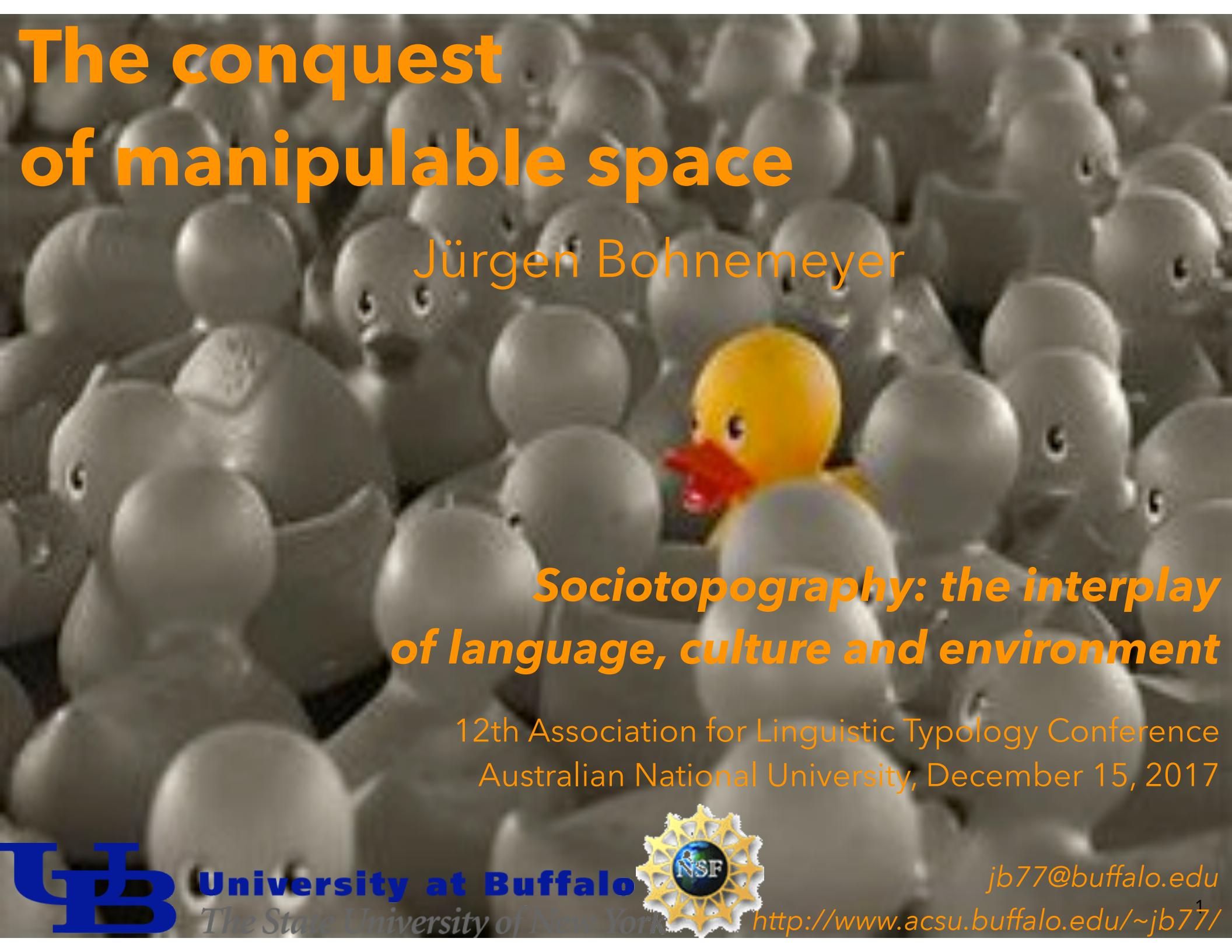
The conquest of manipulable space

Jürgen Bohnemeyer



Sociotopography: the interplay of language, culture and environment

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SYNOPSIS

- The innate geocentrism bias hypothesis: Haun et al 2006
- Addressing objections
- New evidence I: distribution
- New evidence II: imperfect alignment
- The cultural evolution of small-scale space
- Summary

THE INNATE GEOCENTRISM BIAS HYPOTHESIS: HAUN ET AL 2006

- rationalist assumptions…

"Similarly, our geographical knowledge, even our commonest knowledge of the position of places, would be of no aid to us if we could not, by reference to the sides of our body, assign to regions the things so ordered and the whole system of mutually relative positions." (Kant 1991 [1768]: 29; cited after Levinson & Brown 1994: 4)

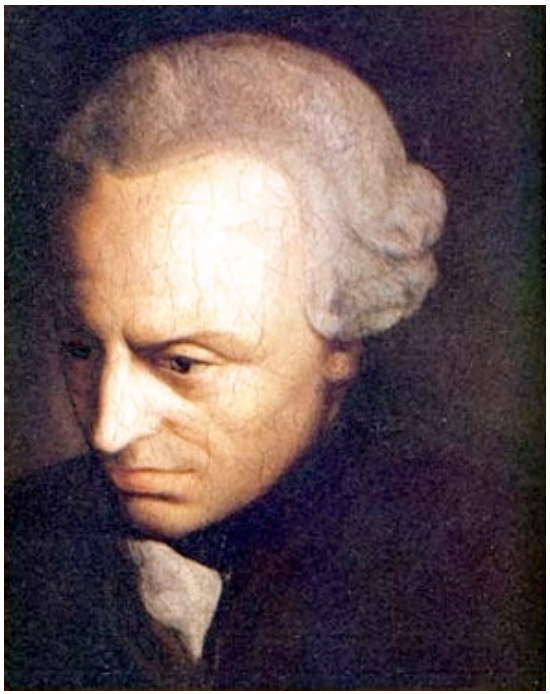


Figure 1.1. *Immanuel Kant (1724-1804) (Wikimedia Commons)*

- … meet empirical evidence: Haun et al (2006): Experiment 1
  - frame use in modern humans
    - participants: four populations (at 12 p'ants each)
      - Dutch vs. ≠Akhoe Hai‖om; children vs. adults
    - method: combined recall memory and inference task

