EEG from infants reveals the representation of single word meaning

INSIGHTS INTO EARLY WORD COMPREHENSION: TRACKING THE NEURAL REPRESENTATIONS OF WORD SEMANTICS IN INFANTS

INTRODUCTION

- Infants begin to distinguish words as early as 6 months of age.
- Classical studies use ERPs to validate the presence of word representations in infants.
- Less is known about the nature of word semantic representations in infants.
- Machine Learning can help us study these neural representations of word semantics.
- We use neural data recorded from 9 and 12 month old infants.

METHODS

1. Use EEG for neural recordings.
2. Represent stimuli words using 300-dimensional Word2Vec vectors.
3. Use Ridge Regression to *decode* (predict) the word vectors from EEG.

$$\hat{\beta} = (X^T X + \lambda I)^{-1} X^T y$$

4. 2 vs 2 test to evaluate vector predictions.

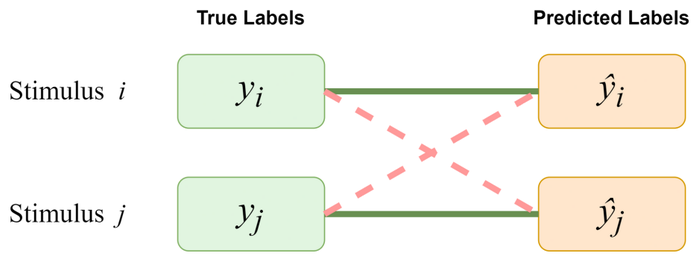

Fig 1. The 2 vs 2 test

TIMING DIAGRAM

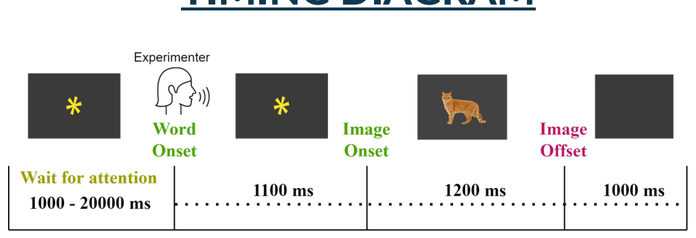

Fig 2. Timing diagram: Each stimulus word was spoken.

RESULTS

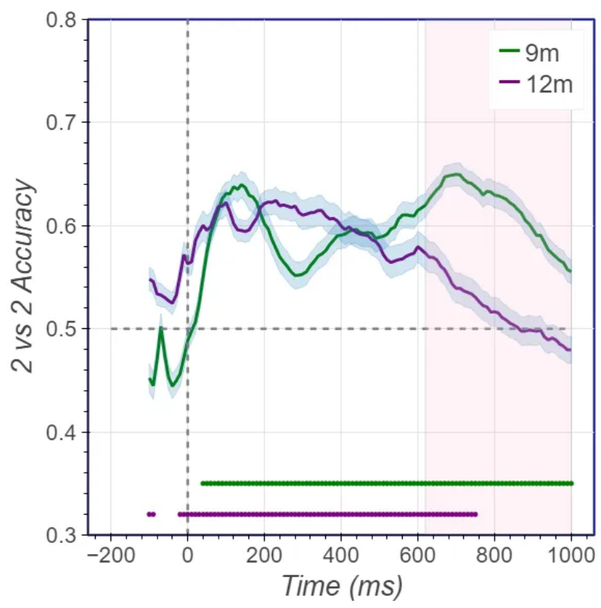

Fig 3. Word decodability from EEG of 9 and 12 month old infants.

- Both 9 and 12 month old infants show above-chance decodability of single words immediately after word onset.

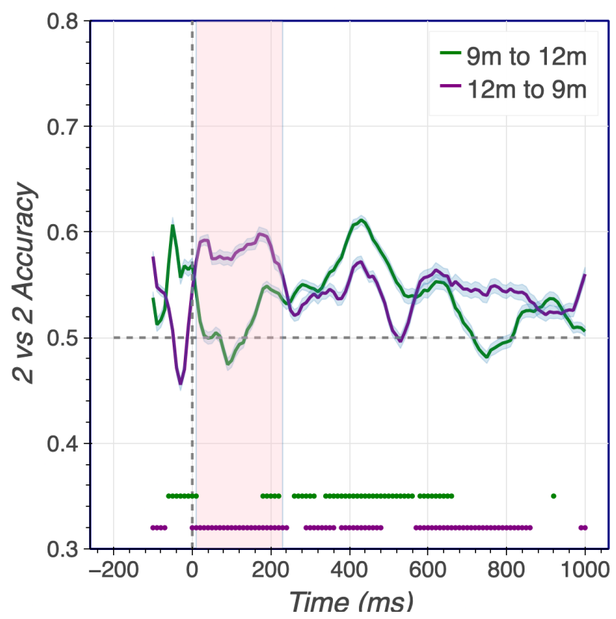

Fig 4. Shared representations of word semantics

- Shared neural representations of word semantics: a model trained on EEG from one age group can predict words from EEG data of the other age group.

STIMULI

baby	banana
bear	bottle
bird	cookie
bunny	cracker
cat	cup
dog	juice
duck	milk
mom	spoon

Table 1: List of animate and inanimate stimulus words.

PHONETIC CORRELATION

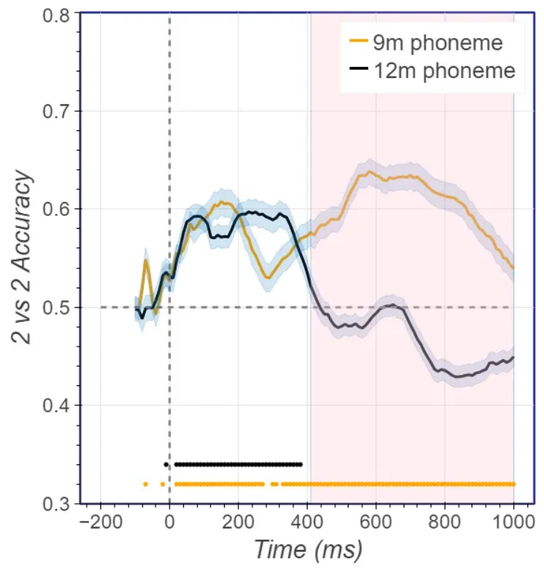

Fig 5: Decodability of stimulus phonemes from EEG data.

DISCUSSION

- For both 9 and 12 month old infants, phonetic representations of word stimuli can be decoded with above chance accuracy.
- Word semantics decodability for 9 month old infants may be correlated to phonetic decoding accuracy.
- Latter part of semantic understanding for 12 month old is unlikely to be correlated with word phonetics decodability.

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