

Language-specific phonological patterning shapes neural encoding of phonetic categories

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PREVIEW

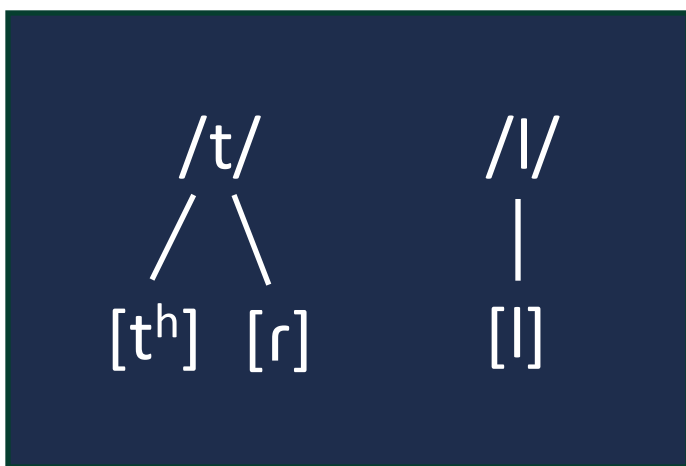
- Question:** To what extent do neural responses reflect language-specific phonological patterning versus language-universal phonetic similarity?
- Findings:** MMN tracks phonological patterning; PRP shows phonetic-perceptual grouping.

BACKGROUND

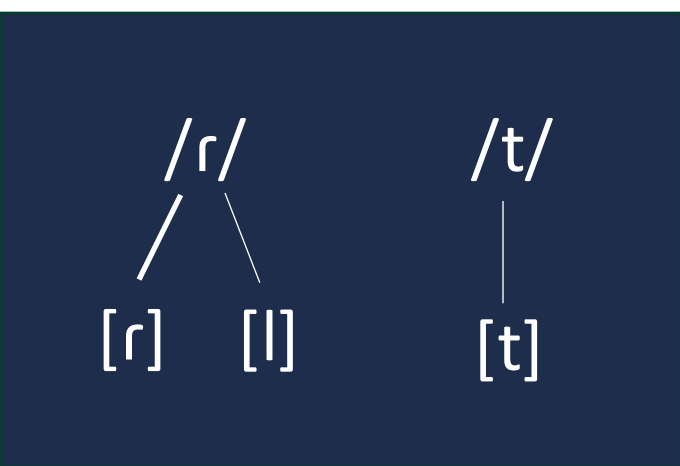
- The flap [r] is allophonic in both English and Korean, but...

Phonological patterning:

English



Korean



Research Question: How is neurophysiological encoding of the flap [r] shaped by English and Korean phonology?

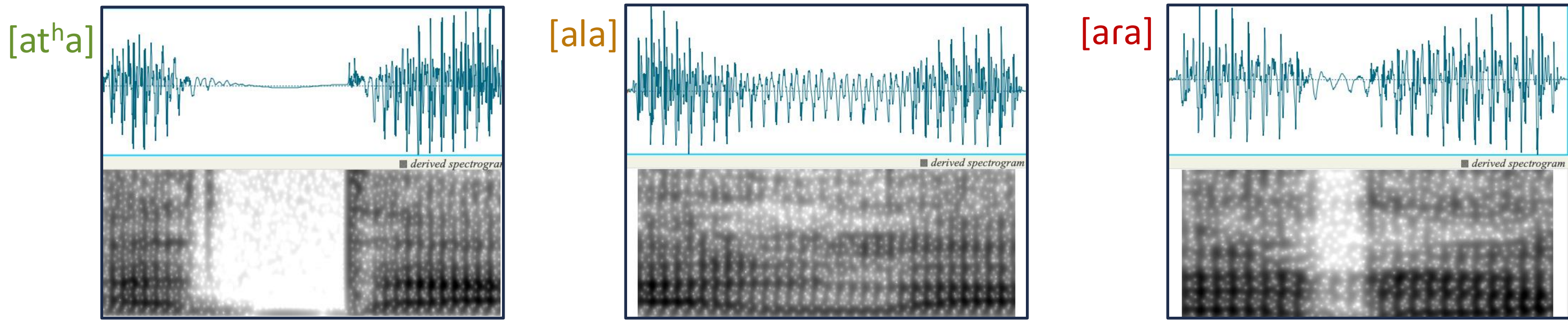
METHODS

Participants

- English speakers (n = 27); Korean speakers: data collection ongoing

Stimuli

- Three auditory CV syllables: [at^ha], [ala], [ara].



