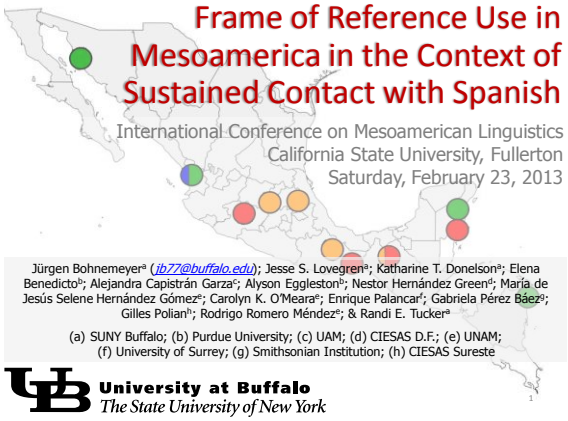

Frame of Reference Use in Mesoamerica in the Context of Sustained Contact with Spanish

International Conference on Mesoamerican Linguistics
California State University, Fullerton
Saturday, February 23, 2013

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University at Buffalo
The State University of New York

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Synopsis

- **Hypothesis**
- MesoSpace: team, goals, tools
- Frames of reference
- Data: the Ball & Chair study
- Qualitative data
- Quantitative analysis:
  - the distribution of the response variables
  - the impact of the predictor variables
- Discussion and conclusions
- Appendix: the linear regressions

2

Hypothesis

- Central question: **are practices of language use**
  - Diffused through contact (neo-whorfian)?
  - Modified by non-linguistic factors, ex. education/literacy, environment (Li, Gleitman)?
  - Altered by other factor(s)?

- **Hypothesis:**
  - The use of the relative Frames of Reference by contemporary speakers of Mesoamerican (MA) languages is largely – possibly exclusively – the result of **contact with Spanish**.

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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

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MesoSpace: team, goals, tools (cont.)

- 13 Mesoamerican (MA) languages
  - Mayan
    - Chol (J.-J. Vázquez)
    - K'anjob'al (E. Mateo)
    - Tseltal (several variants; G. Polian)
    - Yucatec (J. Bohnemeyer)
  - Mixe-Zoquean
    - Ayutla Mixe (R. Romero)
    - Soteapanec (S. Gutierrez)
    - Tecpatán Zoque (R. Zavala)
  - Oto-Manguean
    - Juchitán Zapotec (G. Pérez Báez)
    - Otomí (N. Hernández, S. Hernández, E. Palancar)
  - Huave (S. Herrera)
  - Purépecha (A. Capistrán)
  - Totonac-Tepehuan
    - Huehuetla Tepehua (S. Smythe)
  - Uto-Aztecan
    - Pajapan Nawat (V. Peralta)

Figure 9. *MesoSpace: Field sites*

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MesoSpace: team, goals, tools (cont.)

- non-MA "controls"
  - Seri (C. O'Meara)
  - Cora (Uto-Aztecan; V. Vázquez)
  - Mayangna (E. Benedicto, A. Eggleston in collaboration with the Mayangna Yulbarangyang Balna)
  - Mexican, Nicaraguan, and Barcelonan Spanish (R. Romero; E. Benedicto, A. Eggle :on)

Figure 10. The *MesoSpace team (minus V. Peralta and R. Tucker)*

- 2 (interrelated) domains
  - **frames of reference** and **meronyms** (labels for entity parts)

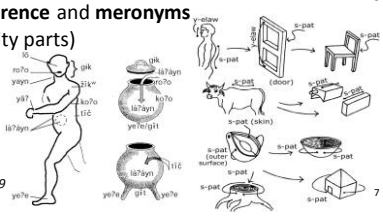

Figure 11. *Meronyms in Ayoquesco Zapotec (left) and Tenejapa Tseltal (adapted from MacLaury 1989 and Levinson 1994)*

