Symbolic vs. Gradient Phonemes

Chao Han[1], Ryan Rhodes[2], William Idsardi[3], Arild Hestvik[1]

[1]Department of Linguistics and Cognitive Science, University of Delaware; [2]Center for Cognitive Science, Rutgers University; [3]Department of Linguistics, University of Maryland

UNIVERSITY OF DELAWARE · UNIVERSITY OF MARYLAND · RUTGERS

Summary

Question: Does a phoneme representation contain phonetic information?
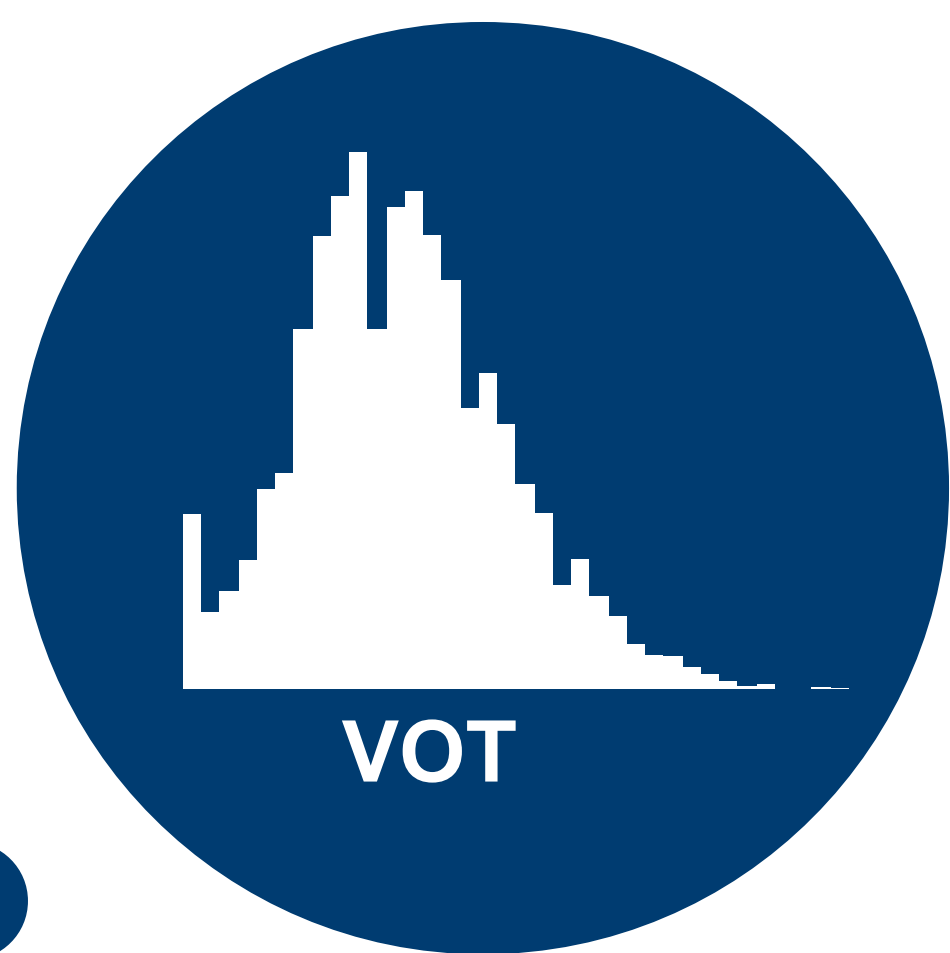**Main Finding: Yes.**
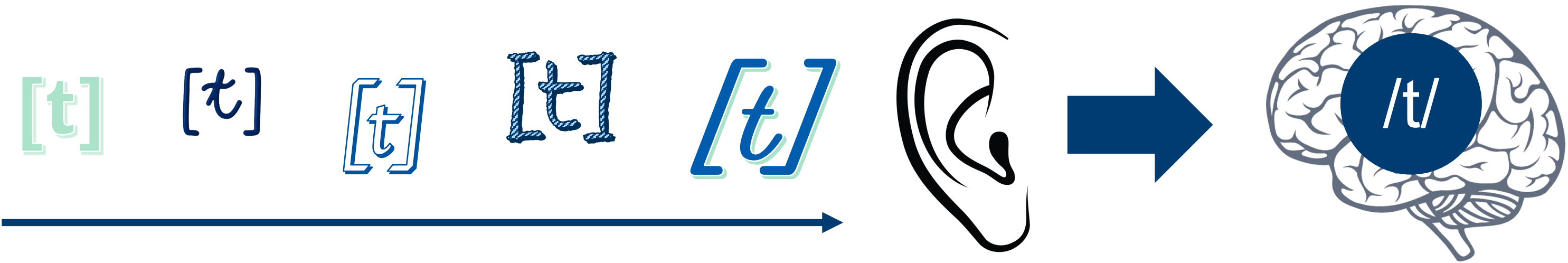
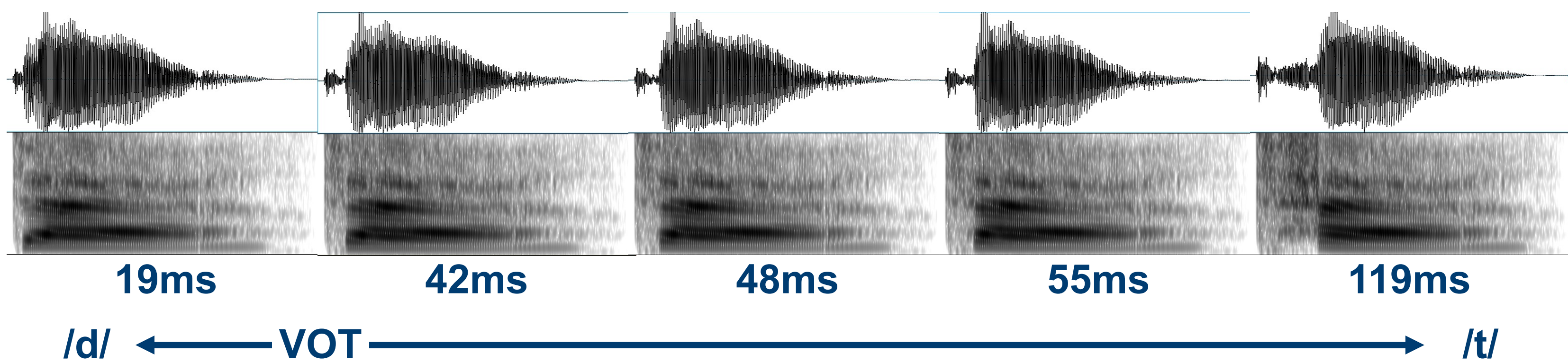## Background: Competing views

