

SEMANTIC AND COGNITIVE TRANSFER

CONCEPTS IN SOCIOCULTURAL SPACE AUSTRIAN ACADEMY OF SCIENCES MAY 12, 2023

Jürgen Katharine Yen-Ting **Bohnemeyer Donelson** Lin







SYNOPSIS

- the Linguistic Transmission Hypothesis
- linguistic evidence
- nonverbal cognition: alignment and mismatches
- areality and evolution
- conclusions

THE LINGUISTIC TRANSMISSION HYPOTHESIS

- as we communicate, we transmit
 - our intended messages
 - linguistic properties
 (phones, constructions, ...)
 - social identities
 - cultural practices, including
 cognitive practices



origins: the capsizing incident in Hopevale



Figure 1.1. JB gesturing the capsizing of the boat in 1980 (left) and 1982 (Haviland 1993: 15-16)

"I film this same Jack Bambi telling the story about how he was shipwrecked and swam miles to shore through the sharks. Watching my film, John Haviland realizes that he filmed Jack telling the same story two years before, and he goes and compares the films frame by frame. Despite the fact that Jack is facing west on the first telling and north on the second, the linguistic and gestural details of how the boat turned over, who jumped out where, where the big shark was and so on, match exactly in cardinal directions, not egocentric ones - the events are directionally anchored in all their detail in Jack's memory." (Levinson 2003: 5)

- the puzzle of cognitive transfer: how can practices of nonverbal cognition be transmitted and shared without telepathy?
 - the answer: carrier behaviors
 - e.g., in the example of the capsizing narrative, co-speech gesture



L generalizes that S may be the conventional approach to P in the community and tests this hypothesis in further observations

Figure 1.2. Cognitive transfer through carrier behaviors

- by hypothesis, carrier behaviors allow
 - the members of a community to converge on cognitive practices
 - the diffusion of cognitive practices between communities

illustration: the gender effect in Yucatec cardinal directions use

Table 1.1. Knowledge of spatial direction terms assessed by asking participants to identify as left-handed or right-handed and to point to surrounding villages in various directions (Le Guen 2011: 914)

English Gloss	Male Answers in % $(n = 11)$	Female Answers in $\%$ ($n = 9$)
"right (hand)"	100	66.7
"left (hand)"	100	55.6
"east"	90.9	22.2
"west"	81.8	0
"north"	63.6	33.3
"south"	54.5	0
_	English Gloss ''right (hand)'' ''left (hand)'' ''east'' ''west'' ''north'' ''south''	English Gloss (n = 11) ''right (hand)'' 100 ''left (hand)'' 100 ''east'' 90.9 ''west'' 81.8 ''north'' 63.6 ''south'' 54.5

- cardinal directions are used in this community to
 - orient the walls of buildings
 - orient the boundaries of *milpa* swiddens
 - orient food offerings on an altar
 - all of which are practiced mostly by men (Bohnemeyer 2011)

 language as carrier behavior: the Linguistic Transmission Hypothesis (LTH; Bohnemeyer et al. 2014, 2015)

Linguistic Transmission Hypothesis: (i) Practices of nonverbal cognition are transmitted and diffused via observable carrier behaviors from which they can be inferred; consequently, (ii) language contact may facilitate the diffusion of such practices across populations and (iii) language acquisition may facilitate the habituation to such practices.

First language acquisition: Habituation to cognitive practices associated with the use of L_A ; *linguistic scaffolding* effects



(Bohnemeyer 2020: 6)

- the LTH and linguistic relativity
 - the LTH predicts that
 - language and gesture are not the sole channels of cognitive transfer
 - rather, they share this capacity in principle with all observable cultural practices
 - however, language and gesture are particularly powerful channels of cognitive transfer because of
 - their extraordinary versatility as representational engines
 - the frequency with which we use them
 - the fact that they are themselves (socially shared) cognitive systems (unlike, say, ritual or agricultural practices)

