – the fitted relative model showed
    the use of L2 Spanish as the sole significant factor

• discussion: the role of the first language
  – the L1-Spanish speakers differed significantly
    from the speakers of the indigenous languages
    • using relative frames overall much more frequently
      and geocentric frames overall much less frequently
  • this contribution of L1 cannot be reduced
    to a combination of any of the other factors
  • to this extent contra Li & Gleitman 2002
The impact of the predictor variables (cont.)

• discussion: the role of the second language
  – the speakers of the indigenous languages use relative frames in their native languages more frequently
  • the more frequently they use Spanish as an L2
  – this suggests that habituation to the use of relative frames diffuses through contact with Spanish
  • consistent with the Neo-Whorfian view of language as a transmission system for nonlinguistic cognition

• discussion: the role of the nonlinguistic factors
  – literacy, assessed in terms of the frequency of reading and writing, is a significant predictor of frame use
  • this variable makes a significant independent contribution to the use of geocentric frames, but not to that of relative ones
    – presumably, speakers who read and write more frequently are less likely to use geocentric frames
  – in contrast, we did not find any effect of education
  – overall, this picture is consistent with the varying role of education and literacy across our sample
    • some of the indigenous populations have high education scores across the board
      – and nevertheless use geocentric frames more frequently than relative ones
      – especially the Isthmus Zapotec and Sumu-Mayangna communities

Probing the lack of evidence for an areal effect

• we ran a cluster analysis of the original similarity matrix
  • including the data from the L1-Spanish speakers
  • we applied an agglomerative algorithm using the ‘cluster’ and ‘MASS’ packages in R

Figure 19. Cluster analysis dendrogram of the similarity matrix of the Ball & Chair data.

Figure 20. Color-coding the clusters: red – Mesoamerican; green – non-Mesoamerican indigenous languages; blue – varieties of Spanish.

Synopsis

• spatial reference frames in language contact
• MesoSpace: team, goals, tools
• the Ball & Chair study
• the distribution of the response variables
• the impact of the predictor variables
• discussion and future prospects
References


References (cont.)