Phoneme is symbolic

[-voice]

?

Phoneme is gradient

/t/

VOT

How to test them?

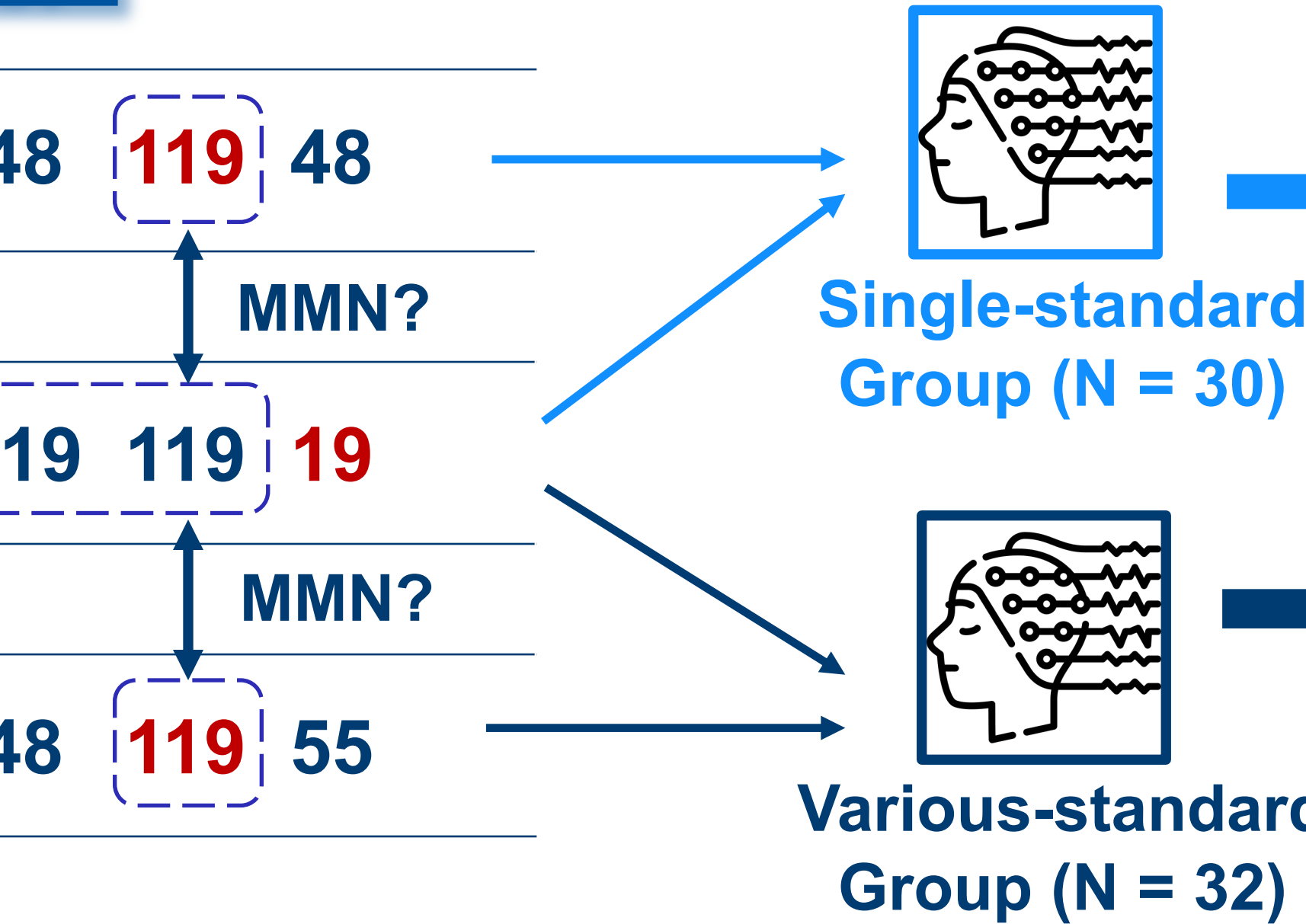- The "various-standard" assumption: Varying standards enforces a phoneme representation.

[t] [t] [t] [t] [t] → /t/

Stimuli: /d-t/ continuum

19ms   42ms   48ms   55ms   119ms

/d/ ←—— VOT ——→ /t/

Experiment design and analysis strategy

Single-standard block	48	48	48	48	48	**119**	48

MMN?

Roving-standard block (control)	19	**119**	119	119	119	119	19

MMN?

Various-standard block	42	55	48	42	48	**119**	55

Single-standard Group (N = 30)

Various-standard Group (N = 32)

$$\text{Amplitude} = \text{Group} + \text{Stimulus} + \text{Group} \times \text{Stimulus}$$

Single-standard Group — 119ms VOT as standard
Various-standard Group — 119ms VOT as deviants

Predictions

48 + 119 → MMN

Gradient phoneme: + 119 → MMN

Symbolic phoneme: [-voice] + 119 → no MMN

Results

- Measure MMN as ERP average over 176-248ms, and 7 frontocentral channels (delimited by PCA).