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Frames of reference

- background on reference frames
  - two kinds of *place functions* (Jackendoff 1983)
    - i.e., functions from reference entities into regions
      - *topological* (Piaget & Inhelder) – perspective=frame-free
        - » independent of the orientation of the ground, the observer, and the figure-ground array (the configuration)

(1.1) *The apple is on the skewer*
(1.2) *The band aid is on the shin*
(1.3) *The earring is in the ear (lobe)*

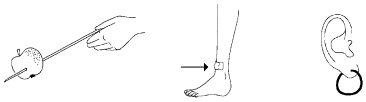

Figure 1. *Some configurations that might be described in terms of topological place functions*

Frames of reference (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

Intrinsic — *The man is on the side of the tree.*
Relative — *The man is to the right of the tree.*
Absolute — *The man is east of the tree.*

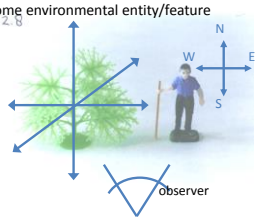

Figure 2. *The three types of spatial FoRs distinguished in Levinson 1996, 2003*

Frames of reference (cont.)

- alternative classifications and subtypes

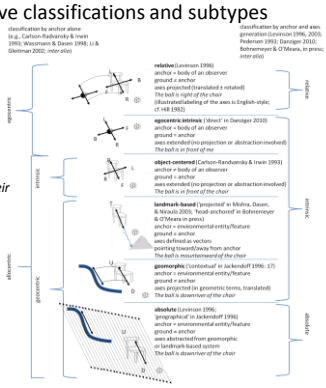

Figure 3. *Reference frame types and their classification (A - 'away from', B - 'back', D - 'downriver', F - 'front', L - 'left', R - 'right', T - 'toward', U - 'upriver'; Bohnemeyer & Levinson ms.)*

Frames of reference (cont.)

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

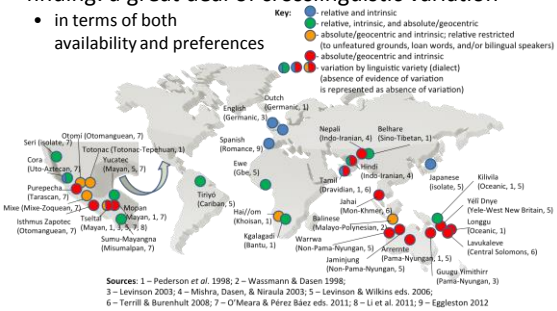

Figure 4. *Reference frame use in small-scale horizontal space across languages (Bohnemeyer & Levinson ms.)*

Spatial reference frames in language, culture, and cognition

- alignment between language and cognition
  - preferences for particular frame types in discourse and recall memory covary

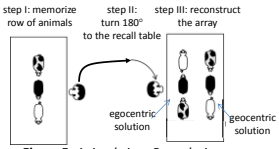

Figure 5. *Animals-in-a-Row: design*

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

Linguistically Relative	English, Dutch, Japanese, Tamil-Urban	*Prediction:* Non-verbal coding will be relative	N = 85
Linguistically Absolute	Arrernte, Hai//om, Tseltal, Longgu, Belhare, Tamil-Rural	*Prediction:* Non-verbal coding will be absolute	N= 99

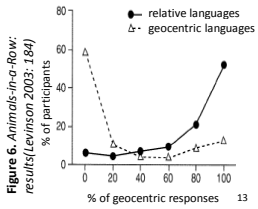

Figure 6. *Animals-in-a-Row: results(Levinson 2003: 184)*

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

- two competing interpretations

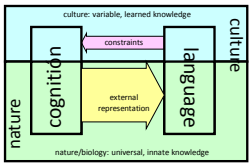

Figure 7. *The innatist vision*

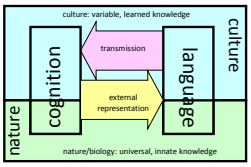

Figure 8. *The Neo-Whorfean vision*

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

The role of language contact

- Neo-whorfian view
  - Language is a system of transmission for nonlinguistic cognition
    - this suggests that **not only a person's L1, but also their L2/3/…,** may affect their cognition
- experimental support
  - Athanasopoulos 2006
    - advanced Japanese-English bilinguals pattern with monolingual English speakers in the cognitive processing of number
  - Athanasopoulos 2009
    - L2 influence on color naming and color categorization in Greek-English bilinguals

