Synopsis

- CogSci 2.0
- frame use: the sociophonetics of cognition
- the MesoSpace studies
- example: Talking Animals
- discussion
- a pan-simian geocentrism bias?
- challenges and new frontiers

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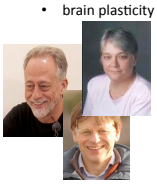
CogSci 2.0

Cognitive science 1.0:
rationalist foundational assumptions:
- innate knowledge
- symbolic processing
- modularity

Cognitive science 2.0:
empiricist turn; embrace of:
- culture-specificity
- individual variation
- brain plasticity



3

CogSci 2.0 (cont.)

- the empiricist turn in the cognitive sciences resembles a general dynamic in paradigm evolution
  - by which idealizations previously deemed necessary are made obsolete by empirical progress

4

CogSci 2.0 (cont.)

- looking for culture in cognition
  - sources of knowledge
    - nature – biological transmission

Figure 1. *Biological transmission*

    - nurture – cultural transmission

Figure 2. *Cultural transmission*

    - individual experience

Figure 3. *Individual experience*

5

CogSci 2.0 (cont.)

- culture-specificity in cognition
  - example I: ethnobotany
    - how many species of trees can you identify and name?
      - for more on Yucatec ethnobiology, cf. Atran et al (1999, 2001, 2003)

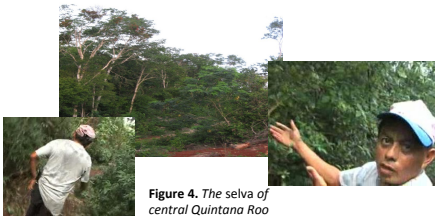


Figure 4. *The* selva *of central Quintana Roo*

6

- culture-specificity in cognition (cont.)
  - example II: "dead-reckoning"
    - how accurately can you point "home"
      - after having been taken to a windowless room in another town?

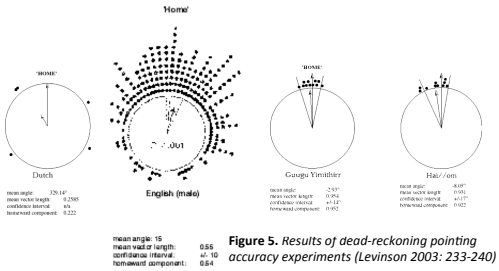


Figure 5. *Results of dead-reckoning pointing accuracy experiments (Levinson 2003: 233-240)*

- but just how deep does culture-specificity run in cognition?
- plus, the transmission problem: how would deep culture-specific ***cognitive practices*** be transmitted?
  - two contemporary views

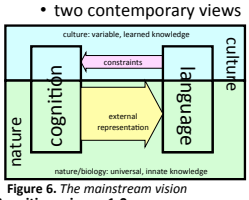


Figure 6. *The mainstream vision*

Cognitive science 1.0

- culture-specificity in cognition is shallow and irrelevant to theorizing how the mind works
- no deep transmission – observable behavior such as speech and gesture cannot "restructure" cognition

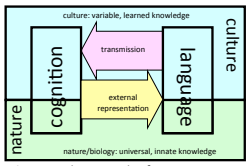


Figure 7. *The Neo-Whorfean vision*

Cognitive science 2.0

- the mind is a 'bio-cultural hybrid' (Evans & Levinson 2009)
- culture-specific cognitive practices are transmitted through observable behavior, including speech and gesture

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Frame use: the sociophonetics of cognition

- since the 1960s, sociolinguists have been modeling the pronunciation of certain sounds
  - as a function of social variables
    - such as age, sex, occupation, income, education, etc. (e.g., Labov 1966, 1972; Trudgill 1972, 1974; Wolfram 1969)

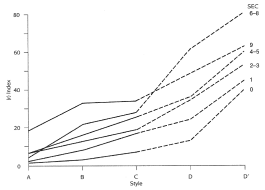

FIGURE 6.1. **Class Stratification for *r-t/, d/*.** (Labov 1972b:114)
Class stratification of a linguistic variable in process of change: (r) in *guard, car, beer, board, beard,* and so on. SEC (socioeconomic class) scale: 0–1, lower class; 2–4, working class; 5–6, 7–8, lower middle class; 9, upper middle class. A, casual speech; B, careful speech; C, reading style; D, word lists; D', minimal pairs.