SYNOPSIS

- the Linguistic Transmission Hypothesis
- linguistic evidence
- nonverbal cognition: alignment and mismatches
- areality and evolution
- conclusions

LINGUISTIC EVIDENCE

a test case: spatial frames of reference



Figure 2.1. Reference frames and anchors

Table 2.1. Exemplifying reference frame types with respect to Figure 2.1

Frame type	Anchor	Description of Figure 1
Egocentric	Observer	The ball is right of the chair
Geocentric	Environmental gradient	The ball is east of the chair
Object-centered intrinsic	Reference entity (ground)	The ball is in front of the chair

Figure 2.2. 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.)



egocentric

allocentric

10

- Study I: Mesoamerica
 (Bohnemeyer et al. 2014, 2015)
 - does frequency of L2 Spanish use predict relative frame use in the indigenous L1?
 - sample



Figure 2.3. MesoSpace I field sites

Table 2.2. MesoSpace I sample populations(Bohnemeyer et al. 2015: 183)

Linguistic variety	Genealogical affiliation	Membership in the Meso- american area	Field site(s)	Researcher(s)
East Highlands Mixe	Mixe-Zoquean	Yes	Ayutla, Oaxaca, Mexico	R. Romero Méndez
Isthmus Zapotec	Oto-Manguean	Yes	La Ventosa, Oaxaca, Mexico	G. Pérez Báez
P'urhépecha (Tarascan)	isolate	Yes	Santa Fe de la Laguna, Michoacán, Mexico	A. Capistrán Garza
San Ildefonso Tultepec Otomí	Oto-Manguean	Yes	San Ildefonso Tultepec, Querétaro, Mexico	M.S. Hernández Gómez; N. Hernández Green; E.L. Palancar
Seri	Isolate	No	El Desemboque del Rio San Ignacio, Sonora, Mexico	C. O'Meara
Spanish European	Romance	No	Barcelona, Cataluña, Spain	E. Benedicto; A. Eggleston
Mexican			Chimalacatlán, Morelos, Mexico	S. Herrera; H. Rodriguez; R. Moore
Nicaraguan			Rosita and Siuna; Las Minas area, North Atlantic Autonomous Region, Nicaragua	A. Eggleston
Sumu-Mayangna	Misumalpan	No	Rosita, Las Minas area, North Atlantic Autonomous Region, Nicaragua	E. Benedicto; A. Eggleston; The Mayangna Yulbarangyang Balna
Tseltal	Mayan	Yes	Chacoma, Chiapas, Mexico	G. Polian
Yucatec	Mayan	Yes	Yaxley and Felipe Carrillo Puerto, Quintana Roo, Mexico	J. Bohnemeyer

- Study I: Mesoamerica (cont.)
 - method: Ball & Chair (B&C)
 referential communication task

Table 2.3. Ball & Chair participants(Bohnemeyer et al. 2015: 184)

Linguistic variety	Dyads	Age < 30 / ≥ 30	Sex м / ғ	
Tseltal (MA)	Chacoma, Chiapas	5	7/3	6/4
Yucatec (ма)	Yaxley, Quintana Roo	4	2/6	4/4
	Felipe Carrillo Puerto, Quintana Roo	1	0/2	1/1
East Highlands Mixe (мА)	Ayutla, Oaxaca	5	3/7	3/7
Otomí (MA)	San Ildefonso Tultepec, Querétaro	4	o/8	1/7
Isthmus Zapotec (ма)	La Ventosa, Oaxaca	6	4/8	3/9
Tarascan (мА)	Santa Fe de la Laguna, Michoacán	5	4/6	4/6
Seri (NMA)	El Desemboque, Sonora	5	1/9	2/8
Sumu (NMA)	Rosita and Siuna, RAAN ⁴	5	2/8	5/5
Mexican Spanish	Chimalacatlán, Morelos	5	6/4	3/7
Nicaraguan Spanish	Rosita and Siuna, RAAN	4	o/8	2/6
European Spanish	Barcelona, Cataluña	4	2/6	1/7
Total		53	31/75	35/71