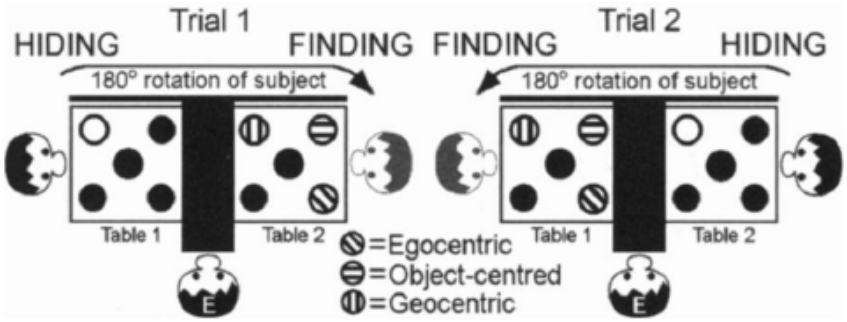
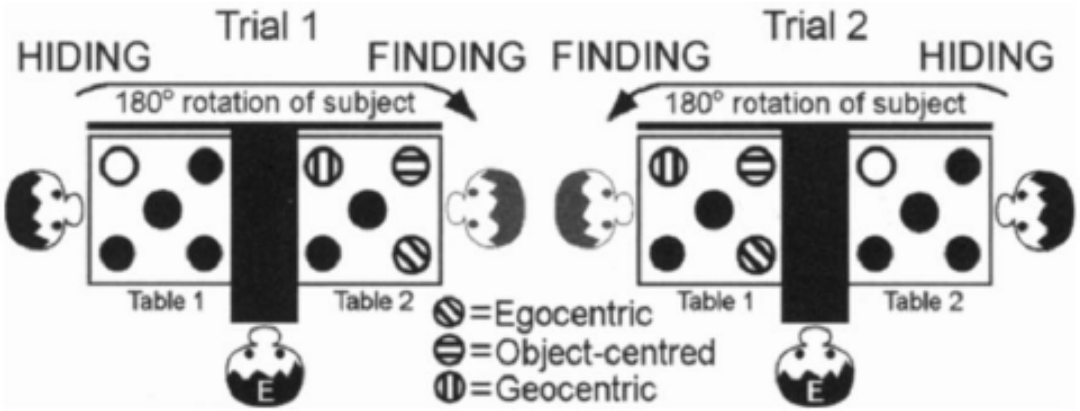


Fig. 1. Experiment 1: Experimental setup in two consecutive example trials. Ten exactly identical cups were placed on two tables (five cups on each table). Participants were watching while a target was hidden under the cup depicted as white (HIDING). Then the participants moved to the other table and indicated where they thought a second target might be hidden (FINDING). The three differently striped cups show the different contingencies rewarded in the three consecutive blocks of trials.

Figure 1.2. *Design of the first experiment (Haun et al 2006: 17569)*

- Haun et al (2006): Experiment 1 (cont.)



  - three within-subject conditions:
    egocentric, geocentric, object-centered
  - 10 trials per condition,
    administered in counter-balanced lists
  - transitions between blocks were unmarked
  - the question was how many trials would the participants need to adjust to a new condition following a transition

- Haun et al (2006): Experiment 1 (cont.)
  - results

Figure 1.3. *Findings of the first experiment (Haun et al 2006: 17570)*

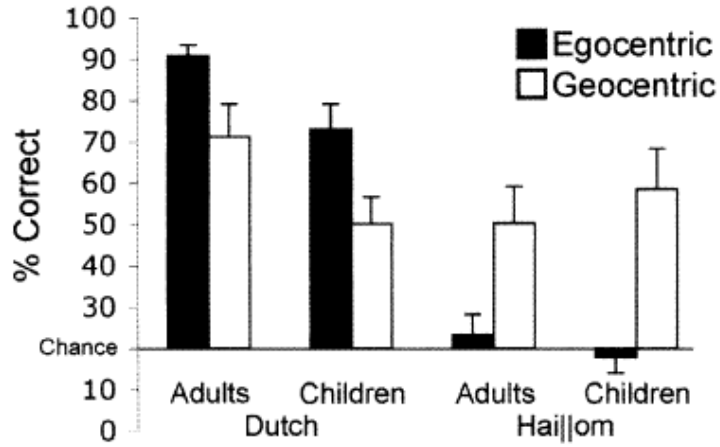


Fig. 2. Mean percentage correct (±SE) for the egocentric and geocentric conditions for both adults and children in the Dutch and Hai||om communities. Means are plotted against chance level (20%, one of five cups).

- Dutch adults and kids were significantly more successful in the egocentric condition
- Hai||om adults and kids were significantly more successful in the geocentric condition
  - in the egocentric condition, adults performed barely above and children below chance

- Haun et al (2006): Experiment 2
  - frame use in human and non-human primates
    - method: simplified version of that of Experiment 1 with 3 cups per table instead of 5
      - accordingly, the geocentric and object-centered conditions are collapsed
        - into a single allocentric conditions

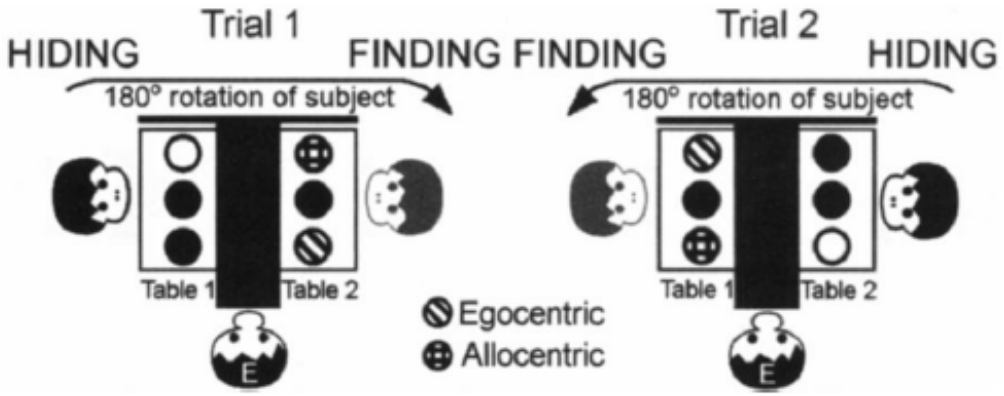


Figure 1.4. *Design of the second experiment (Haun et al 2006: 17570)*

- Haun et al (2006): Experiment 2 (cont.)
  - participants
    - human: 12 German preschool kids (6m, 6f, mean age = 4;10, range = 4;10 to 4;11)
    - nonhuman: 3 orangutans, 2 gorillas, 3 bonobos, 5 chimpanzees
      - 4m, 9f; 8-28 yoa. (M = 14;2 SD = 6;9)
      - all nonhuman great apes were housed at the Wolfgang Köhler Primate Research Center
        - at Zoo Leipzig

- Haun et al (2006): Experiment 2 (cont.)