Figure 8. *Distribution of consonantal pronunciation of final (r) in NYC by interview condition ("style") and socioeconomic class (Labov 1972: 114)*

- phonetic variables are for several reasons ideal for such studies
- in much the same way, **spatial reference frames** offer an ideal testing ground
  - for the study of the role of culture in cognition
  - cognitive axis ("coordinate") systems used to interpret 'projective' (Piaget & Inhelder 1956) spatial relations
    - in representations of location, motion, and orientation

- alternative classifications and subtypes

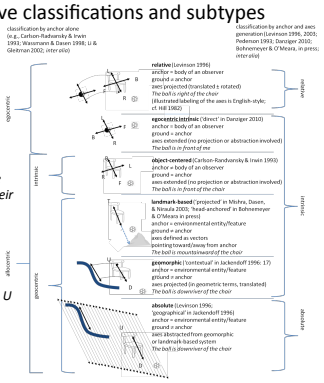

Figure 9. *Reference frame types and their classification (A - 'away from', B - 'back', D - 'downriver', F - 'front', L - 'left', R - 'right', T - 'toward', U - 'upriver'; Bohnemeyer & Levinson ms.)*

- what makes frame use such a great probing ground for the role of language, culture, and environment
  - reference frames are likely phylogenetically old in animal cognition and thus have a biological basis (Gallistel 1990)
  - considerable variation across human populations in the types of frames customarily used ***at the small scale***
  - a given population's linguistic preferences fairly narrowly predict its preferences in nonverbal tasks
    - Pederson et al 1998; Levinson 2003; Mishra et al 2003; Majid et al 2004; Haun et al 2011; Le Guen 2011; Bohnemeyer et al 2014
  - geocentric frames are sensitive to the environment
    - their axes are defined with respect to landmarks or gradients of the environment with varying levels of abstraction
      - Wassman & Dasen 1998; Levinson 2003; Polian & Bohnemeyer 2011; Bohnemeyer & O'Meara 2012; Palmer 2015).

- crosslinguistic variation

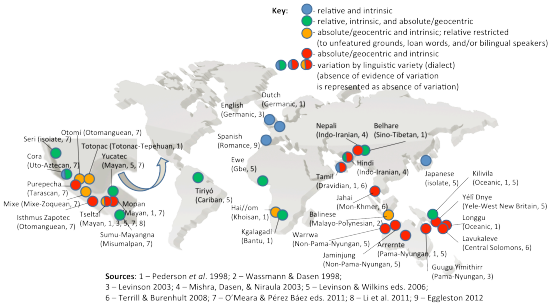

Figure 11. *Reference frame use in small-scale horizontal space across languages (Bohnemeyer & Levinson ms.)*

- two competing interpretations

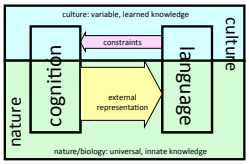

Figure 14. *The mainstream vision*

Non-Whorfian interpretation (Li & Gleitman 2002; Li et al 2011; *inter alia)*
- innate knowledge of all frame 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

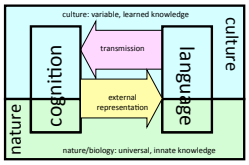

Figure 15. *The Neo-Whorfian vision*

Neo-Whorfian interpretation (Levinson 1996, 2003; Pederson et al 1998; *inter alia)*
- knowledge of some frame 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

- – all languages have the lexical and grammatical resources for using all major frametypes
  - in no case does the grammar or lexicon of the language constrain the use of particular frame types
  - a given speech community's preferences for using particular frame types are strictly a matter of usage

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

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

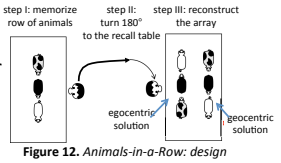

Figure 12. *Animals-in-a-Row: design*

Table 2. *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, Tzeltal, Longgu, Belhare, Tamil-Rural	*Prediction:* Non-verbal coding will be absolute	N= 99

