Language-specific phonological patterning shapes neural encoding of phonetic categories

Chao Han[1], Tae-Won Lim[2], Say Young Kim[2], William J. Idsardi[3], Philip J. Monahan[1,4,5]

1. Department of Language Studies, University of Toronto Scarborough (Canada), 2. Department of English Language and Literature, Hanyang University (Korea); 3. Department of Linguistics, University of Maryland (USA), 4. Department of Linguistics, University of Toronto (Canada); 5. Department of Psychology, University of Toronto Scarborough (Canada)

QR code

PREVIEW

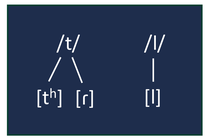
- **Question**: To what extent do neural responses reflect language-specific phonological patterning versus language-universal phonetic similarity?
- **Findings**: MMN tracks phonological patterning; PRP shows phonetic-perceptual grouping.

BACKGROUND

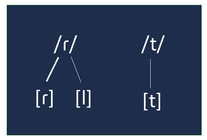
- The flap [ɾ] is allophonic in both English and Korean, but…

Phonological patterning:

English



Korean



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

METHODS

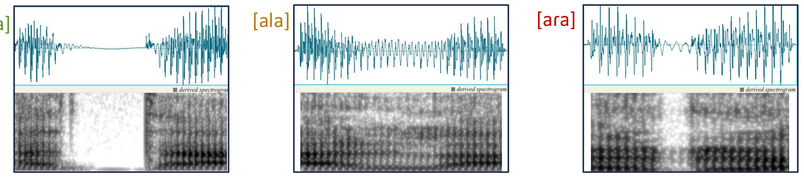
Participants

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

Stimuli

- Three auditory CV syllables: [atʰa], [ala], [ara].

[atʰa] [ala] [ara]



Procedure

- Experiment 1: MMN (Mismatch Negativity) [1]
  - Roving-standards paradigm:

… atʰa–atʰa–atʰa–atʰa–**ara**–ala–ala–ala–ala–ala–**ara**–atʰa–atʰa– …

- Experiment 2: PRP (Phoneme-related Potential) [2-3]
  - Randomized presentation of the three syllables, 70 repetitions each.

… atʰa–ala–atʰa–**ara**–**ara**–atʰa–ala–**ara**–ala–**ara**–atʰa–ala–atʰa– …

Analysis

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

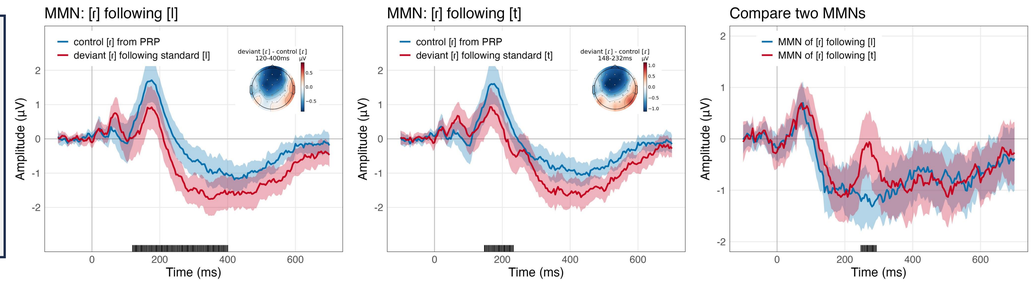
PREDICTIONS

Language-specific phonological patterning			Language-universal phonetic similarity		
English:	[ara] MMN size	PRP clustering	**English &Korean:**	[ara] MMN size	PRP clustering
	following [atʰa] < following [ala]	[atʰa] [ara] [ala]		following [atʰa] < following [ala]	[atʰa] [ara] [ala]
Korean:	[ara] MMN size	PRP clustering			
	following [atʰa] < following [ala]	[atʰa] [ara] [ala]			

RESULTS: MMN (English data)

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

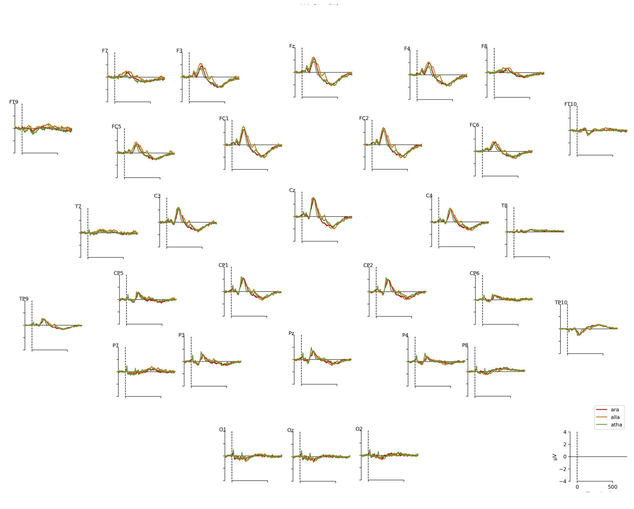
- MMN observed for [ara] following both [ala] and [atʰa].
- Smaller MMN when [ara] followed [atʰa]: Consistent with language-specific phonological patterning account.



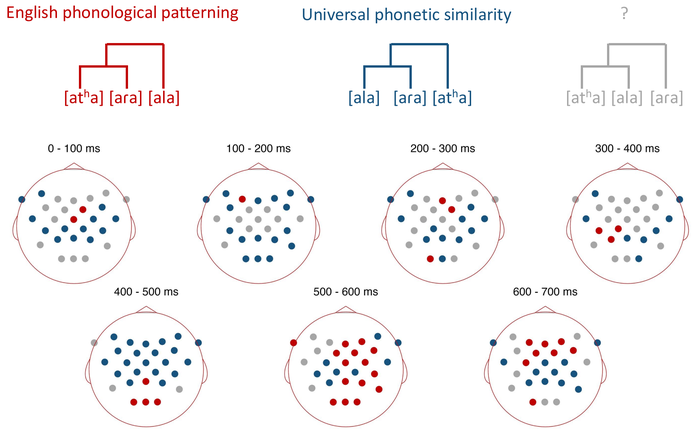
RESULTS: PRP (English data)

PRP waveforms:

- ERPs for each syllable ([atʰa], [ala], [ara]).



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



Discussion:

- MMN: Smaller MMN for [ara] following [atʰa] than for [ara] following [ala], consistent with English phonological patterning ([ɾ]~[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.

References:

1. 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).
2. Mesgarani, N., Cheung, C., Johnson, K. & Chang, E. F. Phonetic Feature Encoding in Human Superior Temporal Gyrus. *Science* **343**, 1006–1010 (2014).
3. 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).

17th Annual Meeting Society for the Neurobiology of Language, September 12–14, 2025. Gallaudet University, Washington DC

We thank Research Assistants in the CAP Lab for their support. This work was funded by SSHRC and NSERC of Canada.