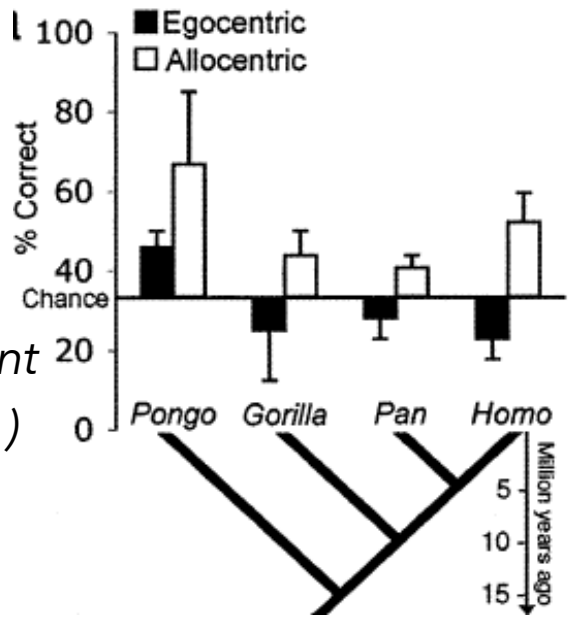


Figure 1.5. *Findings of the second experiment (Haun et al 2006: 17571)*

- findings
  - all groups performed significantly better in the geocentric condition
  - in the egocentric condition, only the Orangutans performed above chance level

- Haun et al carried out a further simplified version of the second experiment with non-human participants only
  - and found the results confirmed
  - in response to these findings, Haun et al formulate the **Pan-Simian Geocentrism Bias Hypothesis** (PSGBH)

"The standard methods of comparative cognition suggest a common phylogenetic inheritance of a preference for allocentric over egocentric spatial strategies from the ancestor shared by all four genera. This conclusion upsets the Kantian assumption of the priority of egocentric spatial reasoning, but it does so on firm empirical grounds. This inherited bias toward the allocentric coding of spatial relations can be overridden by cultural preferences, as in our own preference for egocentric or relative spatial coding." (Haun et al 2006: 17572)

- a precedent for the notion that cultural evolution can override innate biases: Dehaene et al (2008)
  - whereas G.E.I.R.D. adults map numbers to linear scales,
    - G.E.I.R.D. infants, non-G.E.I.R.D. adults, and animals map numbers to logarithmic scales
      - 'G.E.I.R.D' instead of Henrich et al's (2010) 'W.E.I.R.D'
        - ~~Western,~~ *Globalized*, Educated, Industrialized, Rich, Democratic

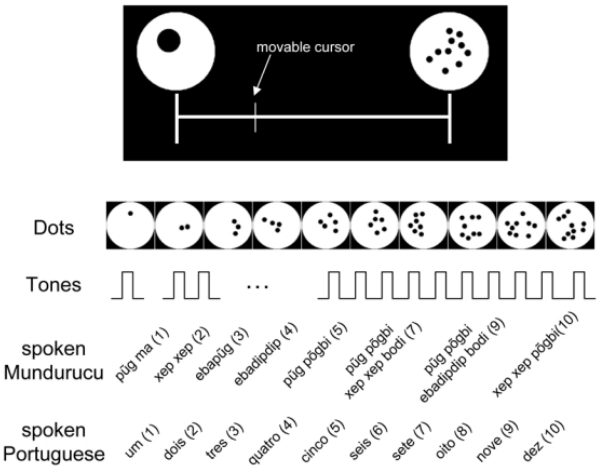


Figure 1.6. *Number mapping task design (Dehaene et al 2008: 1217)*

THE INNATE GEOCENTRISM BIAS HYPOTHESIS: HAUN ET AL 2006 (CONT.)

- goals of this presentation
  - address two possible objections against the PSGBH
  - present new evidence in support of the PSGBH from typology and the behavior of bilinguals
  - propose a possible scenario for the cultural evolution of egocentrism in modern humans

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ADDRESSING OBJECTIONS

- Objection I: egocentrism must be innate in all higher animals since perception is inherently egocentric
  - Gallistel (1990, 2002)
  - response: true! BUT…
    - … this doesn't mean that spatial information is encoded egocentrically in central cognition

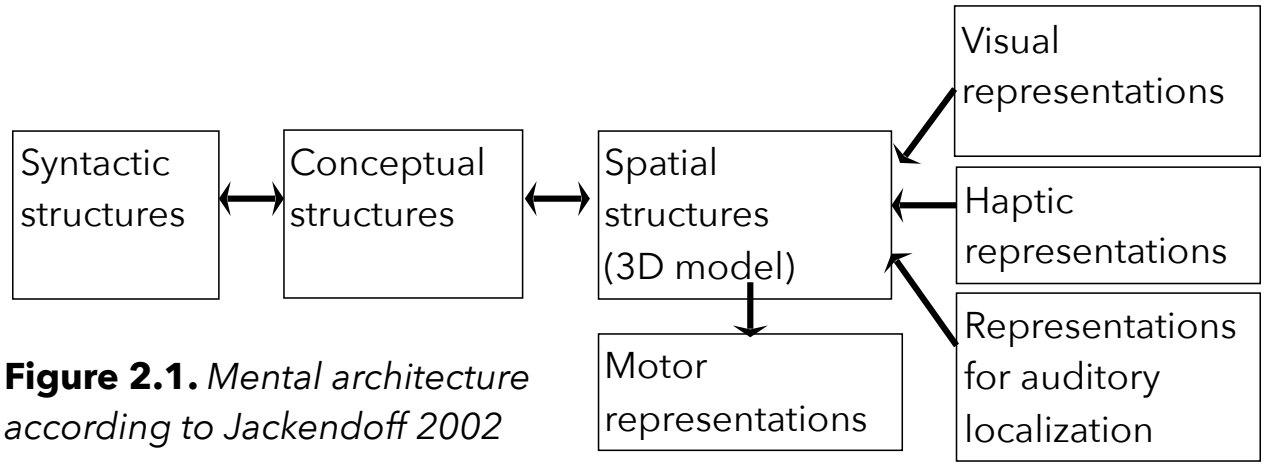

Figure 2.1. *Mental architecture according to Jackendoff 2002*

- Objection II: adult and child speakers of Tseltal Maya are equally successful at solving egocentric and geocentric tasks
  - even though Tseltal speakers prefer geocentric frames
    - Li et al (2011); Li & Abarbanell (2018)
  - response: Li and colleagues' egocentric tasks can be solved using *intrinsic* egocentric frames

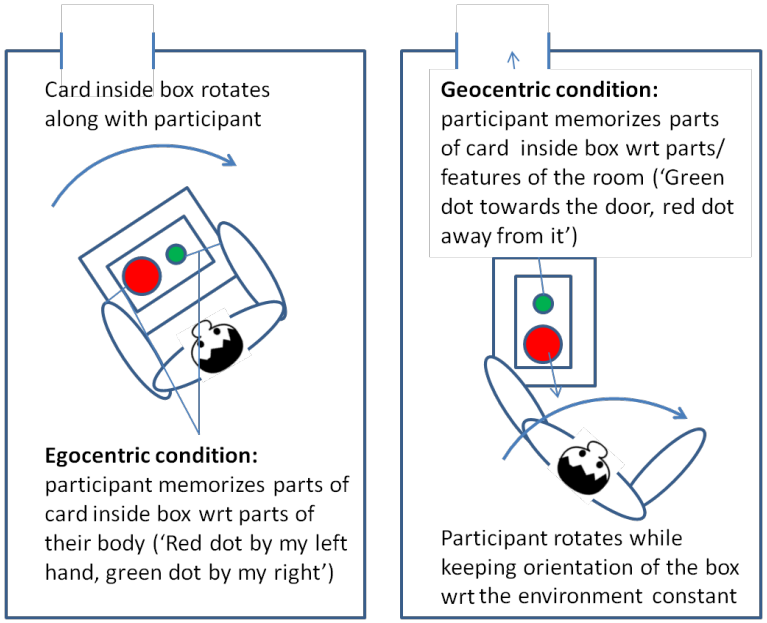

Figure 2.2. *Anchor points for spatial memory in Experiment 1 of Li et al 2011 (Bohnemeyer & Levinson ms.)*

