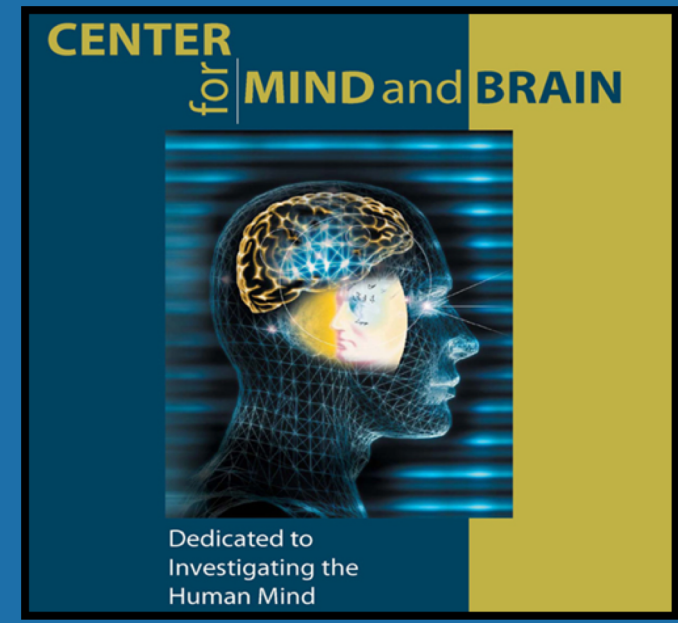




Electrophysiological Responses to Audiovisual-Words and Pictures in Hearing and Deaf Children with Cochlear Implants

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Introduction

Background. Congenitally deaf children who receive cochlear implants (CI) experience a delay in their access to auditory input, which may hinder their acquisition of spoken language. Deaf children's ability to integrate semantic knowledge with word forms, the process of semantic integration, could be impacted by early auditory deprivation (Lederberg et al. 2013).

Present study. The goal of this study was to reveal group differences between hearing and CI-using children in their ability to integrate verbal and nonverbal semantic content. To test the effect of early auditory experience on semantic integration, we used a novel EEG paradigm that required the integration of audiovisual words with pictures. This word-picture priming task allowed us to index semantic integration through the N400 ERP component (Lau et al., 2008).

Methodology

Participants.

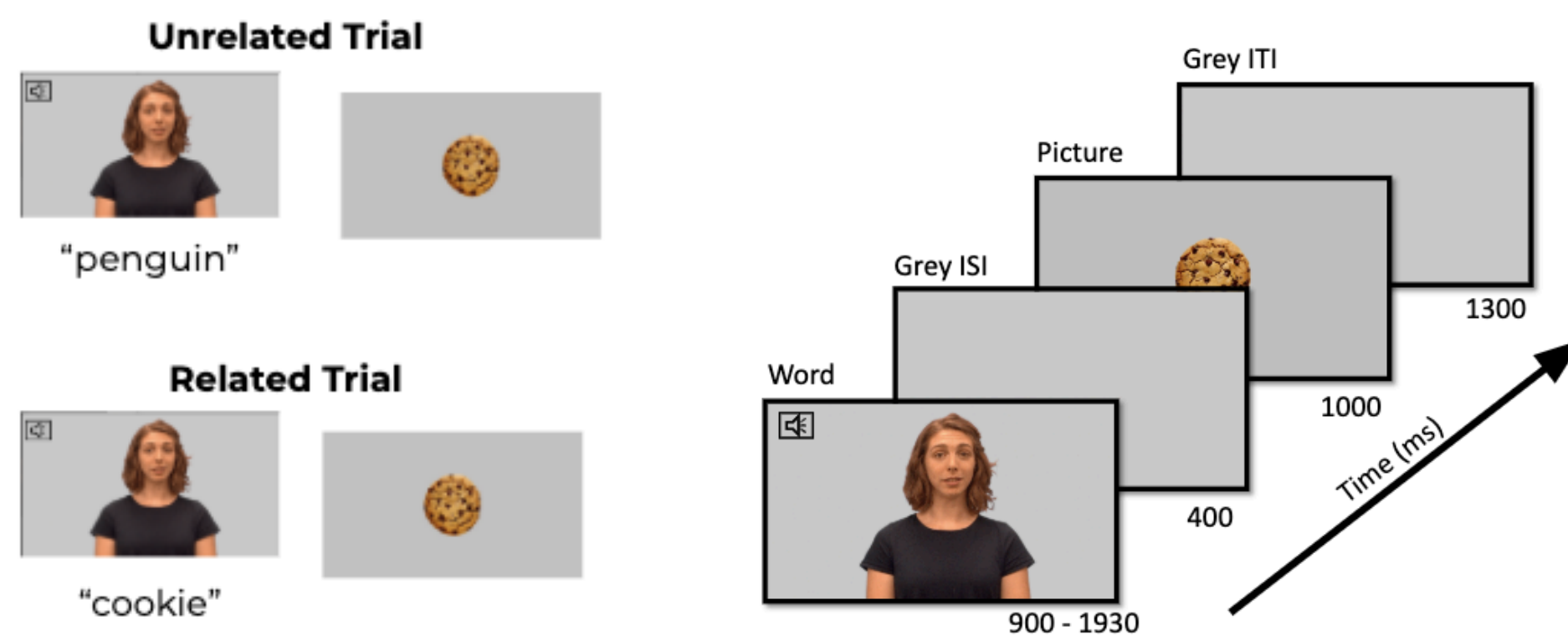
- 43 children, age 2.8 – 10.7 years.
- 18 children with normal hearing (mean age 6.4 years)
- 25 children with cochlear implants (mean age 6.9 years)