Procedure

- Experiment 1: MMN (Mismatch Negativity) [1]
 - Roving-standards paradigm:
- Experiment 2: PRP (Phoneme-related Potential) [2-3]
 - Randomized presentation of the three syllables, 70 repetitions each.

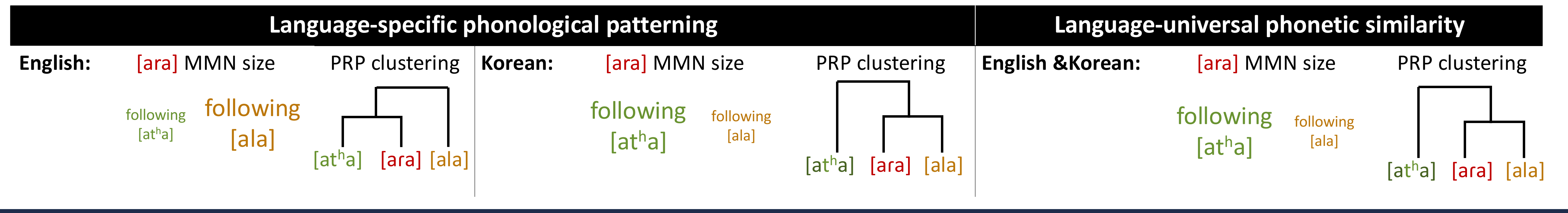
... at^ha-at^ha-at^ha-at^ha-**ara**-ala-ala-ala-ala-ala-**ara**-at^ha-at^ha- ...

... at^ha-ala-at^ha-**ara**-ara-at^ha-ala-ara-ala-ara-at^ha-ala-at^ha- ...

Analysis

- EEG waveforms: epoched -100–700 ms
- MMN: Compared deviant [ara] in two standard contexts (following [at^ha] and following [ala]) with [ara] from PRP experiment.
- PRP: 1) ERPs for each syllable ([at^ha], [ala], [ara]). 2) Hierarchical clustering of neural responses in 100 ms windows (0–700 ms) to assess neural similarity.

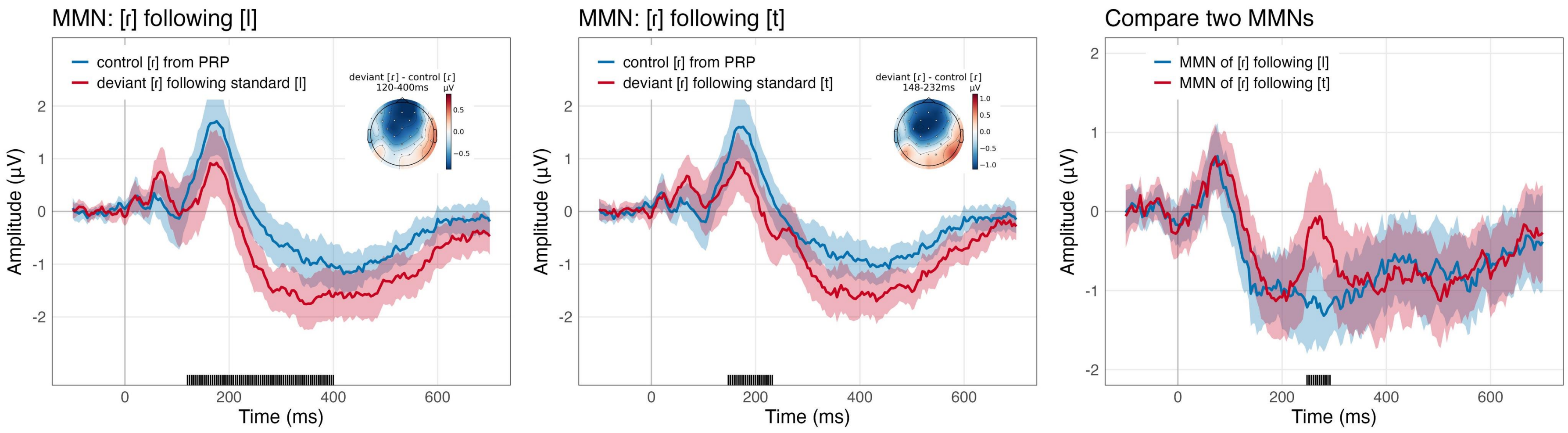
PREDICTIONS



RESULTS: MMN (English data)

MMN assessed by spatiotemporal cluster-based permutation tests (cluster formation p = 0.01, cluster-level p = 0.05).