Figure 2.5. B&C 2.2, 4.2, 2.1 (from left) and a Tarascan (P'urhépecha) sample response to 4.2. Karháwa erákuteni 'upward' is a geomorphic relator



Figure 2.4. Design of picture matching tasks: Men & Tree (Pederson et al. 1998: 562)



Pelóta karháwa erákuteni, tátsepani, ximá pí-ťa-ku-ni. ball up toward behind there approach-side-LOC.EXP-NF 'The ball [is] in an upward direction, behind [the chair], there approaching the wall.' CAPISTRÁN-GARZA, 2011: 1022

- Study I: Mesoamerica (cont.)
 - results: descriptive



Figure 2.6. Frequency of response types by language in descriptions locating the ball vis-à-vis the chair (Linguistic varieties: BAR–European Spanish (Barcelona); JCH– Isthmus Zapotec (Juchitán de Zaragoza); MEX–Mexican Spanish; MIX–South Highlands Mixe; NIC–Nicaraguan Spanish; OTO–San Ildefonso Tultepect Otomí; SER– Seri; SUM–Sumu Mayangna; TAR–Tarascan; TSE–Tseltal; YUC–Yucatec Maya; Response types: AMB–ambiguous; TOP–topological (frame-free); INT–allocentric intrinsic; VERT–vertical geocentric; GEO–horizontal geocentric; DIR–egocentric intrinsic (direct); REL–egocentric extrinsic (relative)) (Bohnemeyer et al. 2015: 187)

- Study I: Mesoamerica (cont.)
 - results: modeling
 - confirmed: the speakers of the indigenous
 languages used relative frames the more
 frequently *in their L1* the more frequently they used Spanish as an L2
 - suggesting that Spanish is a conduit for the transmission of relative frame use in Mesoamerica

Table 2.4. Generalized linear mixed-effects regression models predicting the use of geocentric and relative frames in the second and fourth trials of four (each trial involving 12 pictures). Models including L2-Spanish frequency excluded L1-Spanish speakers. The LANGUAGE GROUP variable had three levels: MESOAMERICAN, NON-MESOAMERICAN INDIGENOUS (baseline), SPANISH. EDUCATION made no significant contribution to any of the models, and removing it as a variable from the models improved the AIC. (Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.') (Bohnemeyer et al. 2015: 191)

Variables		Models				
		1	2	3	4	
Dependent Independent	Geocentric Relative L2-Spanish use incl.	1	\ \	1	\ \	
Results	Language group L2-Spanish use Literacy	***		***	***	
	Topography Population Density	*		*		

- Study I: Mesoamerica (cont.)
 - results: modeling (cont.)
 - further probing Conditional Inference Tree for Ball and Chair -1-Language shows complex p < 0.001 {JCH, MIX, OTO, SER, SUM, TAR, TSL, YUC} {BAR, MEX, NIC} 9 -2 interactions with Language Language p < 0.001 p < 0.001 {MIX, OTO, SER, SUM, YUC} {JCH, TAR, TSL} MEX {BAR, NIC} 6 10 <u>21</u> n = 768 -3 language, Literacy Literacy Literacy p < 0.001p = 0.043p = 0.001y = 0.052literacy, and 4 n = 120 n = 108 7 8 11 -12 n = 144 n = 636 n = 264 Education y = 0.933y = 0.549p = 0.043y = 0.824y = 0.746y = 0.189education 20 L2Use n = 192p = 0.001y = 0.37514 15 n = 96 Language y = 0.125p < 0.001 {SER, YU({MIX, OTO, SUM} 16 19 Population.Density n = 144p < 0.001 y = 0.167 Figure 2.7. Conditional inference tree model ≤ 1.989 > 1.989 -17-4 18 n = 72 (Hothorn et al. 2006, using the Party and Ranger n = 48 y = 0.708y = 0.361packages in R) predicting the use of relative frames based on data from all four trials.