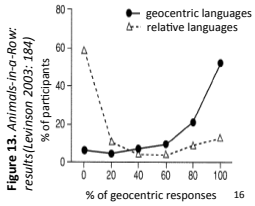

Figure 13. *Animals-in-a-Row: results(Levinson 2003: 184)*

- the forest, the trees, and statistics
  - adjudicating b/w neo- and non-Whorfian interpretations
    - presupposes isolating the effects of language, literacy, education, topography, etc., on the use of reference frames
  - the problem: many of these factors can co-vary
    - e.g., populations that speak different languages may also differ in their levels of education and literacy
      - and they will of course differ on geographic variables
  - the solution: larger population samples and multivariate statistics

Figure 16. *Seeing the forest for the trees*

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The MesoSpace studies

- MesoSpace I: *Spatial Language and Cognition in Mesoamerica* (NSF #BCS-0723694) (2007 – 2014)
  - sample (only datasets in bold have been analyzed; only those underlined contributed to group models)
    - 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**: Isthmus (Juchitán) Zapotec (G. Pérez)**; **Otomí (N. Hernández, S. Hernández, E. Palancar)**
    - Totonac-Tepehuan: Huehuetla Tepehua (S. Smythe)
    - Uto-Aztecan: Pajapan Nawat (V. Peralta)
    - isolates: Huave (S. Herrera); **Purépecha (A. Capistrán)**
    - Non-Mesoamerican neighbors: **Cora (V. Vázquez Soto)**; **Seri (C. K. O'Meara)**; **Sumu-Mayangna (E. Benedicto, A. Eggleston in collaboration with the Mayangna Yulbarangyang Balna)**
    - **Spanish: European, Mexican, Nicaraguan (R. Romero; H. Rodriguez; R. Moore; E. Benedicto, A. Eggleston)**

The MesoSpace studies (cont.)

- MesoSpace Ib: *Spatial Language and Cognition **beyond** Mesoamerica* (NSF #BCS-1053123) (2011 –)
  - sample (only datasets in bold have been analyzed; only those underlined contributed to group models)
  - new languages
    - **Bashkir (Turkic; T. Nikitina)**
    - Jahai (Mon-Khmer; N. Burenhult)
    - **Japanese (isolate; J. Olstad; 4 populations)**
    - Kujirerai (Jola; R. Watson)
    - **Mandarin (Sino-Tibetan; H. Hsiao)**
    - **Taiwanese (Sino-Tibetan; H. Hsiao, Y.-T. Lin; 2 populations)**
    - **Vietnamese (Mon-Khmer; J. Lovegren)**
    - Yurakaré (isolate, Bolivia; R. van Gijn and V. Hirtzel)
  - continuing languages
    - additional data has been collected from speakers of
      - Isthmus Zapotec (R. Moore) and Yucatec Maya (J. Bohnemeyer)

The MesoSpace studies (cont.)

- tools
  - **Ball & Cha**ir (photo stimuli, referential communication task)
  - **Talking Animals** (3-D toy animal stimuli, referential communication task)
  - **New Animals** (3-D toy animal stimuli, recall and recreate array of animals)

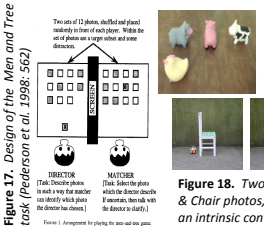

Figure 17. *Design of the Men and Tree task (Pederson et al. 1998: 562)*

Figure 18. *Two of the Ball & Chair photos, featuring an intrinsic contrast*

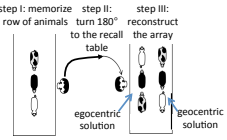

Figure 19. *One of four Talking Animals trials*

Figure 20. *Animals-in-a-Row: design (Pederson et al 1998)*

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The MesoSpace studies (cont.)

– a demographic questionnaire assessed the participants'…
- …level of education
- …frequency of use of a second language (L2)
- …frequency of reading and writing

–two geographic variables of the recording field sites
- topography
  - –a categorical variable classifying elevation and geomorphological patterns based on published map data (Hernández Santana et al 2007_
    - »and the Improved Hammond classification of landforms (ESRI 2011)
- population density
  - –calculated from
    - »the size of the community's population according to census data
    - »the size of the community's area according to Google Earth

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The MesoSpace studies (cont.)

