# Phonological and semantic incongruities in audiovisual spoken word recognition: a developmental ERP study

Elizabeth Pierotti, Sharon Coffey-Corina, Tristan Schaefer, & David P. Corina

Center for Mind and Brain, University of California, Davis

## INTRODUCTION

**Background.** Children use bottom-up processing and top-down contextual cues to drive their recognition of spoken words. However, less is known about how visual facial cues influence children's spoken word recognition – specifically the processing of speech sounds (phonology) and meaning (semantics).

**Present study.** We investigate neural mechanisms of audiovisual (AV) spoken word recognition in typically-developing school-aged children. We use P300 and N400 ERP components as indexes of different stages of word recognition (phonological and semantic processing, respectively). We use a picture-word priming task to test for phonological and semantic incongruity effects.

## METHODS

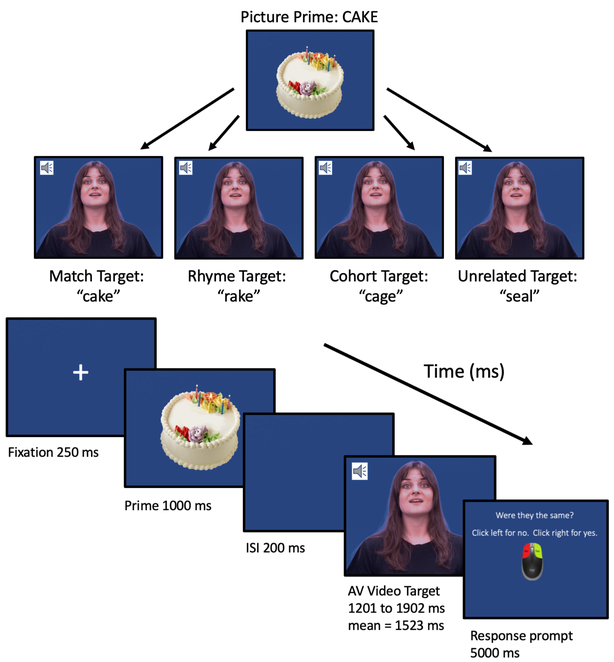
**Participants.** 13 typically-developing children (mean age 10.2 years, range 7.6 – 13.3)

**Stimuli.** 186 pairs of picture primes and AV word targets:
93 congruent/match (phonological + semantic congruent)
93 incongruent:

- 31 rhyme (initial phonological incongruity)
- 31 word initial cohort (terminal phonological incongruity)
- 31 unrelated (full phonological + semantic incongruity)

**Procedure.** Children were asked to mouse-click yes/no if picture and word matched in meaning. EEG was recorded from subjects using BioSemi (Active Two) system, with 22 electrode sites and 2 mastoids.

ERPs were time-locked to the onset of AV word targets.



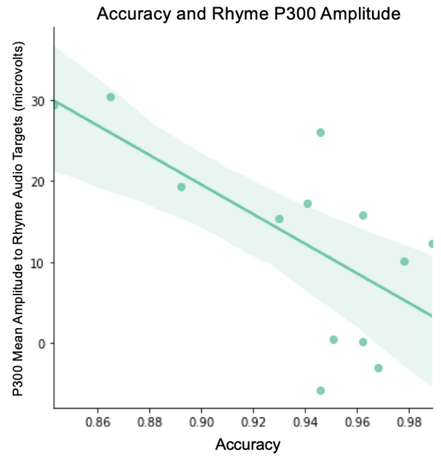

## RESULTS

**P300.**

- Main effect of Condition in P300 mean amplitude measured at Pz ($p = .005$)
- Post-hoc tests showed slight but non-significant difference in P300 amplitude between Match and Rhyme (Match = 9.8 μV, Rhyme = 12.9 μV, $p = .42$)

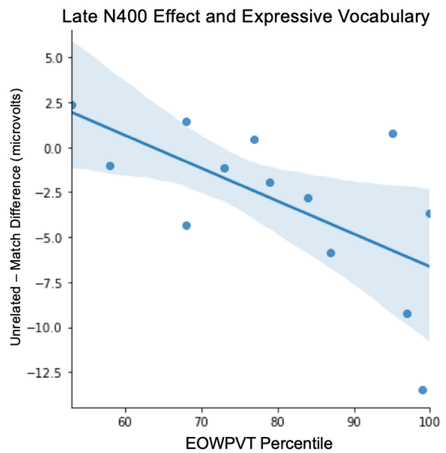
**Late N400 (500 – 700 ms).**

- In Cz, C3, C4, Pz, P3, P4: main effect of Electrode ($p < .0001$) and Condition ($p = .018$).
- Post-hoc tests show an N400 effect between Match and Unrelated ($p = .029$), and Match and Rhyme ($p = .0057$).
- There was no difference in mean amplitude between Match and Cohort ($p = .98$).



