Measuring language-evoked activation in the brains of awake toddlers using fMRI

Halie Olson1, Emily Chen1, Somaia Saba1, Rebecca Saxe1

1MIT Brain and Cognitive Sciences

BACKGROUND

- Toddlers undergo rapid changes in their language production and comprehension skills.
- Some previous fMRI studies have investigated speech processing in infants and toddlers during natural sleep.
- To better understand the neural basis of language comprehension in toddlers, we designed a novel fMRI task that embeds a language control (backwards speech) in movie clips from Sesame Street. In preliminary analyses, we ask:
  1. Can we measure a language response in toddlers?
  2. Is language-evoked activation left-lateralized in toddlers?
  3. Do language regions respond differently to observed conversation than language directed to the child in toddlers?

PARTICIPANTS

- Toddler Participants: N=9 with T1s included in preliminary analyses (age: mean(SD) = 31.5(3.9) months, range 25-36 months)

METHODS

- FMRI TASK

  - Adult Participants: N=20 (age: mean(SD) = 23.9(3.7) years, range 18-30 years)

PRELIMINARY ANALYSES

1. GROUP WHOLE BRAIN ANALYSIS

2. LATERALIZATION

- Lateralization index was calculated for each individual using the formula: LI=(V_{left}−V_{right}+1)/V_{left}+V_{right}+2), where V=suprathreshold voxels in left language search spaces and their mirrored right hemisphere homologue search spaces.

3. SUBJECT-SPECIFIC FUNCTIONAL REGIONS OF INTEREST

 Results

- CONCLUSIONS

  Preliminary results suggest:
  1. We can measure a language-evoked response in toddlers using awake fMRI.
  2. Language responses may be left lateralized in toddlers.
  3. Child-directedness of language stimuli may impact neural activity during language processing in toddlers.

REFERENCES

1. Frank et al., 2021
2. Dahan-Aarnis et al., Science, 2002
3. Redcay et al., Developmental Science, 2008
4. Olson et al., Neurobiology of Language (accepted)
5. Boll et al., Human Brain Mapping, 2014
6. Desmond et al., Brain, 1995
7. Fedorenko et al., J Neurophys, 2010
8. Saxe et al., Neuroimage, 2006

ACKNOWLEDGEMENTS

We would like to thank our funders: National Science Foundation Graduate Research Fellowship (to HAO) and Simons Foundation Autism Research Foundation (SFARF) grant. We would also like to thank the Athinoula A. Martinos Imaging Center at MIT; Kirsten Lydic; Hana Ro, Rebecca O'Connor, Sofia Riskin; Bianca Santi; Matthew Soza, Michelle Hung, Camille Ouamah, and Haoyu Du, and our participants.