- coding of the linguistic data
  - we coded descriptions of the location and orientation of the animals, distinguishing among eight categories
    - egocentric
      - egocentric intrinsic = direct (Danziger 2010)
      - egocentric extrinsic = relative (Levinson 1996)
    - allocentric
      - allocentric intrinsic
      - geocentric
        - » absolute or geomorphic
        - » based on an internal landmark (another animal as landmark)
        - » based on an external landmark
    - intrinsic-relative ambiguity
      - » i.e., the description is true of the same picture under both allocentric intrinsic and egocentric extrinsic interpretations
    - topological (no reference frame involved; Piaget & Inhelder 1956)

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The MesoSpace studies (cont.)

- the flow of the quantitative analysis
  - step I
    - our linguistic data is not suitable for multinomial regression
      - since a single description of a stimulus item can encode multiple propositions each employing a different reference frame
    - therefore, we ran multi-dimensional scaling (MDS) analyses
      - to determine the response types responsible for the greatest amount of variance in the data
      - these turned out to be the use of geocentric and relative frames (as predicted)

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The MesoSpace studies (cont.)

- the flow of the quantitative analysis (cont.)
  - step II: mixed-effects logistic regression models to find the significant predictor variables
    - driving the use of relative and geocentric frames
    - predictor variables (fixed effects): L1 (group), L2 use, reading, writing, education, topography, population density
    - intercepts or slopes (random effects): participant; individual language

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The MesoSpace studies (cont.)

- results

Domain	Design	Populations: language sample	Partici-pants	Significant effects (at p <.05/<.01)	Publication
Discourse	Referential communi-cation: *Ball & Chair*	**Mesoamerican**: Mixe; Otomí; Purépecha/ Tarascan; Tseltal; Yucatec; Zapotec; **Non-Mesoamerican**	112 (56 dyads)	L1 group/ area; L2 use; topography; pop.density	Bohne-meyer et al (2014, 2015)
Recall memory	Array recon-struction: *New Animals*	**Indigenous**: Seri, Sumu; **Indo-European:** Spanish – European vs. Mexican vs. Nicaraguan	127	L1 group/ area; topography; pop.density	Bohne-meyer et al (under revision)
Discourse	Referential communi-cation: *Talking Animals*	**Indo-European:** English; **isolate: Japanese**; **Mesoamerican**: Yucatec, Zapotec; **Southeast Asian:** Mandarin, Vietnamese	416 (208 dyads)	L1; literacy; pop.density	Bohne-meyer et al (in prep.)
Discourse	Referential communi-cation: *Talking Animals*	Mandarin, Taiwanese Southern Min	80 (40 dyads)	L1; L2 use; literacy; education; topography	Lin (in prep.)
Recall memory	Array recon-struction: *New Animals*	All of the above	228	L1 group/ area; pop.density topography	Bohne-meyer et al (in prep.)

Table 2. *MesoSpace regression models: summary of effects*

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Example: Talking Animals

- another referential communication task: Talking Animals (TA)
  - TA allows us to discover selection preferences for any of the FoR types
    - » at the small (personally manipulable) scale
  - advantages over previous tools employing photographs
    - » Men & Tree (M&T, Pederson et al 1998); Ball & Chair (B&C; Bohnemeyer et al 2014, 2015)
    - » 2D stimuli seem to slightly depress the use of geocentric frames
    - » M&T may for various reasons depress the use of intrinsic FoRs

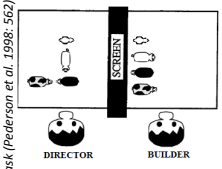

Figure 21. *Design of the Talking Animals task (Pederson et al. 1998: 562)*

Figure 22. *One of four Talking Animals trials*

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Example: Talking Animals (cont.)