- Study II: Taiwan (Lin 2017)
 - does frequency of Mandarin use in bilingual Min Nan speakers predict relative frame use?
 - populations

Table 2.5. Study populations	s of Lin (2017) (Lin 2022: 166)
------------------------------	---------------------------------

		Monoli	nguals	Bilinguals			
		Taiwanese Min Nan (TMN)	Mandarin Chinese (MC)	TMN–MC sequential bilinguals	Simultaneous bilinguals		
Ν		42	29	38	41		
Age (18–92)		73.11 (6.93)	22.07 (3.45)	50.34 (18.66)	29.08 (14.45)		
Education (0–2)		0 (0.00)	2 (0.00)	1.51 (0.50)	1.93 (0.26)		
Frequency of language	MC	-	_	1.63 (0.48)	2 (0.00)		
use (0–2)	TMN	-	_	1.71 (0.45)	1.48 (0.50)		
Language proficiency	MC	-	_	7.92 (1.77)	8.7 (0.6)		
(1-10)	TMN	-	-	7.96 (1.21)	5.42 (1.85)		
Literacy (0–3)	Reading	0.51 (0.50)	3 (0.00)	2.89 (0.31)	2.90 (0.30)		
	Writing	0.51 (0.50)	2.83 (0.53)	2.47 (0.75)	2.90 (0.30)		

- Study II: Taiwan (cont.)
 - method: Talking Animals referential communication task

Figure 2.8. Layout of the four trials of the Talking Animals referential communication task



- Study II: Taiwan (cont.)
 - results: descriptive

Figure 2.9. Response type frequencies by population (TSM - monolingual Min Nan speakers; TMB - Sequential bilinguals (L1 Min Nan); TSB - Simultaneous bilinguals; TMC - Monolingual Taiwanese Mandarin speakers) (Lin 2017: 84)



- Study II: Taiwan (cont.)
 - results: modeling

Table 2.6. Generalized linear mixedeffects regression models predicting the use of geocentric and relative frames in responses of the bilingual participants (Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.') (Lin 2017: 89)

 confirmed: bilinguals are the more likely to use relative frames the more frequently they use Mandarin



 suggesting that Mandarin is a conduit for the transmission of relative frame use in Taiwan

SYNOPSIS

- the Linguistic Transmission Hypothesis
- linguistic evidence
- nonverbal cognition: alignment and mismatches
- areality and evolution
- conclusions

NONVERBAL COGNITION: ALIGNMENT AND MISMATCHES

- evidence of linguistic transmission in nonverbal cognition: Study III (Bohnemeyer et al. ms.) Table 3.1. Participants in the New Animals (red)
 - does L1 predict frame use in recall memory?
 - sample



Figure 3.1. Population sample of the New Animals recall memory study (Bohnemeyer et al. in prep.)

and Talking Animals studies (Bohnemeyer et al. in prep.)

Speech community	Linguistic area	Country Researcher where tested		N participants tested in recall memory study (Experiment 1)		N participants tested in discourse study (Experiment 2)		Totals	
English	N/A	U.S.	K. T. Donelson; J. A. Jódar Sánchez; R. E. Moore; J. Seong	Male 5	Female 10	<u>Male</u> 24	e <u>Female</u> 19	58	
Japanese Isthmus Zapotec	N/A Mesoamericar	Japan Mexico	J. <u>Olstad</u> G. Pérez Báez; R. E. Moore	<u>32</u> 7	15 9	26 24	14 65	87 105	
Mandarin Chinese	Southeast Asian	Taiwan	HC. Hsiao YT. Lin	9	17	7	22	55	
Taiwanese Min Nan Bilingual	Southeast Asian	Taiwan	YT. Lin	8	19	4	38	69	
Mandarin	Asian	Taiwan	YT. Lin	15	15	1/	21	04	
Vietnamese	Southeast Asian	Vietnam	J. Lovegren	2	15	26	54	97	
Yucatec Maya	Mesoamericar	Mexico	J. Bohnemeye	2	7	41	39	89	
Totals			-	78	105	173	276	632	