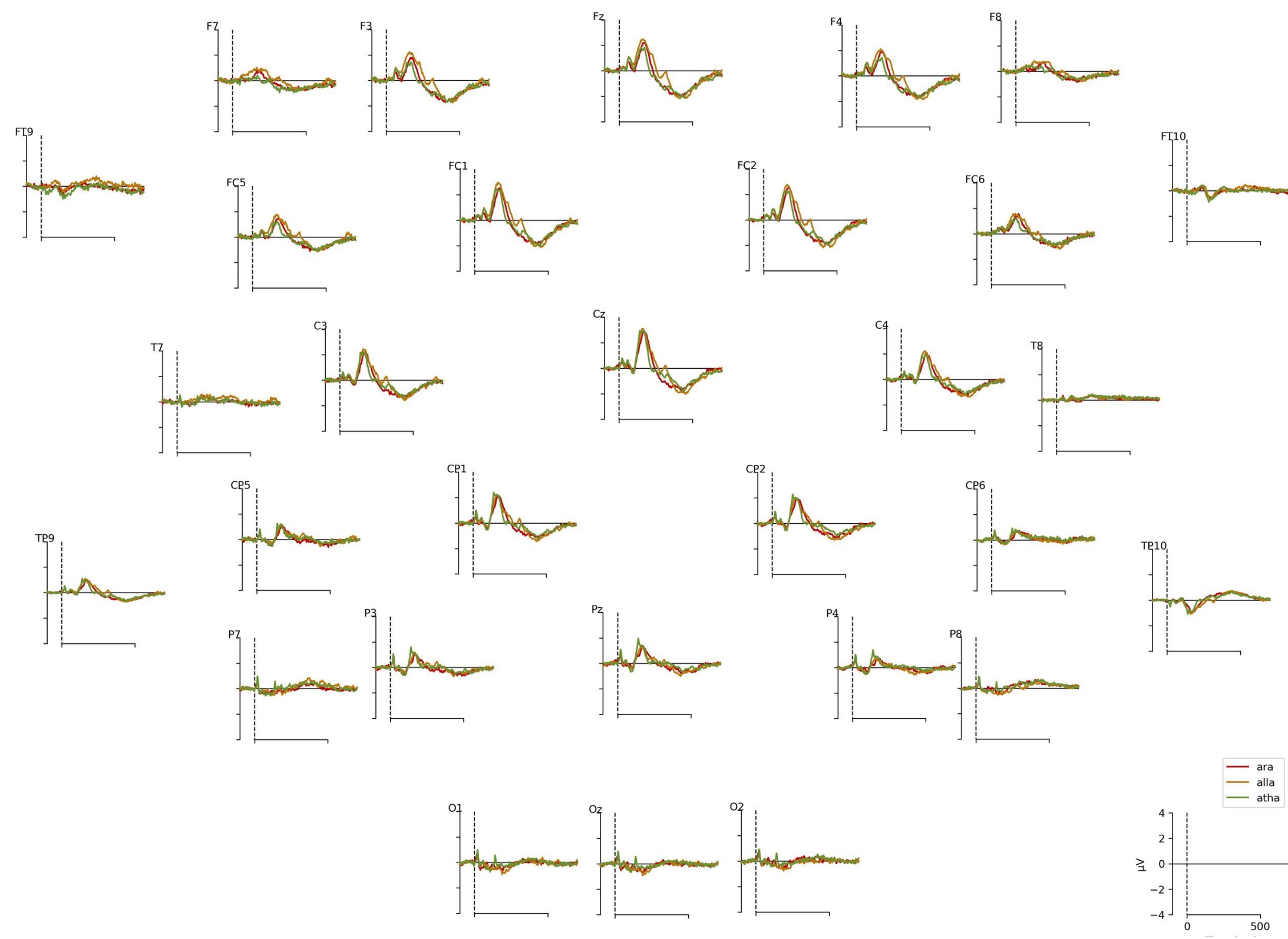
- MMN observed for [ara] following both [ala] and [at^ha].
- Smaller MMN when [ara] followed [at^ha]: Consistent with language-specific phonological patterning account.