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Frames of reference preference in Mesoamerica

- MA languages have been reported to make use of the relative FoR in discourse with much less frequency than in other languages
  - Tenejapa Tseltal
    - Brown and Levinson (1992, 1993, 2000, 2009), Brown (1994, 2001, 2006), Levinson (1994, 1996, 2003), Levinson and Brown (1994), Levinson et al. (2002), Polian and Bohnemeyer 2011.
- O'Meara and Pérez Báez 2011 (eds.)
  - MA language sample: Tarascan (Isolate), Tseltal and Yucatec (Mayan), Ayutla Mixe (Mixe-Zoquean), San Ildefonso Tultepec Otomí and Juchitán Zapotec (Otomanguean), Meseño Cora (Uto-Aztecan)
  - In **no** case was the relative FoR the preferred FoR type in either orientation or location descriptions.
  - Highest frequency of use of the relative FoR
    - Yucatec: 17% of orientation descriptions and 18% of the location descriptions (Bohnemeyer 2011)
    - Still, not the preferred strategy
  - Bias against the use of the relative FoR
    - Tarascan: **1%** of orientation descriptions and **4%** of location descriptions (Capistrán Garza, 2011)
    - Juchitán Zapotec: **Not used at all** in orientation descriptions, **3%** of location descriptions. (Pérez Báez, 2011)

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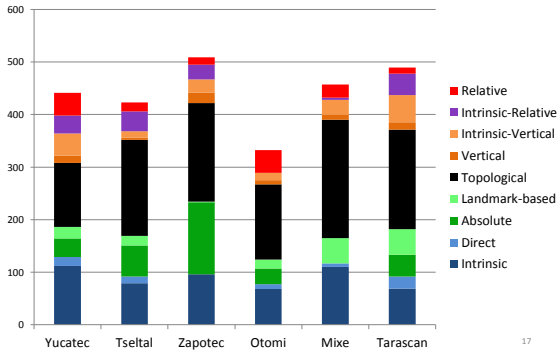
Frames of reference preference in Mesoamerica

Reference frame uses in Ball & Chair locative descriptions



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Frames of reference: summary and hypothesis

- **Premise:**
  - If language plays the role suggested by Neo-Whorfian accounts (Pederson *et al* 1998, Levinson 2003, *contra* Li & Gleitman 2002), both first and second languages should have an effect on FoR preferences.
- **MesoSpace hypothesis:**
  - The use of the relative FoRs by contemporary speakers of Mesoamerican (MA) languages is largely – possibly exclusively – the result of **contact with Spanish as L2**

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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

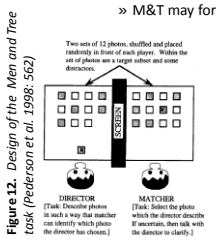

Figure 12. *Design of the Men and Tree task (Pederson et al. 1998: 562)*

Figure 13. *Two of the Ball & Chair fotos, featuring an intrinsic contrast*

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- 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 Ildefonso Tultepec Otomí (N. Hernández, S. Hernández, E. Palancar)
      - Purépecha (or Tarascan; A. Capistrán)
      - Cha'jkoma Tseltal (G. Polian)
      - Juchitán Zapotec (G. Pérez Báez)
    - 2 non-Mesoamerican indigenous lenguages
      - Seri (C. O'Meara)
      - Sumu-Mayangna (E. Benedicto, A. Eggleston, Mayangna Yulbarangyang Balna)
    - 3 varieties of Spanish
      - from Barcelona (A. Eggleston), Mexico (R. Romero), and Nicaragua (A. Eggleston)

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- these are all the languages of the MesoSpace sample from which the data have been coded so far
- 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
    - Juchitán Zapotec and Barcelona Spanish, 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