- Study III (Bohnemeyer et al. ms.) (cont.)
 - method: New Animals recall memory task



Figure 3.3. Design: New Animals array reconstruction task

Cf. Levinson 2003: 156-158, 338-339; Pederson et al 1998

- Study III (Bohnemeyer et al. ms.) (cont.)
 - results: modeling
 - confirmed: language predicts frame use in recall memory
 - suggesting we acquire the cognitive practices
 - for which our L1s
 serve as carrier behaviors

Figure 3.4. Variable importance scores based on Random Forest model (Breiman 2001) (top) and Conditional Inference Tree model (Hothorn et al. 2006) predicting egocentric reconstructions in the New Animals recall





- Study IV: "mismatches" (Bohnemeyer et al. 2022)
 - if language is a conduit for the transmission of nonverbal frame use, what about populations w/o a clear linguistic bias?
 - method: meta-study

Figure 3.5. Mismatches between verbal and nonverbal behavior in individual populations (Bohnemeyer et al 2022). : AIAR -Animals In A Row; B&C - Ball & Chair; CR -Chips Recognition task; M&T -Men & Tree; NA - New Animals; R -140.0% 120.0% 100.0% Relative usage frequency; RC - Route 80.0% 60.0% Completion; TA - Talking Animals. 40.0%





Legend

& Tree & Chair Talking AIAR Animals

- Study IV: "mismatches" (cont.)
 - results: populations w/o a clear linguistic preference for an extrinsic frame type prefer geocentric or allocentric strategies in nonverbal encoding

Figure 3.5. Mismatches between verbal and nonverbal behavior in individual populations (Bohnemeyer et al 2022). : AIAR - Animals In A Row; B&C - Ball & Chair; CR - Chips Recognition task; M&T - Men & Tree; NA - New Animals; R - Relative usage frequency; RC - Route Completion; TA - Talking Animals.





SYNOPSIS

- the Linguistic Transmission Hypothesis
- linguistic evidence
- nonverbal cognition: alignment and mismatches
- areality and evolution
- conclusions

AREALITY AND EVOLUTION

- evolutionary interpretation
 - egocentric/relative frame use is an optimal adaptation for small-scale space



Figure 4.1. Different types of spatial reference frames are optimally suited for different domains of use (Bohnemeyer et al. in prep.)

 evolutionary interpretation: the importance of small-scale space has steadily grown throughout human history



- evolutionary interpretation (cont.)
 - three sources of evidence
 - typological distribution
 - "mismatches" (cf. above)
 - developmental and primate studies: Haun et al. (2006);
 Nardini et al. (2016); Shusterman & Li (2016)

Figure 4.3. Reference frame use in small-scale horizontal space across speech communities. The names of the MesoSpace sample languages are in purple (Bohnemeyer et al. in prep.)



- evolutionary interpretation (cont.)
 - a twist: what Donelson et al. (2012) presented as a possible
 Mesoamerican areal bias in favor of geocentric frames
 - appears to be actually a local "snapshot" of a universal tendency

Figure 4.3. Reference frame use in small-scale horizontal space across speech communities. The names of the MesoSpace sample languages are in purple (Bohnemeyer et al. in prep.)



SYNOPSIS

- the Linguistic Transmission Hypothesis
- linguistic evidence
- nonverbal cognition: alignment and mismatches
- areality and evolution
- conclusions

CONCLUSIONS

- if minds are "bio-cultural hybrids" (Evans & Levinson 2009) then how are practices of nonverbal cognition transmitted?
 - the answer *must be* observable carrier behaviors that permit inferences to underlying cognitive practices
 - including, but not restricted to, language and co-speech gesture

ACKNOWLEDGMENTS

- This material is based upon work supported by the National Science Foundation under Grant BCS-1053123
 - Spatial language and cognition beyond Mesoamerica
- we gratefully acknowledge
 - the contribution of the participants in our studies
 - advice from Erika Bellingham, Eve Danziger, Matthew Dryer, Alice Gaby, Jeff Good, Marianne Gullberg, Florian Jaeger, Jean-Pierre Koenig, Steve Levinson, David Mark, Gunter Senft, Wolfgang Wölck
 - and the members of the UB Semantic Typology Lab
- and thank YOU for listening <a>e