Single-standard Group (N = 30)
- 119ms VOT as standards
- 119ms VOT as deviants
- difference

(µV) 1.5 1 0.5 0 -0.5

(ms) 0 200 400 600

176ms   216ms   248ms

Various-standard Group (N = 32)
- 119ms VOT as standards
- 119ms VOT as deviants
- difference

(µV) 1.5 1 0.5 0 -0.5

(ms) 0 200 400 600

176ms   216ms   248ms

Single-standard Group   Various-standard Group

1.0   0.5   0.0

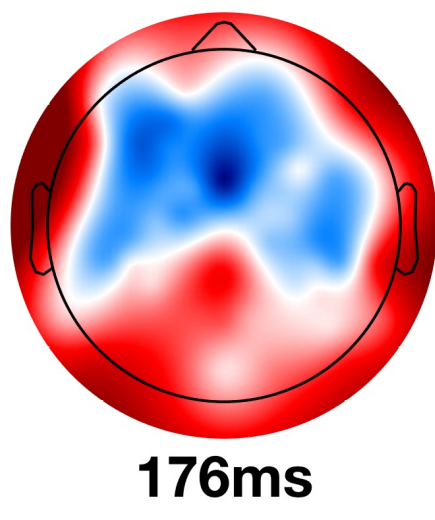- 119ms as standards
- 119ms as deviants