Stimuli.

- 34 nouns and an associated picture were selected as targets
- Each item was presented in two semantic contexts: related or unrelated prime-target pairs.
- Audiovisual spoken word primes
- Picture targets were photographs of common objects

Procedure/ERP Recordings.

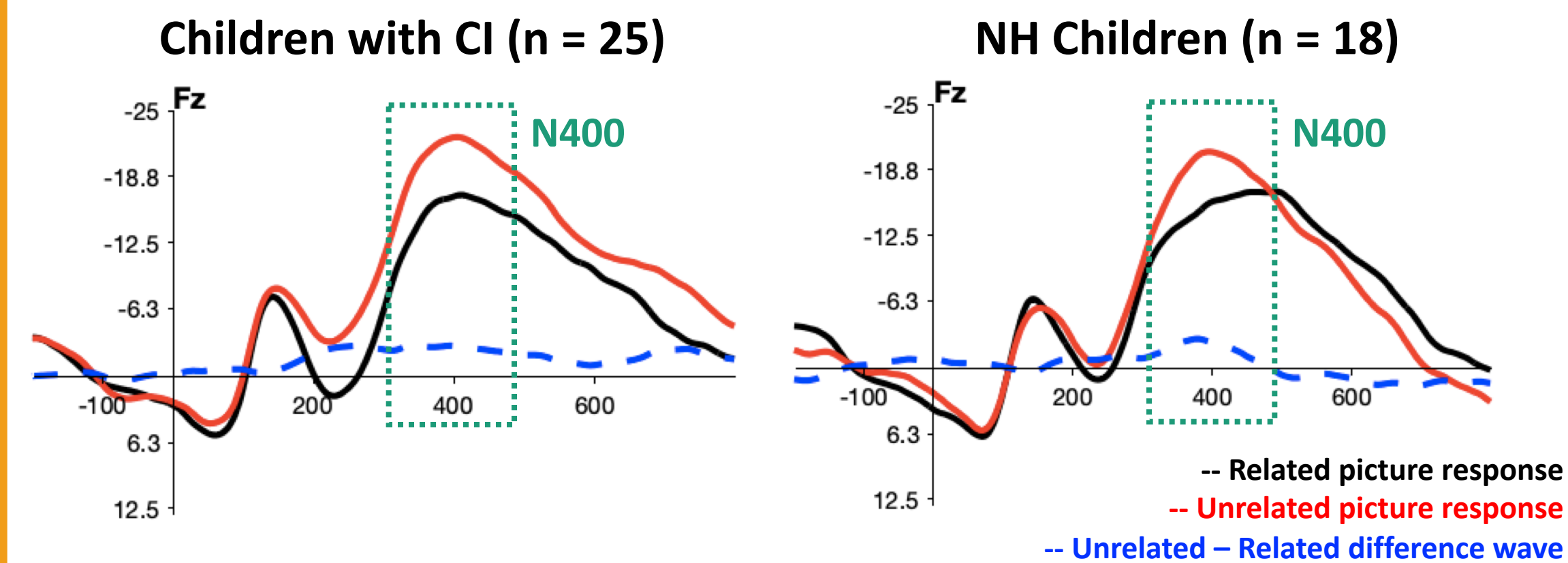
- EEG was recorded from subjects using BioSemi (Active Two) system while they watched a passive word-picture priming task.
- Data was collected at 22 electrode sites and 2 mastoids.
- ERPs were time-locked to the onset of the picture-target.