RESULTS: PRP (English data)

PRP waveforms:

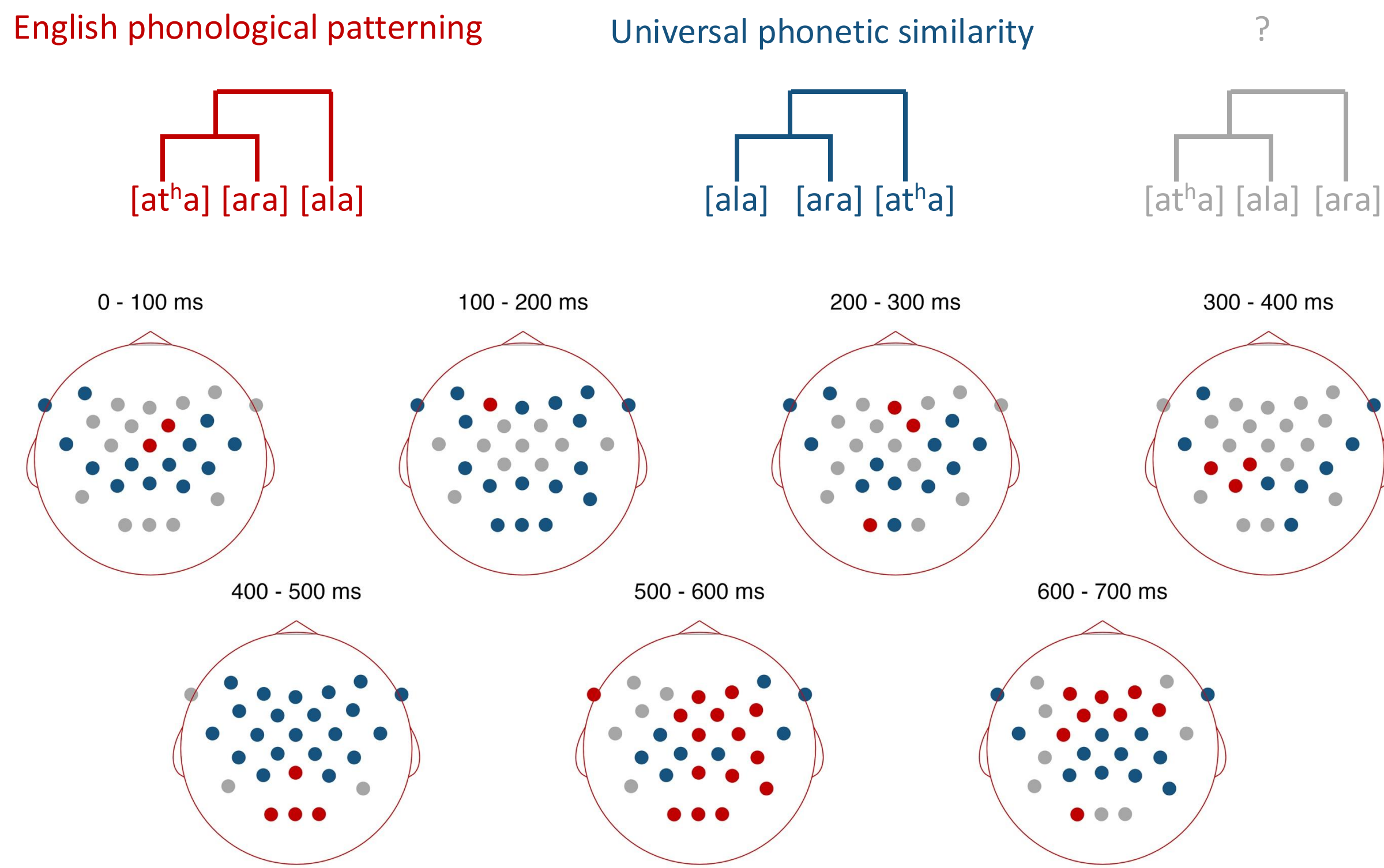
- ERPs for each syllable ([at^ha], [ala], [ara]).



References:

- Näätänen, R., Paavilainen, P., Rinne, T. & Alho, K. The mismatch negativity (MMN) in basic research of central auditory processing: A review. *Clin. Neurophysiol.* **118**, 2544–2590 (2007).
- Mesgarani, N., Cheung, C., Johnson, K. & Chang, E. F. Phonetic Feature Encoding in Human Superior Temporal Gyrus. *Science* **343**, 1006–1010 (2014).
- Khalighinejad, B., Cruzatto Da Silva, G. & Mesgarani, N. Dynamic Encoding of Acoustic Features in Neural Responses to Continuous Speech. *J. Neurosci.* **37**, 2176–2185 (2017).

Hierarchical clustering of PRP waveforms at each 100 ms time-window



Discussion:

- MMN: Smaller MMN for [ara] following [at^ha] than for [ara] following [ala], consistent with English phonological patterning ([r]~[t], contrastive with [l]).
- PRP: Hierarchical clustering showed [ala]~[ara] grouping in early and mid time windows,, likely reflecting phonetic–perceptual similarity.
- Results suggest that language-specific phonological patterning shapes phonetic encoding (as indexed by MMN) but does not neutralize influence of phonetic features.