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- 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)

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- 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

	true in which type of FoR?	
The ball is in front of the chair	relative	intrinsic
The ball is left of the chair	intrinsic	relative

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

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Qualitative Data

- In San Ildefonso Tultepec Otomí the use of the relative FoR occurs almost only in conjunction with the loanword *lado* 'side' (< Sp. lado) (Hernández Green et al 2011)
- Polian & Bohnemeyer 2011 present evidence of increased use of relative FoRs in Tseltal varieties possibly as a result of contact with Spanish

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SIT Otomí

(1) Ø='beng-a=no=r pelohta **n'a *lado***
3.PRS=lie.A-B=DEF=SG ball one side
'The ball is lying on the side.'

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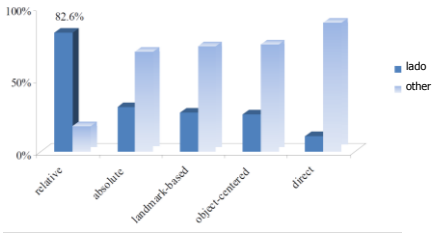
The word *lado*

- The relative FoR accounts for only 3.6% of the total number of propositions.
  - However, the **majority** of these expressions (**82.6%**) contain the word *lado*.



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Tseltal

- Brown and Levinson (1990s)
  - Tenejapans hardly use relative FoRs

Table 1. FoR categories and frequency of use among adults in Tseltal (Brown and Levinson 2009, p. 458)

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

- Polian & Bohnemeyer 2011
  - 'left' (*xin* in Tenejapa, *k'exen* in Oxchuc), 'right' (*wa'el*), and several terms for 'side' (*xujk* or *ts'eel*) are used relatively
  - Relative uses of these terms in Tseltal may be due to contact with Spanish.

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Tseltal: Cha'jkoma, Tenejapa

- Limited use of the relative FoR
  - half the uses documented were produced by dyad 1

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

Table 2. Ball & Chair participants in Ch'ajkoma

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

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Tseltal: Lum, Tenejapa

- Use of relative FoRs: 14%
  - as opposed to 9% in Ch'ajkoma
  - 10% of the Lum population are Spanish monolinguals
    - Cha'jkoma has 100% native speakers of Tseltal
- Four out of five pairs used relative FoRs at least once.
  - Pair 4: only pair to use 'left' and 'right' terms
    - Native and Spanish terms were used
  - use of relative FoRs accounts for 47% of their descriptions and 59% of all relative uses in the overall results.
- Speakers of pair 4 are neither the youngest nor the most educated
  - This suggests that bilingualism, a linguistic factor, may play a more important role in the use of relative FoRs than the non-linguistic factors of education and literacy.

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The distribution of the response variables

- the flow of the quantitative analysis
  - step I: identify the response variables that showed the greatest differentiation among participants
    - **response variables**
      - **the (frequency/probability of) use of each of the eight strategies we coded the data for**
  - step II: linear regressions to find the predictor variables significantly contributing to the variance
    - in those response variables identified in step I
    - **predictor variables:**
      - **L1, L2 use, literacy, education, (topography, population geography)**

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- 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

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- the similarity matrix (cont.)
  - Innovative approach
    - 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

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- how do the participants' responses cluster?
  - we ran a three-dimensional Multi-Dimensional Scaling (MDS) analysis of the similarity matrix
    - three dimensions produced a better goodness of fit than two
    - cf. Schiffman et al 1981

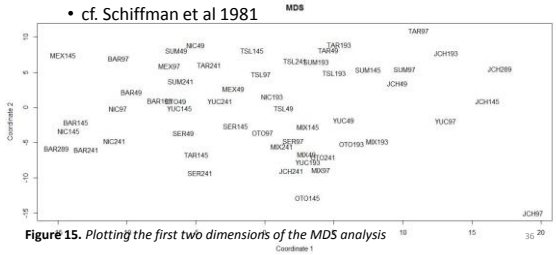

Figure 15. *Plotting the first two dimensions of the MDS analysis*

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MDS analysis (cont.)