Acknowledgements

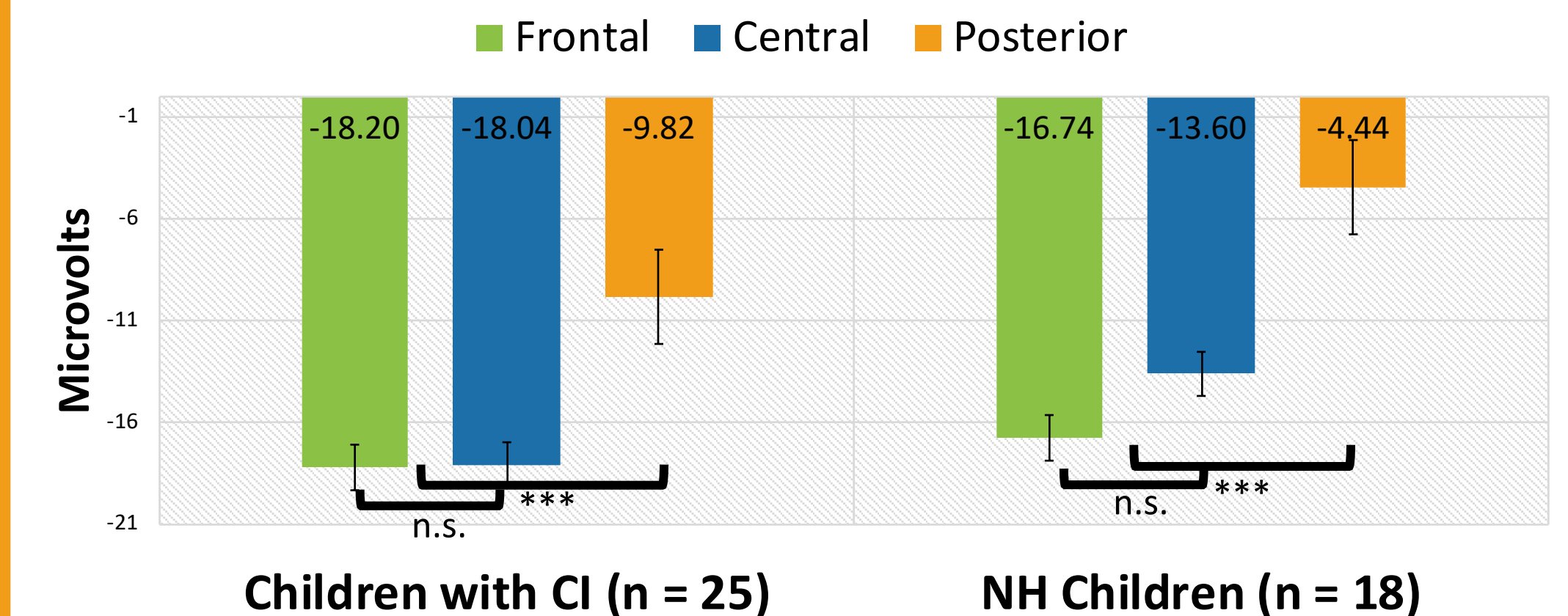
This research was supported by the NIH NIDCD R01DC014767 awarded to David P. Corina (dpcorina@ucdavis.edu). Thanks to Journie Dickerson and Tarah Shively for help with data collection, and to our partner schools for their cooperation (CCHAT Sacramento, CA; Weingarten Children's Center, Redwood City, CA; Hearing Speech and Deaf Center, Seattle, WA).