REFERENCES

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

- Bohnemeyer, J. (2020). Linguistic relativity: From Whorf to now. In Gutzmann, D., L. Matthewson, C. Meier, H. Rullmann, & T. E. Zimmermann (eds.), *The Blackwell companion to semantics*. London: Blackwell.
- Bohnemeyer, J., A. Alshehri, J. Blythe, L. Cerqueglini, E. Danziger, K. Donelson, A. Eggleston, A. Gaby, Y.-T. Lin, J. Lum, R. Moore, T. Nikitina, & H. Stoakes. (2022). Reference frames in language and cognition: Cross-population mismatches. *Linguistics Vanguard* 8(s1): 175-189.
- Bohnemeyer, J., K. T. Donelson, R. Tucker, E. Benedicto, A. Capistrán Garza, A. Eggleston, N. Hernández Green, M. Hernández Gómez, S. Herrera Castro, C. K. O'Meara, E. Palancar, G. Pérez Báez, G. Polian & R. Romero Méndez. 2014. The cultural transmission of spatial cognition: Evidence from a large-scale study. In P. Bello, M. Guarini, M. McShane & B. Scassellati (eds.), Proceedings of the 36th Annual Conference of the Cognitive Science Society. Austin, TX: Cognitive Science Society. 212–217.
- Bohnemeyer, J., K. T. Donelson, R. E. Moore, E. Benedicto, A. Eggleston, C. K. O'Meara, G. Pérez Báez, E. Palancar, G. Polian & R. Romero Méndez. (2015). The contact diffusion of linguistic practices. *Language Dynamics and Change* 5(2). 169–201.
- Bohnemeyer, J., K. T. Donelson, Y.-T. Lin, R. Moore, H.-S. Hsiao, J. A. Jódar Sánchez, J. Lovegren, J. Olstad, G. Pérez Báez & J. Seong. (In prep.) Evidence of an ongoing worldwide shift toward egocentric reference frames. Manuscript, University at Buffalo.
- Breiman, L. (1984). Classification and regression trees. Belmont, CA: Wadsworth International Group.

Breiman, L. (2001). Random forests. Machine Learning 45(1): 5-32.

- Donelson, K. T., J. S. Lovegren, E. Benedicto, A. Capistrán Garza, A. Eggleston, N. Hernández Green, M. Hernández Gómez, C. K. O'Meara, E.
 Palancar, G. Pérez Báez, G. Polian, R. Romero Méndez, R. E. Tucker, & J. Bohnemeyer. (2012). In search of areal effects in semantic typology: Reference frames in Mesoamerica. *Quantitative Approaches to Areal Linguistic Typology*; Royal Dutch Academy of Sciences.
- Evans, N. & Levinson, S. C. (2009). The myth of language universals: language diversity and its importance for cognitive science. *Behavioral and Brain Sciences 32*: 429–48.

Haviland, J. B. (1993). Anchoring, iconicity, and orientation in Guugu Yimithirr pointing gestures. Journal of Linguistic Anthropology 3(1): 3–45.

- Hothorn, T., K. Hornik, & A. Zeileis. (2006). Unbiased recursive partitioning: A conditional inference framework. *Journal of Computational and Graphical Statistics* 15 (3): 651–674.
- Le Guen, O. 2011. Speech and gesture in spatial language and cognition among the Yucatec Mayas. Cognitive Science 35: 905–938.

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

- Lin, Y.-T. (2017). Spatial language and cognition in bilingual minds: Taiwan as a test case. Buffalo: University at Buffalo PhD Dissertation.
- Lin, Y.-T. (2022). The Influence of Language, Culture, and Environment on the Use of Spatial Referencing in a Multilingual Context: Taiwan as a Test Case. *Linguistics Vanguard* 8(s1): 161–73.

Thanks!