- the first dimension of the MDS plot correlates positively with the frequency of geocentric descriptions…
  - » Spearman's Rho 0.88
- … and negatively with the frequency of relative descriptions
  - » Spearman's Rho -0.85

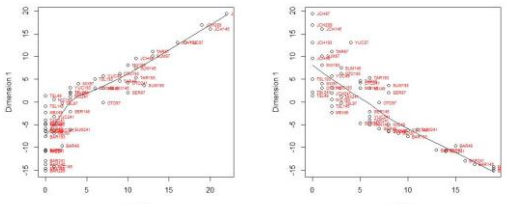

Figure 16. *Correlations between the first dimension of the MDS plot and the frequency of geocentric (left) and relative (right) descriptions.*

MDS analysis (cont.)

- the second dimension shows a very strong negative correlation with the frequency of topological description
  - – Spearman's Rho -0.99
- the third dimension exhibits a rather weak correlation with the frequency of intrinsic descriptions
  - Spearman's Rho 0.76

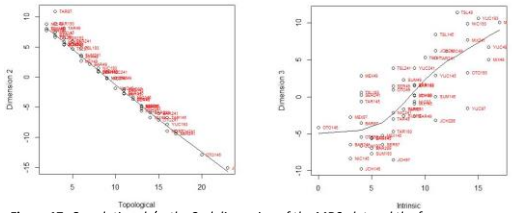

Figure 17. *Correlations b/w the 2nd dimension of the MDS plot and the frequency of topological descriptions (left) and b/w the 3rd and the frequency of intrinsic descriptions.*

MDS analysis (cont.)

- discussion
  - – the MDS analysis shows
    - that the participants differentiated themselves most strongly in their use of relative and geocentric frames of reference
      - – with the topological and intrinsic strategies as runners up
  - – 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)

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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

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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)**

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The impact of the predictor variables (cont.)

- summary of findings
  - see Appendix for details

regressed response variable / sample	L2 use as a predictor variable	probability of geocentric use	probability of relative use
L1-Spanish speakers	included	significant: L1 Spanish literacy	significant: L1 Spanish
	excluded	significant: literacy	**significant: L2 Spanish**

Synopsis

- Hypothesis
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- **Discussion and conclusions**
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The impact of the predictor variables (cont.)

- 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 finding conforms to the Neo-Whorfian predictions
  - 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-Whorfians' view of language as a transmission system for nonlinguistic cognition

The impact of the predictor variables (cont.)

- 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 affecting the use of geocentric FoRs, but not the use of relative FoRs
      - 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 Juchitán Zapotec and Sumu-Mayangna communities

Conclusions

- The data presented here suggest that not only do structural linguistic changes diffuse through language contact, but **practices of language use** do too
- To our knowledge, this study is the first to provide direct evidence of practices of language use diffusing through language contact

Acknowledgements

- we would like to thank
  - … our teachers and consultants, the speakers of the languages the MesoSpace team has been studying
  - … our colleagues, the members of the MesoSpace team
  - … the National Science Foundation, for the necessary resources to conduct these studies
  - … the institutions who have partnered with MesoSpace to lend us support, CIESAS and the MPI for Psycholinguistics
  - … Matthew Dryer, Jeff Good, Marianne Gullberg, Florian Jaeger, Jean-Pierre Koenig, Steve Levinson, David Mark, Wolfgang Wölck
    - and the members of the UB Semantic Typology Lab, for advice
  - … audiences at the *International Conference on Yucatecan Linguistics*, the *Workshop on Quantitative Methods in Areal Typology*, and Bielefeld University
    - for comments on previous presentations of some of the material
  - … you!

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References

Athanasopoulos, P. 2006. Effects of the grammatical representation of number on cognition in Bilinguals. Bilingualism: Language and Cognition 9(1): 89-96.