- independent variables: language (L1; L2 use)
  - we modeled L2 use on a 3-point frequency scale
    - none > occasional > frequent
    - based on participants' responses to a questionnaire

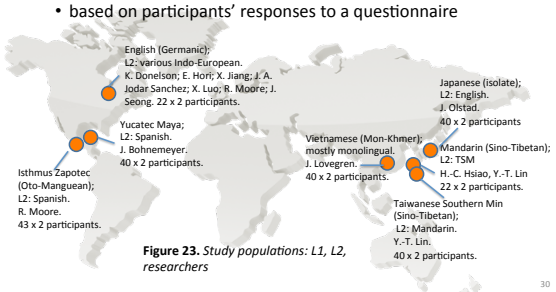

Figure 23. *Study populations: L1, L2, researchers*

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Example: Talking Animals (cont.)

- independent variables: literacy and education
  - education: 3-point scale
    - elementary school only > some secondary > any post-secondary
  - writing (frequency): 4-point scale
    - none > rarely > occasional > frequent/regular
    - no writing data was collected from the Vietnamese participants
  - reading (frequency): 4-point scale
    - none > rarely > occasional > frequent/regular
  - assessed again based on questionnaire responses

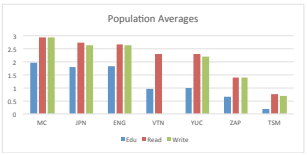


Figure 24. *Mean education and literacy scores by population*

Example: Talking Animals (cont.)

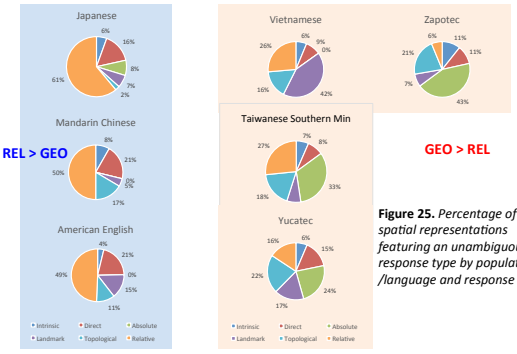
- independent variables: geography of the fieldsites
  - topography: geomorphic 'provinces'
    - 5-level categorical variable based on ESRI 2011
      - flat plains, hills, table lands, low mountains, high mountains
  - population density: log of inhabitants/km^2

Language	Locality	Country	Density	Density Log Scale	Topographic Classification
Japanese	Setagaya	Japan (Mainland)	15551	4.19	flat
Taiwanese Southern Min	Taipei	Taiwan	9949	4.00	flat
Mandarin Chinese	Taipei	Taiwan	9949	4.00	flat
Japanese	Naha	Japan (Okinawa)	8244	3.92	hills
English	Buffalo	United States	2569	3.41	flat
Japanese	Yomitan	Japan (Okinawa)	1200	3.08	hills
Taiwanese Southern Min	Tainan	Taiwan	855	2.93	flat
Vietnamese	Long Mỹ	Vietnam	406	2.61	flat
Japanese	Fujinomiya	Japan (Mainland)	339	2.53	low mountains
	Aizuwakamatsu	Japan (Mainland)	321	2.51	low mountains
	Nago	Japan (Okinawa)	293	2.47	low mountains
	Miyakojima	Japan (Okinawa)	268	2.43	hills
	Yonaguni	Japan (Okinawa)	58	1.76	hills
	Shisho	Japan (Mainland)	49	1.69	low mountains
Isthmus Zapotec	La Ventosa	Mexico	5	0.70	flat
	Juchitán de Zaragoza	Mexico	5	0.70	flat
Yucatec	Yaxley	Mexico	2	0.30	flat
	Felipe Carillo Puerto	Mexico	2	0.30	flat

Table 3. *Field sites by population density and geomorphology*

Example: Talking Animals (cont.)

- results: response strategies across populations



REL > GEO

GEO > REL

Figure 25. *Percentage of spatial representations featuring an unambiguous response type by population /language and response type*

Example: Talking Animals (cont.)