- such 'direct' (Danziger 2010) frames are intrinsic in Levinson's (1996, 2003) classification
  - intrinsic frames may well be available universally

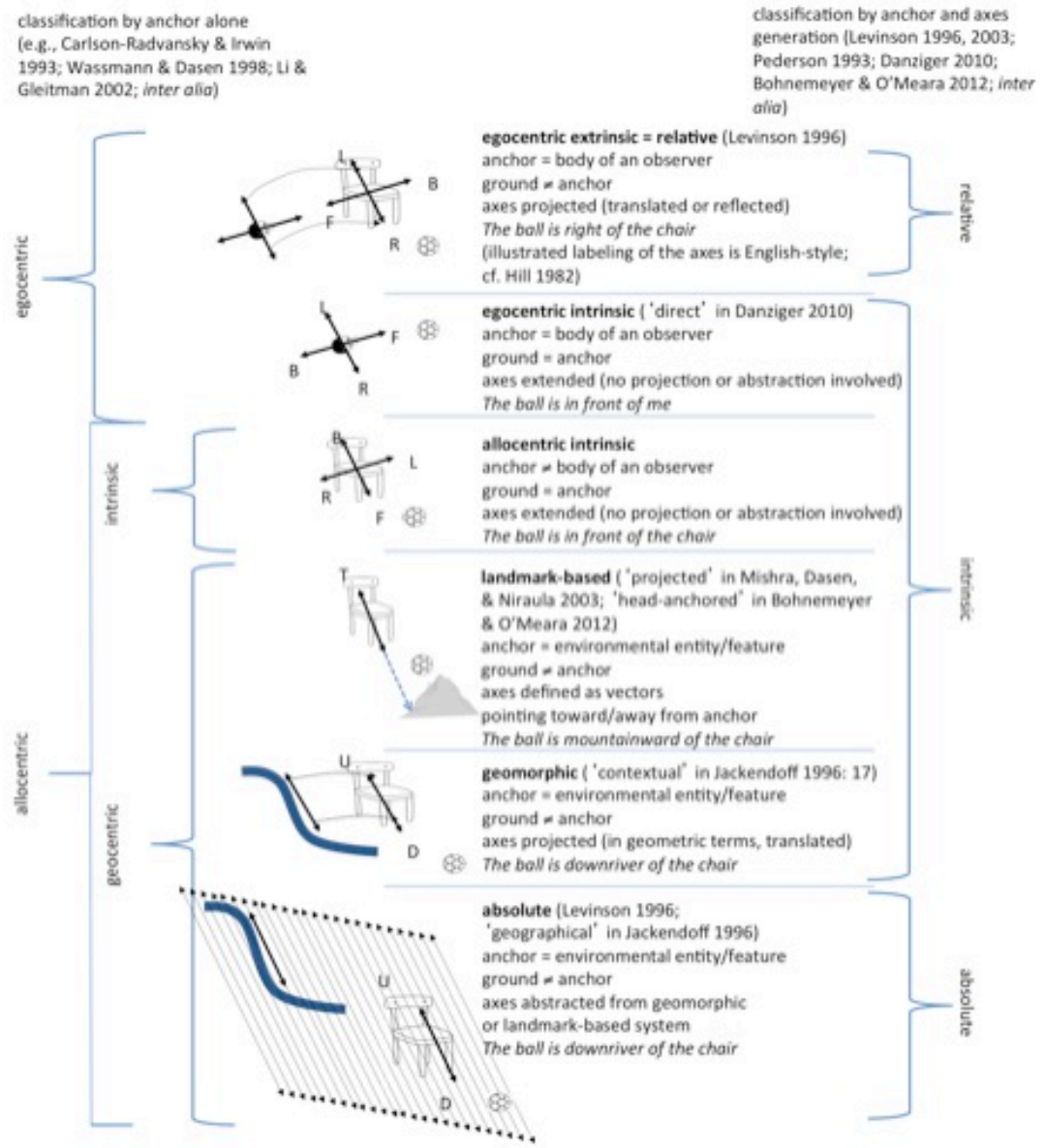

Table 2.1. *A fine-grained classification of frame types*

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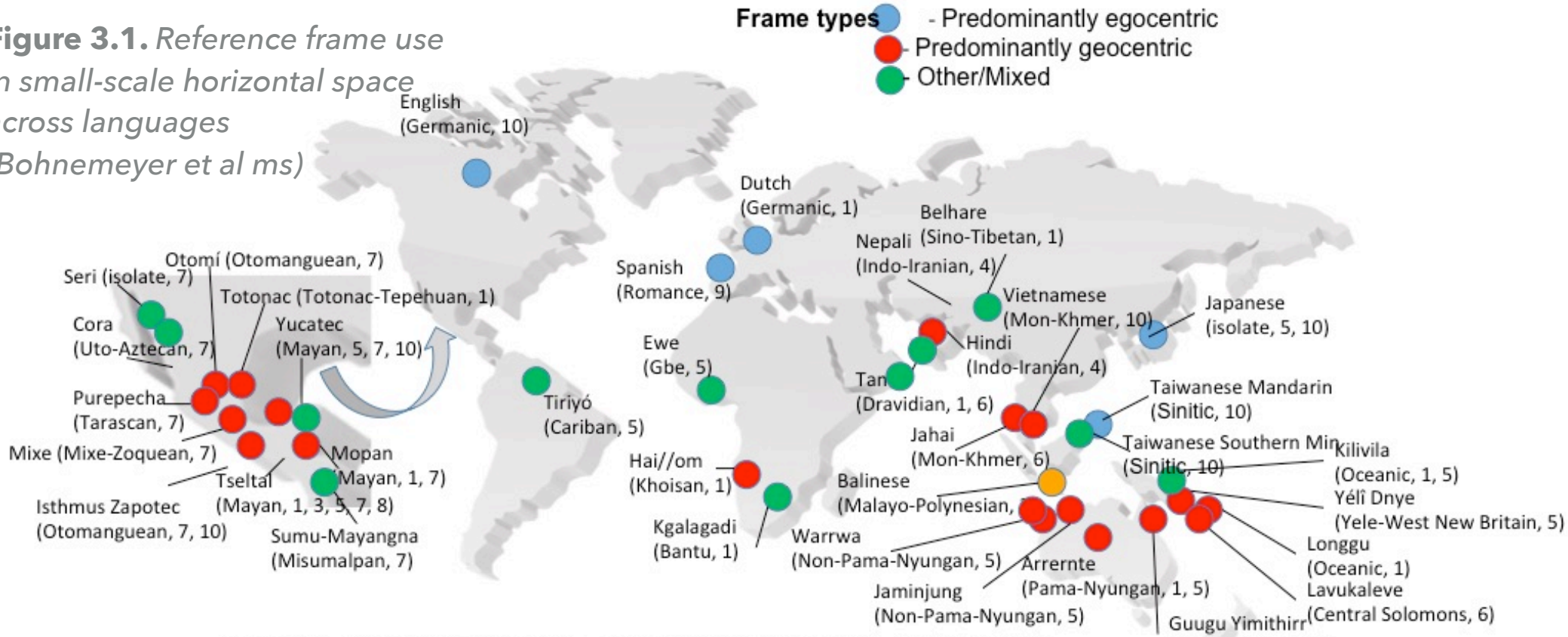
NEW EVIDENCE I: DISTRIBUTION