Athanasopoulos, P. 2009. Cognitive representation of colour in bilinguals: The case of Greek blues. Bilingualism: Language and Cognition 12(1): 83-95.

Bohnemeyer, J. (2011). Spatial frames of reference in Yucatec: Referential promiscuity and task-specificity. Language Sciences 33(6): 892–914.

Bohnemeyer, J. & S. C. Levinson. (ms). Framing Whorf: A response to Li et al. 2011. Cognition.

Bohnemeyer, J. & C. O'Meara. (2012). Vectors and frames of reference: Evidence from Seri and Yucatec. In L. Filipović & K. M. Jaszczolt (Eds.), Space and Time across Languages and Cultures. Amsterdam: John Benjamins.

Brown, P., & Levinson, S. C. 1992. 'Left' and 'right' in Tenejapa: Investigating a linguistic and conceptual gap. Zeitschrift für Phonetik, Sprachwissenschaft und Kommunikationsforschung, 45(6), 590-611

Brown, P., & Levinson, S. C. (1993). 'Uphill' and 'downhill' in Tzeltal. Journal of Linguistic Anthropology, 3(1), 46–74.

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. 167-198). Mahwah, NJ: Lawrence Erlbaum.

Brown, P., & Levinson, S. C. (2009). Language as mind tools: Learning how to think through speaking. In J. Guo, E. V. Lieven, N. Budwig, S. Ervin-Tripp, K. Nakamura, & S. Ozcaliskan (Eds.), Crosslinguistic approaches to the psychology of language: Research in the traditions of Dan Slobin (pp. 451-464). New York: Psychology Press.

Capistrán Garza, A. (2011). Locative and orientation descriptions in Tarascan: Topological relations and frames of reference. Language Sciences 33: 1006-1024.

Carlson-Radvansky, L. A. & D. E. Irwin. (1993). Frames of reference in vision and language: Where is above? Cognition 46: 223–244.

Danziger, E. (2010). Deixis, gesture, and cognition in spatial Frame of Reference typology. Studies in Language 34(1): 167–185.

Gelman, A. & J. Hill. (2007). Data Analysis Using Regression and Multilevel/Hierarchical Models. Cambridge University Press.

Gelman, A., Y. Su, M. Yajima, J. Hill, M. Grazia Pittau, J. Kerman & T. Zheng. (2012). arm: Data Analysis Using Regression and Multilevel/Hierarchical Models. R package version 1.5-03. http://CRAN.R-project.org/package=arm

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References (cont.)

Mishra, R.C., P. R. Dasen & S. Niraula. (2003). Ecology, language, and performance on spatial cognitive tasks. International Journal of Psychology 38: 366-383.

O'Meara, C. & G. Pérez Báez. (2011). Spatial frames of reference in Mesoamerican languages. Language Sciences 33: 837–852.

Pederson, E. (1993). Geographic and manipulable space in two Tamil linguistic systems. In A. U. Frank & I. Campari (Eds.), Spatial information theory. Berlin: Springer. 294–311.

Pederson, E., E. Danziger, D. P. Wilkins, S. C. Levinson, S. Kita & G. Senft. (1998). Semantic typology and spatial conceptualization. Language 74: 557–589.

Pérez Báez, G. (2011). Spatial frames of reference preferences in Juchitán Zapotec. Language Sciences 33: 943-960.

Piaget, J. & B. Inhelder. (1956). The child's conception of space. London: Routledge.

Polian, G., & Bohnemeyer, J. (2011). Uniformity and variation in Tseltal reference frame use. Language Sciences, 33, 868-891.

R Development Core Team. (2011). R: A Language and Environment for Statistical Computing, R Foundation for Statistical Computing, Vienna, Austria. URL http://www.R-project.org. ISBN 3-900051-07-0.

Terrill, A. & N. Burenhult. (2008). Orientation as a strategy of spatial reference. Studies in Language 32(1): 93–116.

Schiffman, S. S., M. L. Reynolds & F. W. Young. (1981). Introduction to multidimensional scaling: Theory, methods and applications. New York: Academic Press.