Frontal N400 Effects to Unrelated Pictures



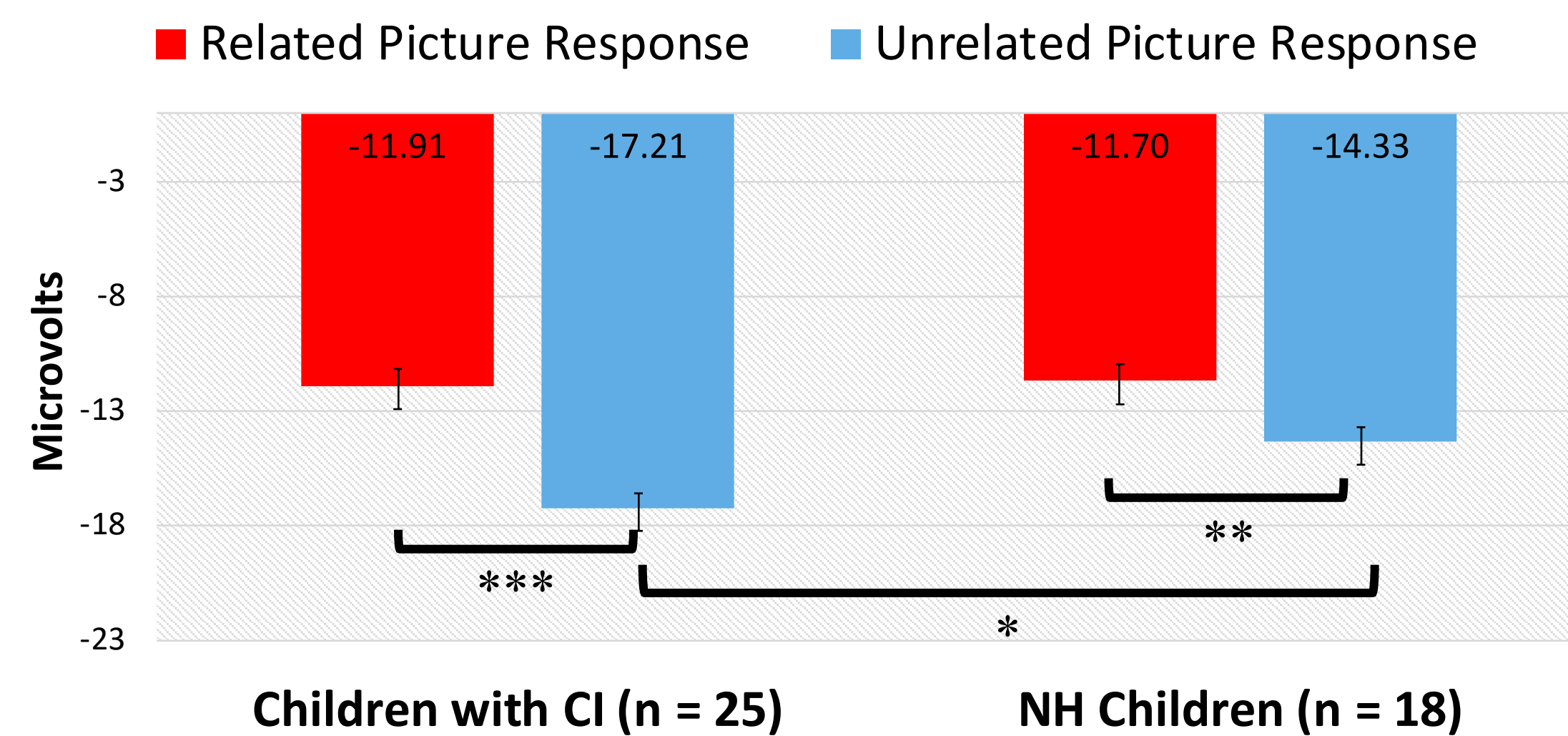
Effect of Semantic Relatedness. CI group: there was a significant difference in mean amplitude (MNA) from 300-500ms post-picture onset such that Unrelated pictures evoked more negative responses than Related pictures ($F(1,448) = 31.06, p < .001$).
Hearing group: This same pattern of results was demonstrated ($F(1,322) = 5.71, p = .017$).

Unrelated Picture Response by Region



Distribution. In both groups, increased negativity to Unrelated pictures had a widespread distribution such that there was no difference in MNA between Central and Frontal regions ($F(1,170) = 1.77, p = .18$). Posterior regions in both groups were less negative than Frontal/Central regions ($F(2,342) = 55.98, p < .000$).

Mean Amplitude 300-500ms Post-Picture



Group Differences in N400 Response. Between the groups, the CI group showed more negative MNA to Unrelated pictures than the Hearing group ($F(1,771) = 4.70, p = .035$).

Data Analysis

- Data was bandpass filtered from 0.01 to 30 Hz and re-referenced to linked-mastoids (ERPLAB v.7.0.0).
- ICA was used to reject all eye and CI artifacts (EGLAB v.2019.0).
- For other noise, all trials surpassing threshold of +/- 115 mv were rejected.
- Single-subject waveforms were used to form grand averages for each group.
- Measurements of waveforms were taken for mean amplitude from 300 to 500 ms.
- ANOVA was used to evaluate differences in component amplitude.

Discussion

Semantic Relatedness.

- In both groups, Unrelated pictures elicited more negative responses than Related pictures.
- CI and Hearing children are able to integrate semantic information from audiovisual spoken words and pictures, demonstrating a semantic incongruity N400 effect.

Group Differences.

- CI children showed more negative responses to Unrelated pictures than the Hearing group.
 - This pattern of responses could indicate more effortful processing of semantic incongruity for CI children (Vavatzanidis et al. 2018)
 - Lexical-semantic vocabulary differences
 - Differences in allocation of attention

Distribution.

- Both groups show widespread negative responses to Unrelated pictures that encompass both Central and Frontal regions.
 - Differs from typical adult distribution
 - Pictorial target stimuli generate an anterior N400 effect (Barrett & Rugg, 1990)
- **Future Directions.**
 - Time-in-Sound
 - Age of implantation
 - Family language use (Kallioinen et al., 2016).

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