- strikingly, preferences for egocentrism in small-scale space appear to be restricted to G.E.I.R.D. societies

Figure 3.1. *Reference frame use in small-scale horizontal space across languages (Bohnemeyer et al ms)*



Sources: 1 – Pederson *et al*. 1998; 2 – Wassmann & Dasen 1998; 3 – Levinson 2003; 4 – Mishra, Dasen, & Niraula 2003; 5 – Levinson & Wilkins eds. 2006; 6 – Terrill & Burenhult 2008; 7 – O' Meara & Pérez Báez eds. 2011; 8 – Li et al. 2011; 9 – Eggleston 2012; 10 – Bohnemeyer et al ms.

- Li & Gleitman (2002) take this skewed distribution as evidence for frame use being driven by
  - education, literacy, and environmental factors
  - enter MesoSpace
    - *Spatial Language and Cognition in/beyond America*; NSF award no.s BCS-0723694 and BCS-1053123
      - studying the "sociophonetics" of space

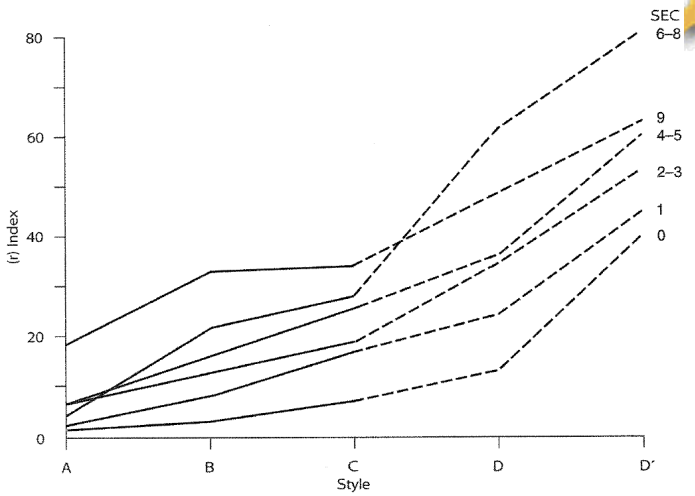


FIGURE 6.1. Class Stratification for /-r/. (Labov 1972b:114)
Class stratification of a linguistic variable in process of change: (r) in *guard, car, beer, beard, board,* and so on. SEC (socioeconomic class) scale: 0–1, lower class; 2–4, working class; 5–6, 7–8, lower middle class; 9, upper middle class. A, casual speech; B, careful speech; C, reading style; D, word lists; D', minimal pairs.

Figure 2.9. *Distribution of consonantal pronunciation of final (r) in NYC by interview condition ("style") and socioeconomic class*

- the MesoSpace approach: the "sociophonetics" of cognition
  - collect data on reference frame use in discourse and nonverbal cognition from multi-population samples
    - samples are composed "strategically" out of populations balanced in terms of predictor variables
    - recruitment proceeds by L1, testing/recording as many participants per population as is feasible

- the MesoSpace approach (cont.)
  - mixed-effects regression models
    - regressing the probability of use of a given strategy against the proposed predictors
      - population variables: L1 (group)
      - field site variables:
        topographic profile (ESRI); population density
      - participant variables: L2 usage frequency; reading/writing frequency; formal education level(; age; sex)
        - as assessed via questionnaire responses
          checked against researcher estimates

- the MesoSpace approach (cont.)
  - mixed-effects regression models (cont.)
    - include random intercepts for participant, item(, L1)
    - latest twist: exhaustive model comparison
      - slogging through more than 800 models of discourse data from 440 speakers (4600 observations)
      - attempting to find the best-performing models
        - and studying the performance of particular factors in particular combinations

- MesoSpace results (executive summary)
  - L1 (group) is generally the most robust predictor
  - literacy and population density
    likewise tend to be strong predictors
  - topography, age, L2 use play more circumscribed roles
  - cf. Bohnemeyer et al (2012, 2014, 2015, under revision, ms.); Eggleston 2012; Lin (2017); Moore et al (2015); Moore & Bohnemeyer (under revision)

NEW EVIDENCE I: DISTRIBUTION (CONT.)

- how does the PSGBH account for the skewed typological distribution of egocentric (specifically, relative) frame use?
  - preview: there are factors present in G.E.I.R.D. societies
    - that specifically favor the evolution and transmission of egocentrism

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NEW EVIDENCE II: IMPERFECT ALIGNMENT

- in general, a community's dominant strategy in discourse
  - has been found to predict that community's dominant strategy in nonverbal cognition