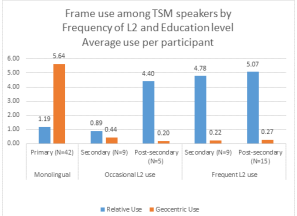
- results I: sans Taiwanese Southern Min speakers
  - we fitted binomial mixed-effects logistic regression models of the probability of use of two response types
    - relative (egocentric extrinsic) and geocentric frames
      - using the lme4 package in R
  - we eliminated the education factor from the models
    - since one model containing it failed to converge
      - and none of the others showed a significant education effect
    - due to the number of models we ran, we believe only effects at the $p < .01$ level should be fully trusted (Baayen 2008: 62)

Table 4. *Regression models of the Talking Animals data: summary of effects (Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1)*

Dependent variable	Literacy variable		Independent variables (fixed effects)				
	Writing	Reading	L1	L2 use	Literacy	Topography	Pop. density
Geocentric	Yes	No	*		•	•	*
	No	Yes	*	•	**	•	**
Relative	Yes	No	**		*		
	No	Yes	***		•	•	

Example: Talking Animals (cont.)

- these models exclude Taiwanese Southern Min (TSM) speakers
  - TSM speakers show a bimodal distribution of frame use by L2 (Mandarin) and Education levels
    - which distort the (polarity of the) coefficients in the multi-population models



Example: Talking Animals (cont.)

- modeling just the Taiwanese populations
  - produces significant effects of *language use*, education level, literacy (reading frequency), and topography
    - these models include random intercepts for L1
      - allowing us to infer that the usage effects include L2 contributions

Table 5. *Regression models of the Talking Animals data for the Taiwanese populations : summary of effects (Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1)*

Dependent variable	Literacy variable		Independent variables (fixed effects)					
	Writing	Reading	MC use	TSM use	Education	Literacy	Topography	Pop. density
Geocentric	Yes	No	***	**	***		*	
	No	Yes	***	**	**	**	**	
Relative	Yes	No	*	*	**			
	No	Yes	***		**	**		

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Discussion

- confirmed: L1 makes an irreducible contribution to spatial cognition
  - so does L2 use potentially
    - Mesoamericans are the more likely to use relate frames in their L1 the more frequently they use Spanish as L2
    - similarly, in Taiwan, Mandarin appears to act as a conduit for the diffusion of egocentrism
  - the effect of language on reference frame use does not appear to be epiphenomenal
- non-linguistic factors driving reference frame use
  - education, literacy, population density, topography
    - first quantitative demonstration of environment affecting cognition

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Discussion (Cont.)

- a new take: the **Linguist Transmission Hypothesis (LTH)**

Linguistic Transmission Hypothesis (LTH) – abstract formulation:
"Using a language or linguistic variety may facilitate the acquisition of cultural practices of nonlinguistic cognition shared among the speakers of the language."

  - more concretely:

Linguistic Transmission Hypothesis (LTH) – concrete formulation:
"The comprehension of utterances may provide clues to the cognitive practices involved in their production, and both the comprehension and the production of utterances may afford habituation to these cognitive practices. The cognitive practices so acquired may or may not subsequently be extended beyond the domain of speech production."

Discussion (Cont.)

- the basic idea
  - cognitive practices must "hitch a ride" on observable behaviors to be transmitted or diffused
  - language is one such behavior among others
    - e.g., co-speech gesture (Haviland 1979; Le Guen 2011); agricultural and religious practices (Bohnemeyer 2011)
  - not a new idea – cf. Levinson (2003: 315-325)

Synopsis

- CogSci 2.0
- frame use: the sociophonetics of cognition
- the MesoSpace studies
- example: Talking Animals
- discussion
- a pan-simian geocentrism bias?
- challenges and new frontiers

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A pan-simian geocentrism bias?

- a twist
  - Table 8 compares linguistic and recall memory data for **five** Spanish-speaking populations
    - including **three Mexican Spanish** ones
  - all and only those populations that preferred relative descriptions also preferred egocentric reconstructions
  - all other populations preferred geocentric reconstructions!

Community	B&C	#	%	NA	#	%
Santa Ines	Relative	49	34	Egocentric	42	58
	Intrinsic	24	17	Geocentric	28	39
	Geocentric	2	1			
San Miguel Balderas	Relative	50	17	Egocentric	10	24
	Intrinsic	133	46	Geocentric	22	52
	Geocentric	8	3			
Chimalacatlán	Relative	87	52	Egocentric	N/A	N/A
	Intrinsic	45	27	Geocentric	N/A	N/A
	Geocentric	4	2			
Rosita	Relative	84	35	Egocentric	41	33
	Intrinsic	81	34	Geocentric	73	58
	Geocentric	5	2			
Barcelona	Relative	131	45	Egocentric	63	75
	Intrinsic	61	21	Geocentric	14	17
	Geocentric	0	0			

Table 8: *Responses to the two tasks from members of five Spanish-speaking communities. A Fisher's exact test shows the distribution of egocentric and geocentric reconstructions across speakers from Barcelona, Santa Ines, Rosita, and San Miguel, to be highly significant (one-tailed p < .0001).*

A pan-simian geocentrism bias? (cont.)