Vázquez Soto, V. (2011). The "uphill" and "downhill" system in Meseño Cora. Language Sciences 33: 981-1005.

Wassmann, J. & P. R. Dasen. (1998). Balinese spatial orientation: Some empirical evidence for moderate linguistic relativity. The Journal of the Royal Anthropological Institute 4(1): 689–711.

References (cont.)

Hernández-Green, N, E. L. Palancar, & S. Hernández-Gómez. (2011). The Spanish loanword lado in Otomi spatial descriptions. Language Sciences 33: 961-980.

Jackendoff, R. S. (1983). Semantics and cognition. Cambridge, MA: MIT Press.

Jackendoff, R. (1996). The architecture of the linguistic-spatial interface. In P. Bloom, M. A. Peterson, L. Nadel, & M. F. Garrett (Eds.), Language and space. Cambridge, MA: MIT Press. 1-30.

Jaeger, T. F. (2008). Categorical Data Analysis: Away from ANOVAs (transformation or not) and towards Logit Mixed Models. Journal of Memory and Language 59(4): 434–446.

Levinson, S. C. (1994). Vision, shape, and linguistic description: Tzeltal body-part terminology and object description. In S. C. Levinson & J. B. Haviland (Eds.), Space in Mayan languages. Special issue of Linguistics 32(4): 791-856.

Levinson, S. C. (1996). Frames of reference and Molyneux's Question: Crosslinguistic evidence. In P. Bloom, M. A. Peterson, L. Nadel & M. F. Garrett (Eds.), Language and space. Cambridge, MA: MIT Press. 109–169.

Levinson, S. C. (2003). Space in language and cognition. Cambridge, UK: Cambridge University Press.

Levinson, S. C., & Brown, P. (1994). Immanuel Kant among the Tenejapans: Anthropology as empirical philosophy. Ethos, 22(1), 3-41.

Levinson, S. C., Kita, S., Haun, D. B. M. & Rasch, B. H. 2002. Returning the tables. Cognition 84: 155-188.

Levinson, S. C. & S. Meira. (2003). 'Natural concepts' in the spatial topological domain - adpositional meanings in crosslinguistic perspective: An exercise in semantic typology. Language 79(3): 485–516.

Levinson, S. C. & D. P. Wilkins. (2006). Grammars of space. Cambridge: Cambridge University Press.

Li, P. & L. Gleitman. (2002). Turning the tables: Language and spatial reasoning. Cognition 83: 265-294.

Li, P., L. Abarbanell, L. Gleitman & A. Papafragou. (2011). Spatial reasoning in Tenejapan Mayans. Cognition 120: 33–53.

MacLaury, R. E. (1989). Zapotec body-part locatives: prototypes and metaphoric extensions. International Journal of American Linguistics 55: 119-154.

Majid, A., J. S. Boster & M. Bowerman. (2008). The cross-linguistic categorization of everyday events: A study of cutting and breaking. Cognition 109(2): 235–250.

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Synopsis

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Appendix: the linear regressions

- implementation
  - we used generalized linear mixed-effects models (GLMM; cf. Gelman & Hill 2007, Jaeger 2008)
    - 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

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

```
Generalized linear mixed model fit by the Laplace approximation
Formula: Lgeoc ~ (1 | ID) + (1 | LANG) + edu + Ltyp + lit
   Data: ..1
  AIC  BIC logLik deviance
 1784 1825   -885     1770
Random effects:
 Groups Name        Variance Std.Dev.
 ID     (Intercept) 1.77905  1.33381
 LANG   (Intercept) 0.15166  0.38944
Number of obs: 2463, groups: ID, 109; LANG, 11

Fixed effects:
            Estimate Std. Error z value Pr(>|z|)
(Intercept)  -2.9991     0.6077  -4.935 8.02e-07 ***
edu          -0.6906     0.4709  -1.467  0.14248
LtypESP      -3.0228     0.6907  -4.376 1.21e-05 ***
LtypMES       0.9009     0.5493   1.640  0.10099
lit           1.3133     0.5014   2.619  0.00881 **
---
Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1   1

Correlation of Fixed Effects:
        (Intr) edu    LtyESP LtyMES
edu      0.015
LtypESP -0.379 -0.133
LtypMES -0.830 -0.150  0.488
lit     -0.359 -0.864  0.051  0.309
```