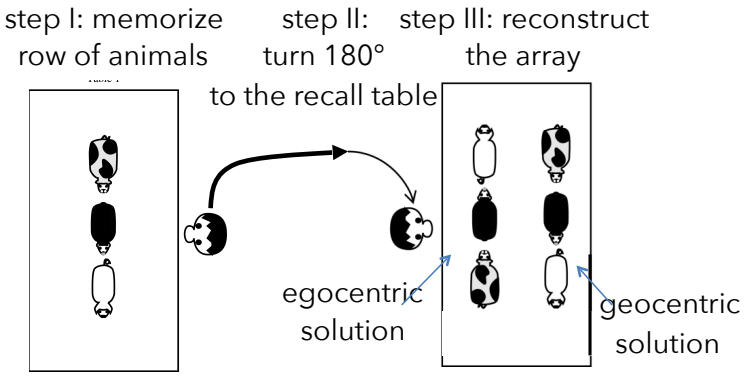

Table 5.1. *Animals-in-a-Row in Levinson 2003: the large sample*

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

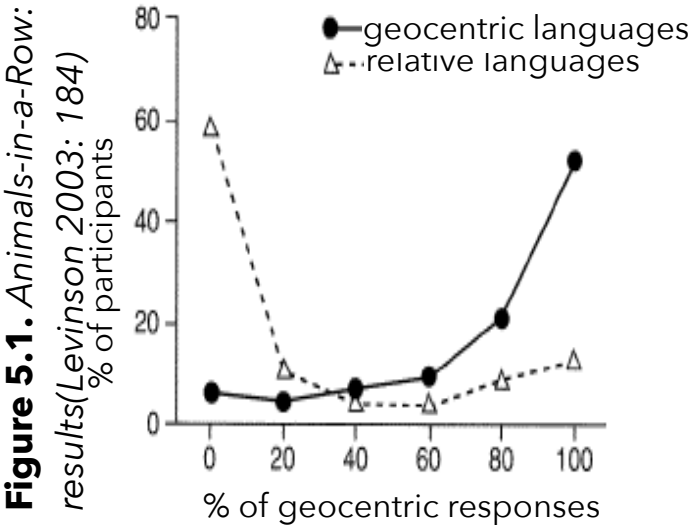

Figure 5.1. *Animals-in-a-Row: results(Levinson 2003: 184)*

- however, there are a few exceptions
  - exception I: populations that show a preference for (allocentric) intrinsic frames in discourse
    - Pederson et al (1998) report this for Kilivila (Austronesian; PNG) and Mopan (Mayan; Belize)
      - in both cases, there is evidence of a geocentric bias in the nonverbal tasks (Danziger 2001; Senft 2001)
        - although at least in the Mopan case, the pattern appears to be task-specific
    - unpublished evidence from Murrinhpatha (Southern Daly?; NT, Australia) points in the same direction
      - cf. Gaby, Blythe, & Stoakes (under revision)

- exception II: Yucatec - “anything goes/all of the above” in discourse, but robust geocentric bias in recall memory
  - Bohnemeyer (2011); Bohnemeyer & Stolz (2006); Le Guen (2011); Bohnemeyer et al (ms.)
  - Le Guen (2011) proposes that geocentrism is transmitted in this population thru gesture not speech
    - but Le Guen’s gesture data was not collected at the same scale as his linguistic data

- the Yucatec Talking Animals data (Bohnemeyer et al ms.)

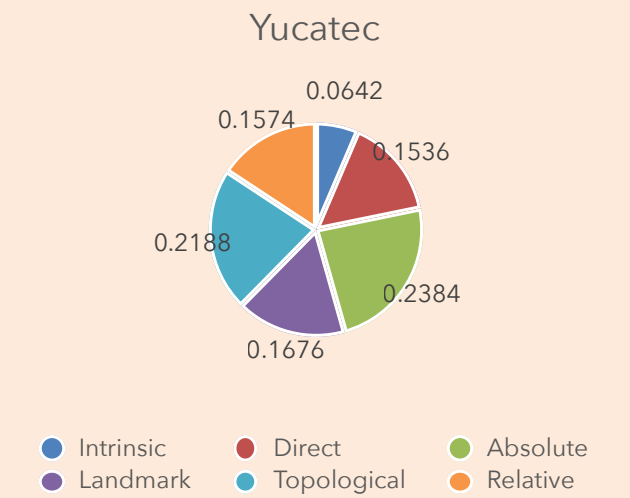

Figure 5.2. *Percentage of spatial representations featuring an unambiguous response type in the Yucatec TA responses (N = 40x2)*

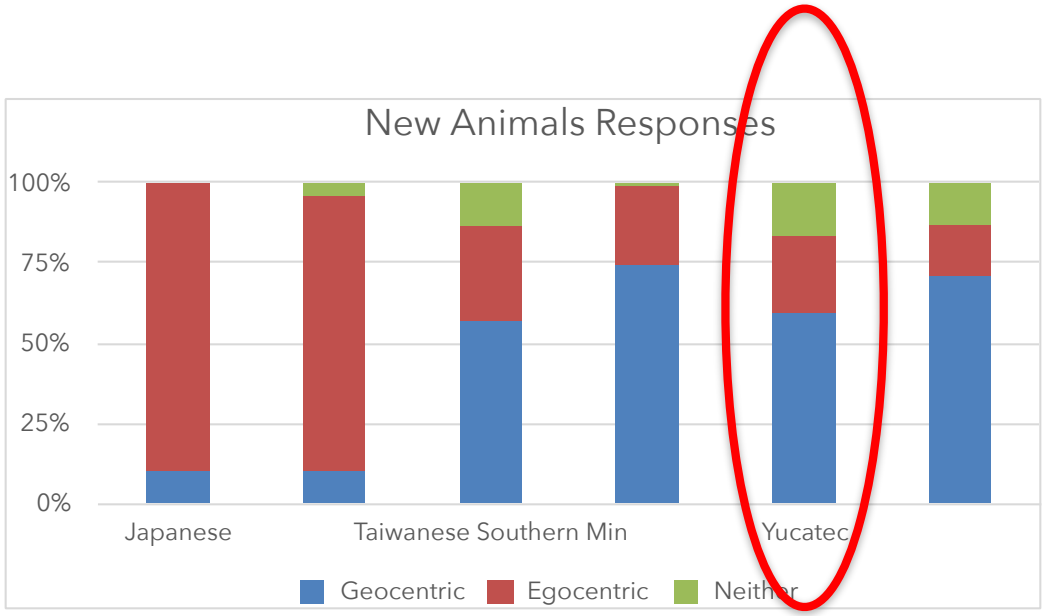

Figure 5.3. *New Animals response type frequency by L1*

- exception III: comparison of Spanish-speaking communities in Mexico, Nicaragua, and Spain (Bohnemeyer et al 2014)
  - verbal GEO use ≤ 5% predicts cognitive GEO use < 50%
  - verbal REL use > 33% predicts cognitive EGO use > 50%

