Efficient estimation of bilingual children's language exposure from daylong audio recordings

Meg Cychosz,[1] Anele Villanueva,[2] & Adriana Weisleder[2]
[1]University of Maryland, College Park, [2]Northwestern University

Overview

- Child-directed speech (CDS) and dual language exposure are sources of variation in children's language environments [1, 2]
- Daylong recordings provide a naturalistic way to estimate CDS and dual language exposure
  - Current algorithms don't distinguish between languages or speech registers
  - Time-consuming annotation

Research Questions

- Manual annotation usually samples from select portions of recordings like morning, afternoon, and night [3, 4]

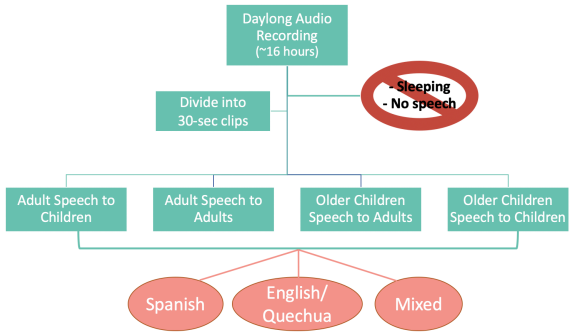
Using random sampling, can we efficiently estimate the quantity of
1. bilingual language input and
2. child-directed speech
in children's language environments? [5]

Data Collection

- 10 infants (aged 0;6-1;0)
- Two bilingual speech communities
  - Quechua & Spanish in Bolivia
  - English & Spanish in the U.S.
- Age- and gender-matched across communities
- Families completed daylong audio recording
  - Range: 8.78-16 hrs.

Citations: [1] Place , S. & Hoff, E. (2011). Properties of dual language exposure that influence 2-year-olds' bilingual proficiency…*Child Development*, *82*(6), 1834-1849. [2] Carbajal, J., & Peperkamp, S. (2019). Dual language input and the impact of language separation on early lexical development. *Infancy*, *25*(1), 22-45. [3] Weisleder, A., & Fernald, A., (2013). Talking to children matters…*Psychological Science*, *24*(11), 2143-2152. [4] Orena, A., et al. (2019). Reliability of the Language Environment Analysis (LENA) in French-English Bilingual Speech. *JSLHR*, *67*(2), 2491-2500. [5] Micheletti, M., et al. (2020). Optimal sampling strategies for characterizing behavior and affect from ambulatory audio recordings. *Journal of Family Psychology*.

Pre-processing & Annotation

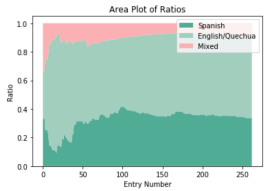


Evaluate random sampling method by comparing CDS and dual language input estimated from:

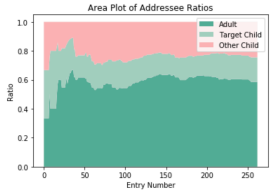
Annotate by **random sampling** (At least 10% of clips annotated)

Annotate **entire recording** (Every other clip annotated)

Result #1: Ratios between language categories and speech registers stabilize after just ~1.5 hrs. of annotation



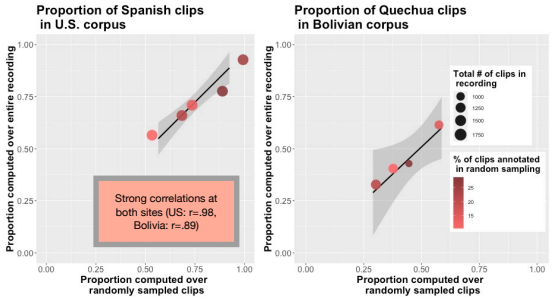
Ratio between language categories (left) and speech registers (below) asymptotes



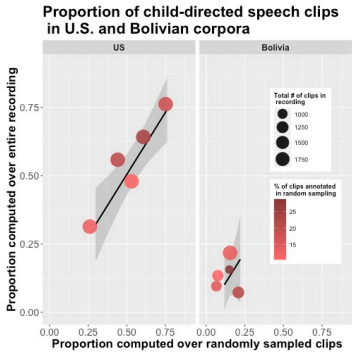
Stability reached after ~1.5 hrs. of annotation, or ~185 30-second clips

Acknowledgements: Thank you to the families who participated in this research program. Additional thanks to Ron Sprouse (UC Berkeley).

Result #2: Similar language estimates from full-day and random sampling annotation methods



Result #3: Stable CDS estimates by annotation method in US, but not Bolivia



Strong correlations in US (r=.97), but weaker in Bolivia (r=.64), possibly due to infrequent CDS in Bolivian recordings

Conclusions

- Researchers frequently need to compute children's CDS and dual language exposure
  - Random sampling of naturalistic recordings may be an efficient, ecologically-valid method
  - Possibly less reliable for low-frequency events
- Our approach requires annotation of ~10% of a daylong recording
  - Less than 1.5 hrs. of recording

- **Next steps:** compare random sampling estimates of bilingual exposure to estimates from background questionnaires
- Compare CDS and bilingual exposure estimates across speakers and cultural sites (see poster #47)