- a twist (cont.)
  - similarly, Yucatec speakers show no clear overall bias for egocentric or geocentric descriptions in discourse
    - yet strongly prefer geocentrism in the recall memory task
      - cf. Bohnemeyer (2011); Le Guen (2011)

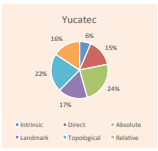

Figure 26. *Percentage of spatial representations featuring an unambiguous response type in the Yucatec TA responses*

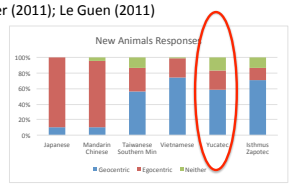

Figure 27. *New Animals response type frequency by L1*

A pan-simian geocentrism bias? (cont.)

- a possible explanation: a pan-simian innate bias for processing geocentric information
- supporting evidence
  - Haun et al (2006) conducted recall memory experiments with all Great Ape species and with German preschoolers
    - all populations committed more errors in egocentric than in geocentric conditions
  - developmental studies indicate early acquisition of geocentric terms in populations with a geocentric bias
    - Brown 2001; Brown & Levinson 2000, 2001; de León 1994
      - however, Cablitz 200? did not find this effect in Marquesan
- this geocentric bias would be readily supplanted by a learned, culturally transmitted preference
  - for using egocentric frames in small-scale space
  - since the primitives for computing reference frames of any type are the same: vectors, angles, and distances

A pan-simian geocentrism bias? (cont.)

- an evolutionary scenario: the conquest of small-scale space
  - in the course of hominid evolution, control of small-scale space gains in importance
    - with the advent of tool use and enclosed living spaces
  - the rise of small-scale space management boosts the cognitive efficiency of egocentrism
  - a possible turning point is the invention of writing
    - characters may be the first "objects" that have a canonical orientation in the horizontal defined egocentrically
  - as egocentrism rises, speech and gesture serve as the primary conduits of its cultural transmission

Synopsis

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Challenges and new frontiers

- spin-off studies
  - Kate Donelson: frame use and audience design
    - speakers' adaptations to hearers in frame use
      - in speakers of English and Tseltal
      - NSF Award #BCS-1430883
  - Randi Moore: frame use at the community level
    - applying the MesoSpace design to three Isthmus Zapotec communities
      - NSF Award #BCS-1264064
  - Yen-Ting Lin: frame use and bilingualism
    - evidence from bilingual Taiwanese Southern Min speakers supports the Linguistic Transmission Hypothesis
      - NSF Award #BCS-1551925

Challenges and new frontiers (cont.)

- desiderata
  - a topographic classification that is sufficiently fine-grained to pick up effects at the community level

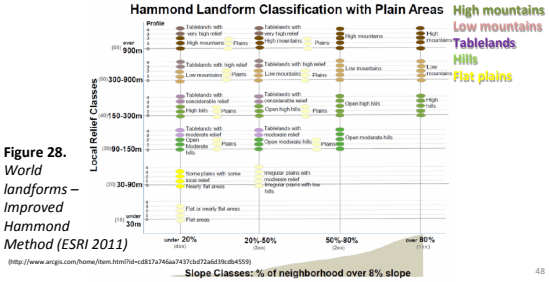

Figure 28. *World landforms – Improved Hammond Method (ESRI 2011)*

Challenges and new frontiers (cont.)

- desiderata (cont.)
  - a nonlinguistic measure of the cognitive salience of landmarks
    - Randi Moore is planning to work on this as part of her postdoc project
  - network variables rather than group variables as predictors
  - exploration of the effects of age and sex
  - analytical algorithms that are better equipped to deal with massively inhomogeneous distributions
  - a cultural history of egocentrism

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