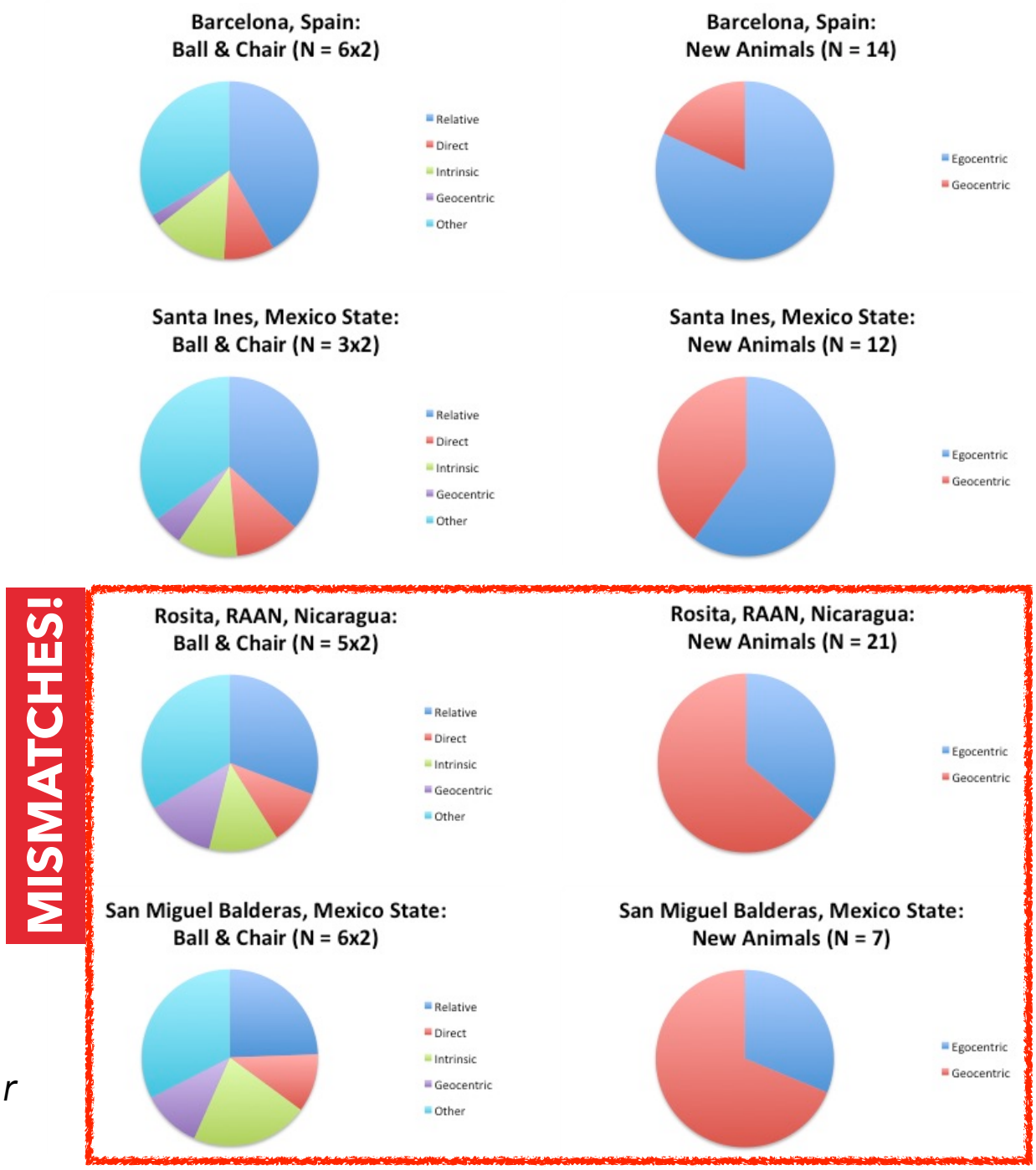

Figure 5.4. *Reference frame use in discourse and recall memory in four Spanish-speaking populations*

- exception III (cont.)
  a similar pattern emerges from a comparison of monolingual and bilingual populations in Taiwan (Lin 2017)
  - verbal GEO use < 10% predicts cognitive GEO use < 50%

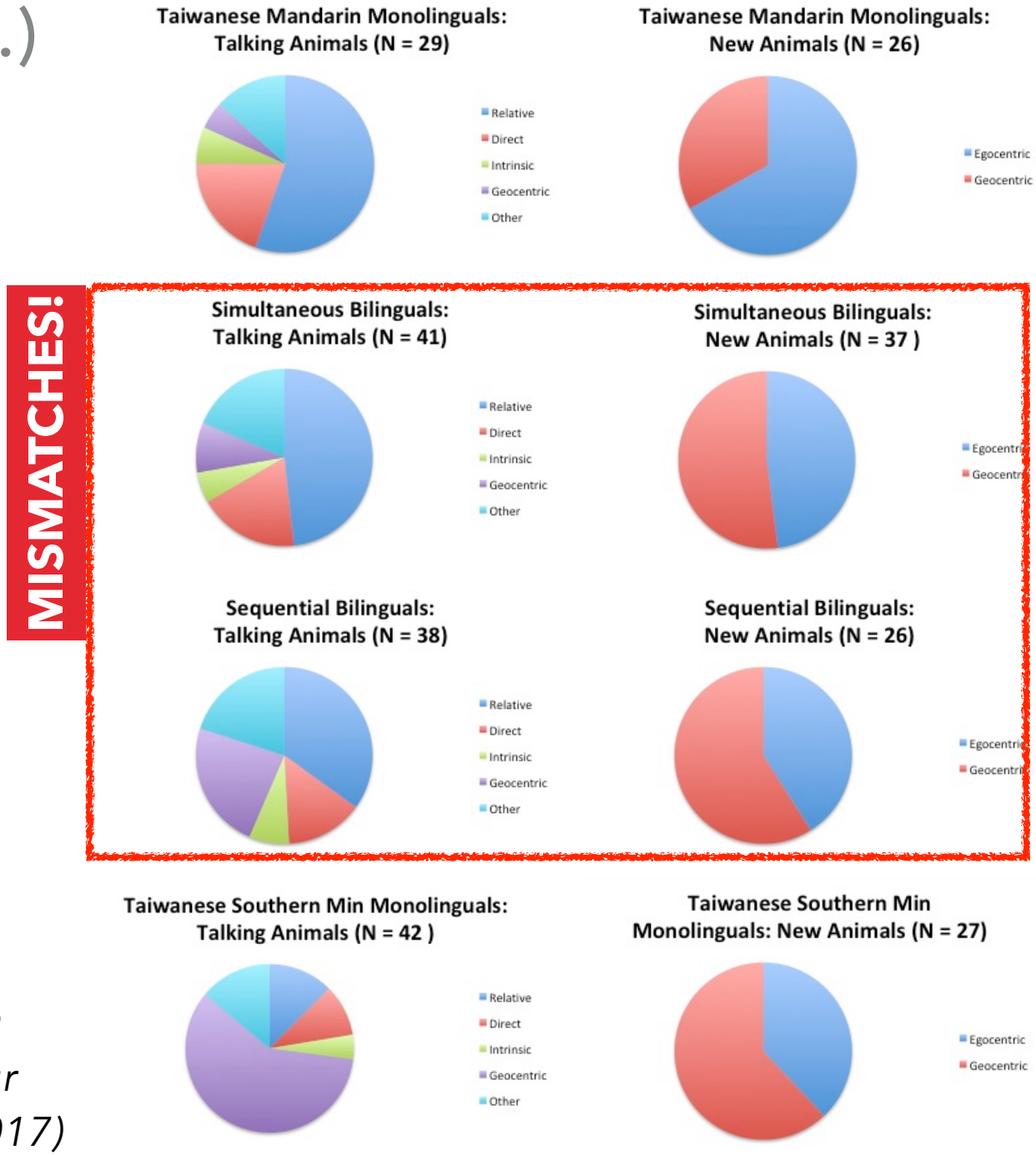

Figure 5.5. *Reference frame use in discourse and recall memory in four Taiwanese populations (data Lin 2017)*

- descriptive generalization: in array reconstruction tasks, the geocentric strategy emerges as a default across populations
  - the only populations that show a clear egocentric bias in this task
    - are populations that show a clear preference for relative frames in the discourse task
      - and simultaneously a marginalization of geocentric use in this domain

- these patterns support the idea that language acts as a conduit for the cultural transmission of egocentrism
  - in line with the **Linguistic Transmission Hypothesis** (Bohnemeyer et al 2014, 2015, under revision)

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."

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."