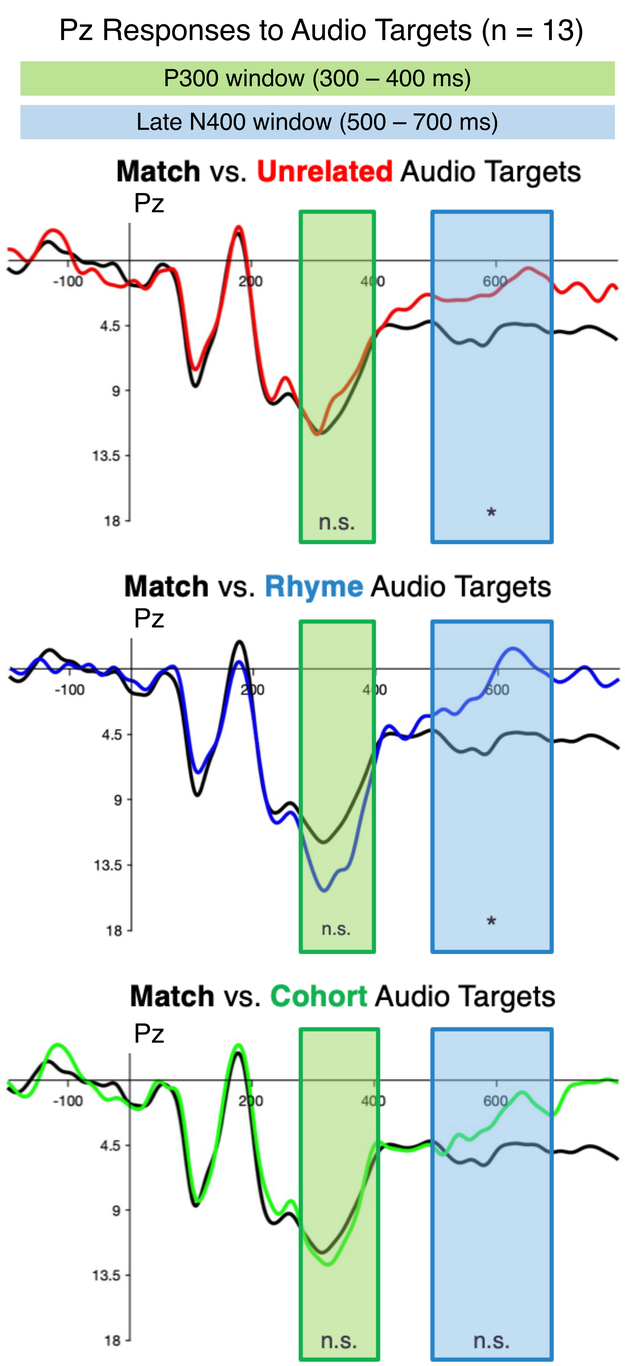

**Rhyme P300 Amplitude and Accuracy.**

Regression analyses showed a negative correlation between P3 amplitude at Pz and task Accuracy ($R = -0.662$, $p = .014$).




**Late N400 Effect and Vocabulary.**

We found negative associations between Expressive vocabulary scores and the magnitude of participants' Late N400 effects (Unrelated – Match) at Pz. $R = -0.634$, $p = .02$.




## ANALYSIS

- Data was bandpass filtered from 0.1 to 30 Hz and re-referenced to linked-mastoids (ERPLAB v.9.0.0).
- ICA was used to reject all eye artifacts (EEGLAB v.2023.0). For other noise, all trials surpassing threshold of +/- 130 mv were rejected.
- Single-subject waveforms were used to form grand averages for each group.
- RM ANOVA was used to evaluate differences in component amplitude.
- Linear regression was used to test for associations between components and age/behavioral factors.

## CONCLUSIONS

**Key Findings.**

- We observed the following patterns of responses in ERPs to audiovisual speech:
  - A prominent positivity in a 300-400 ms window.
  - A late N400 effect in a 500-700 ms window.
- Younger and less accurate children showed larger P300 amplitudes to phonologically-incongruent Rhymes, suggesting Rhymes may not be processed as efficiently in these participants.
- The late N400 effect was observed for all semantically-incongruent targets, but was significant in the measured time window for only Rhyme and Unrelated conditions.
- Smaller semantic incongruity effects were associated with worse vocabulary scores: these participants may have relied more on bottom-up input compared to children with better expressive vocabulary who may use top-down predictive processing.

**Next Steps.**

- Measure responses time-locked to video onset and compare with audio onset responses.
- Separate analysis of incorrect trials (e.g. Cohorts responded as Matches)
- Cross-group comparison with deaf cochlear-implant using children for differences in phonological and semantic processing.

## REFERENCES

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## ACKNOWLEDGMENTS

This research was supported by the NIH NIDCD R01DC014767 awarded to David P. Corina (dpcorina@ucdavis.edu). Thanks to Sana Shehabi and Plyfaa Suwanamalik-Murphy for help with data collection, and to Kalyhanie Palencia for behavioral data analysis.