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- 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

```
Generalized linear mixed model fit by the Laplace approximation
Formula: Lrel ~ (1 | ID) + (1 | LANG) + edu + Ltyp + lit
   Data: ..1
  AIC  BIC logLik deviance
 2208 2248  -1097     2194
Random effects:
 Groups Name        Variance Std.Dev.
 ID     (Intercept) 0.71834  0.84755
 LANG   (Intercept) 0.10877  0.32980
Number of obs: 2410, groups: ID, 110; LANG, 11

Fixed effects:
            Estimate Std. Error z value Pr(>|z|)
(Intercept)  -1.5700     0.4571  -3.435 0.000592 ***
edu          -0.1684     0.3021  -0.557 0.577328
LtypESP       1.3228     0.4367   3.029 0.002451 **
LtypMES      -0.5622     0.4069  -1.382 0.167073
lit           0.1261     0.3101   0.407 0.684163
---
Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1   1

Correlation of Fixed Effects:
        (Intr) edu    LtyESP LtyMES
edu     -0.144
LtypESP -0.401 -0.149
LtypMES -0.789 -0.094  0.568
lit     -0.312 -0.779  0.002  0.274
```

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

```
Generalized linear mixed model fit by the Laplace approximation
Formula: Lgeoc ~ (1 | ID) + (1 | LANG) + edu + Ltyp + esp + lit
   Data: BC.9Dec.newTseltal.noSpanish
  AIC  BIC logLik deviance
 1672 1710 -828.9     1658
Random effects:
 Groups Name        Variance Std.Dev.
 ID     (Intercept) 1.59743  1.26389
 LANG   (Intercept) 0.60968  0.78082
Number of obs: 1840, groups: ID, 81; LANG, 8

Fixed effects:
            Estimate Std. Error z value Pr(>|z|)
(Intercept)  -1.8847     0.9264  -2.034  0.04190 *
edu          -0.5401     0.4822  -1.120  0.26267
LtypMES       0.7504     0.7769   0.966  0.33415
esp          -0.5436     0.2823  -1.925  0.05420 .
lit           1.3009     0.4934   2.636  0.00838 **
---
Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1   1

Correlation of Fixed Effects:
        (Intr) edu    LtyMES esp
edu      0.087
LtypMES -0.733 -0.082
esp     -0.511 -0.240  0.029
lit     -0.241 -0.785  0.228 -0.037
```

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

```
Generalized linear mixed model fit by the Laplace approximation
Formula: Lrel ~ (1 | ID) + (1 | LANG) + edu + Ltyp + esp + lit
   Data: BC.9Dec.newTseltal.noSpanish
  AIC  BIC logLik deviance
 1428 1467 -707.1     1414
Random effects:
 Groups Name        Variance Std.Dev.
 ID     (Intercept) 0.46167  0.67946
 LANG   (Intercept) 0.13865  0.37236
Number of obs: 1840, groups: ID, 81; LANG, 8

Fixed effects:
            Estimate Std. Error z value Pr(>|z|)
(Intercept) -2.41519    0.52152  -4.631 3.64e-06 ***
edu         -0.19986    0.30713  -0.651   0.5152
LtypMES     -0.56041    0.40771  -1.375   0.1693
esp          0.43381    0.17372   2.497   0.0125 *
lit          0.06692    0.31463   0.213   0.8316
---
Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1   1

Correlation of Fixed Effects:
        (Intr) edu    LtyMES esp
edu      0.086
LtypMES -0.675 -0.067
esp     -0.545 -0.256 -0.016
lit     -0.246 -0.789  0.240 -0.030
```

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