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THE CULTURAL EVOLUTION OF SMALL-SCALE SPACE

- restating the PSGBH based on the evidence presented

Pan-Simian Geocentrism Bias Hypothesis:
"The central spatial cognition (as opposed to the perceptual system) of hominids is innately biased toward anchoring extrinsic representations with respect to the environment. This innate bias can be overridden by a learned, culturally transmitted practice of isolating a separate domain of easily manipulable space and using observer-anchored frames as a default for this domain."

- cultural transmission is merely a mechanism
  - it doesn't explain *why* egocentrism seems to have risen to prominence in some human populations
    - over the course of cultural evolution
  - a possible evolutionary explanation: egocentric frames are more efficient for representations of small-scale space
    - and the cognitive importance of small-scale space has continuously risen during cultural evolution

- the rise of the small scale: an evolutionary scenario

Figure 6.1. *Spatial cognition in animals - is there a scale difference?*

- Stage I: prior to the onset of intensive cultural evolution, it is not evident that small-scale space *exists*
  - as a distinct domain of spatial cognition in hominids

- the rise of the small scale: an evolutionary scenario (cont.)

Figure 6.2. *Tool use - the onset of the evolution of the manipulable scale?*

- Stage II: early manifestations of tool use are opportunistic and presumably don't require longterm storage
  - nevertheless, for hominids, tool use may be the beginning of reshaping the environment

- the rise of the small scale: an evolutionary scenario (cont.)

Figure 6.3. *A big leap in the evolution of manipulated space: building enclosures*

- Stage III: hunter-gatherers
  - people begin to acquire more gear and to build walled-off spaces (if temporary ones)

- the rise of the small scale: an evolutionary scenario (cont.)

Figure 6.4. *Consolidating enclosed space: agriculture*

  - Step IV: horticulture and agriculture
    - significant parts of human life are taking place in permanently enclosed spaces, including even economic production
    - for the first time, the geographic scale becomes clearly separated from the area in which most of everyday life takes place

- the rise of the small scale: an evolutionary scenario (cont.)

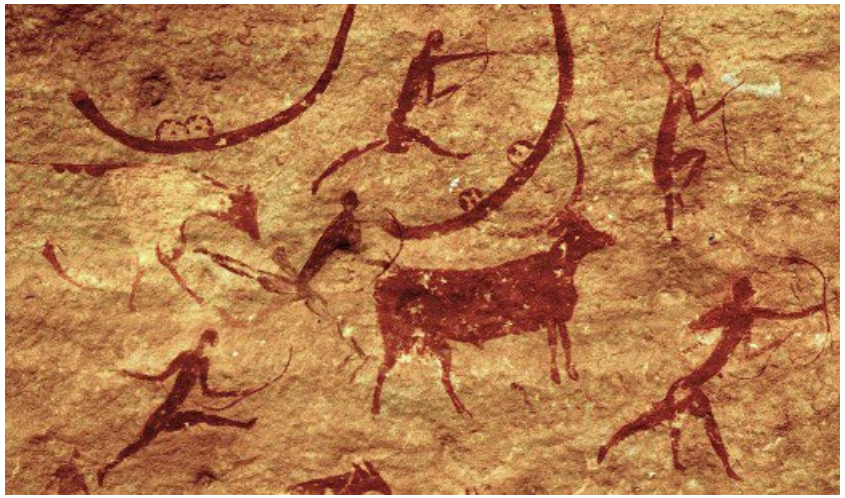

Figure 6.4. *Manufactured visual representations: the emergence of inherent egocentrism*

Figure 6.5. *Manufactured visual representations go into overdrive: the invention of writing*

- Step V: the evolution of visual art and writing
  - manufactured visual representations have a canonical orientation in the viewer's visual field
  - they are the first egocentrically designed tools/artifacts

- the rise of the small scale: an evolutionary scenario (cont.)

Figure 6.6. *Inhabiting egocentric space: urban roadway systems*

- Step VI: the advent of urban roadway systems
  - the most efficient way to memorize and communicate information about routes in a roadway system
    - is in terms of left vs. right turns with respect to the driving direction, i.e., egocentrically

!TEST ME!

- the adaptive mechanism
  - each successive stage provides new opportunities for the emergence of egocentrism
    - and simultaneously reduces the domain of geocentrism
      - e.g., even in geocentric cultures, visual representations have a canonical egocentric orientation
        - and roadway routes are probably at least to some extent represented egocentrically
          - results of various route description studies point in this direction

- the adaptive mechanism (cont.)
  - the impact of the final two stages is likely more dramatic than that of the earlier stages
  - shift is not automatic!
    - a culture's established geocentric practices weigh against it
  - likely a powerful trigger of shift: cultural contact (often through language)

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SUMMARY

- Haun et al (2006)
  - experiments with human infants and non-human primates suggest an innate bias for geocentric cognition
    - which gets overridden in individual adult populations by a culturally transmitted egocentrism bias
- evidence from semantic typology in support of this idea
  - distribution: robust egocentrism biases have so far only been attested in G.E.I.R.D populations

- evidence from semantic typology (cont.)
  - mismatches: populations that show divergence between frame selection biases in discourse and internal cognition
    - robust egocentric preferences in non-verbal tasks are attested exclusively in populations
      - whose linguistic practices include
        - a clear preference for relative frames
        - and no more than marginal use of geocentric frames at the manipulable scale

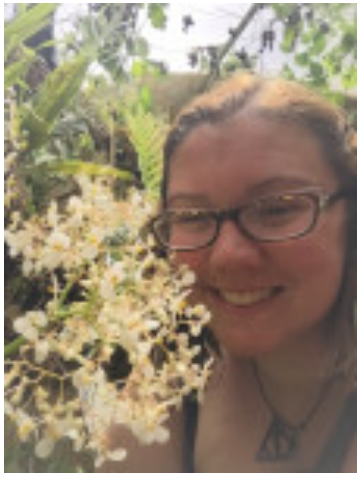
- evidence from semantic typology (cont.)
  - the observed patterns are consistent with the hypothesis that language plays a role in the cultural override
    - by serving as a conduit in the cultural transmission of egocentrism

- the evolutionary scenario for the innate geocentrism bias
  - the manipulable scale may have gradually emerged as a distinct domain of spatial cognition in hominids
    - involving stages marked by
      - tool use
      - the creation of fenced-off and walled-off spaces
      - the advent of manufactured visual representations including especially writing
      - the evolution of urban roadway systems

- the evolutionary scenario (cont.)
  - for the performance of tasks associated with these stages, egocentrism might present an adaptive advantage
  - the greater the importance these developments assume in a given culture
    - the greater the hypothetical benefits in cognitive efficiency to be gained by shifting to egocentrism
  - however, existing cultural practices favoring geocentrism may counteract the shift
    - shift to egocentrism appears to occur most likely through contact with already shifted cultures

Acknowledgements

- the MesoSpace team
  - 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 and topography 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



Acknowledgements (cont.)

- thanks to
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Thanks!