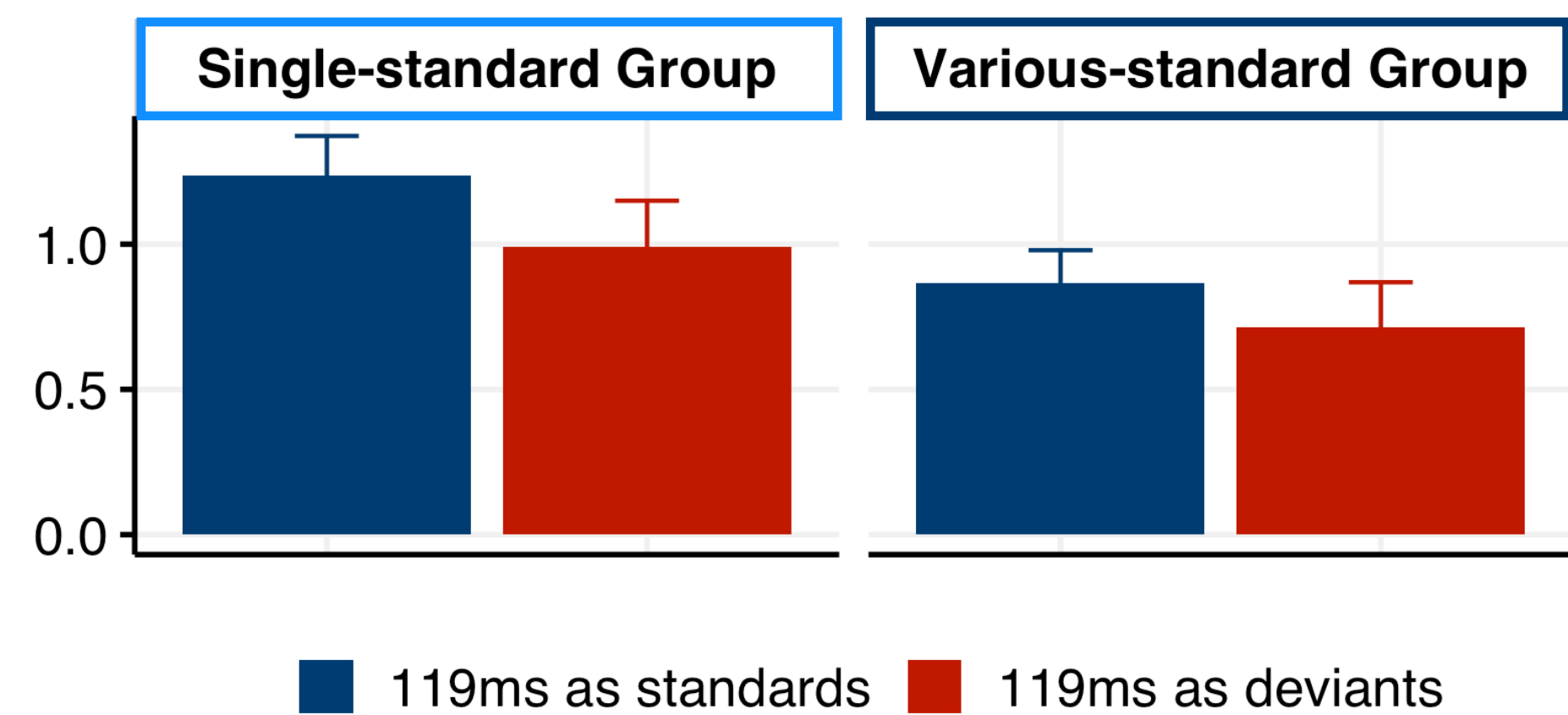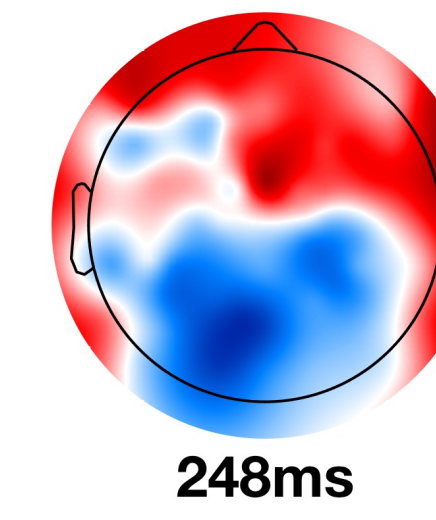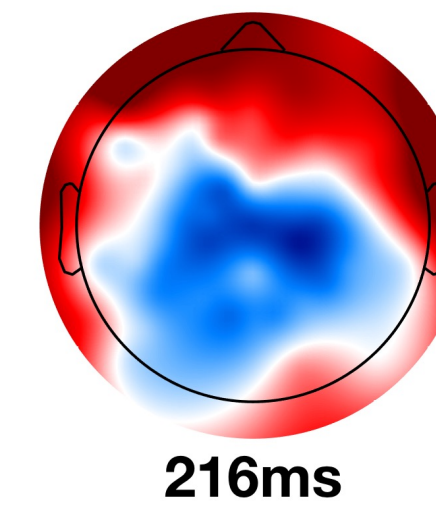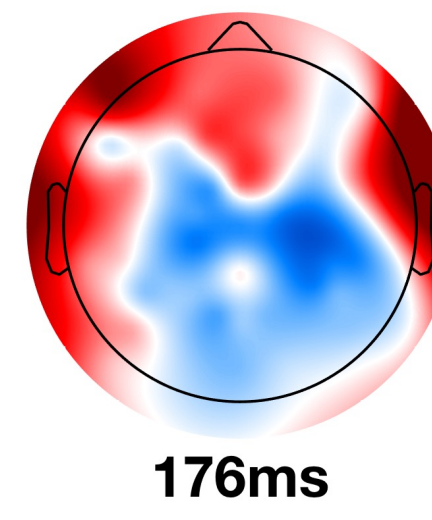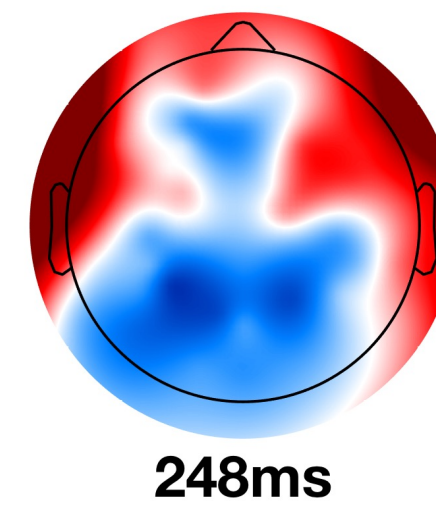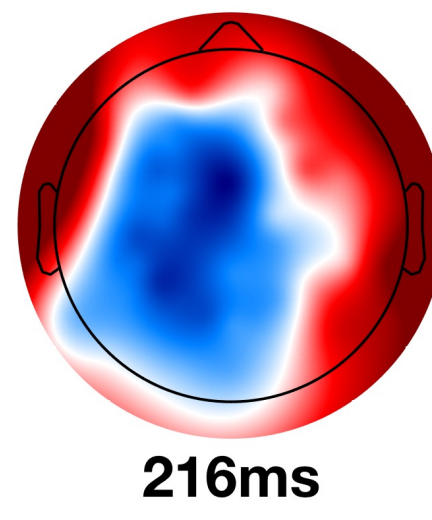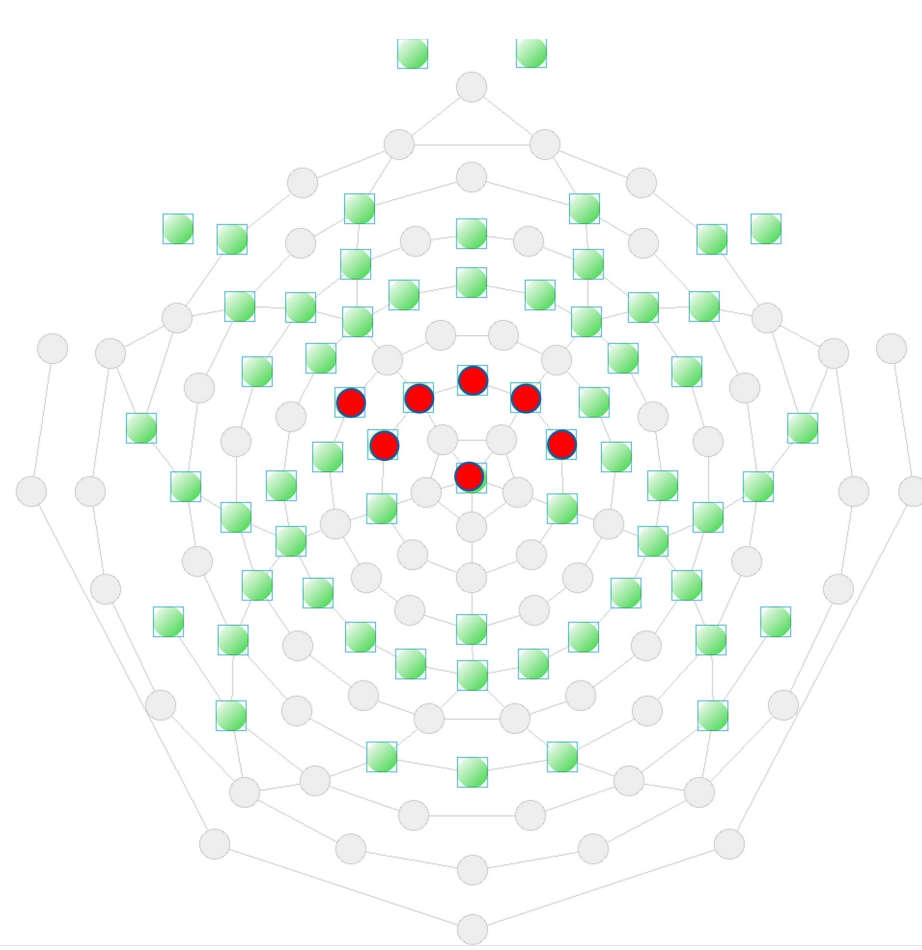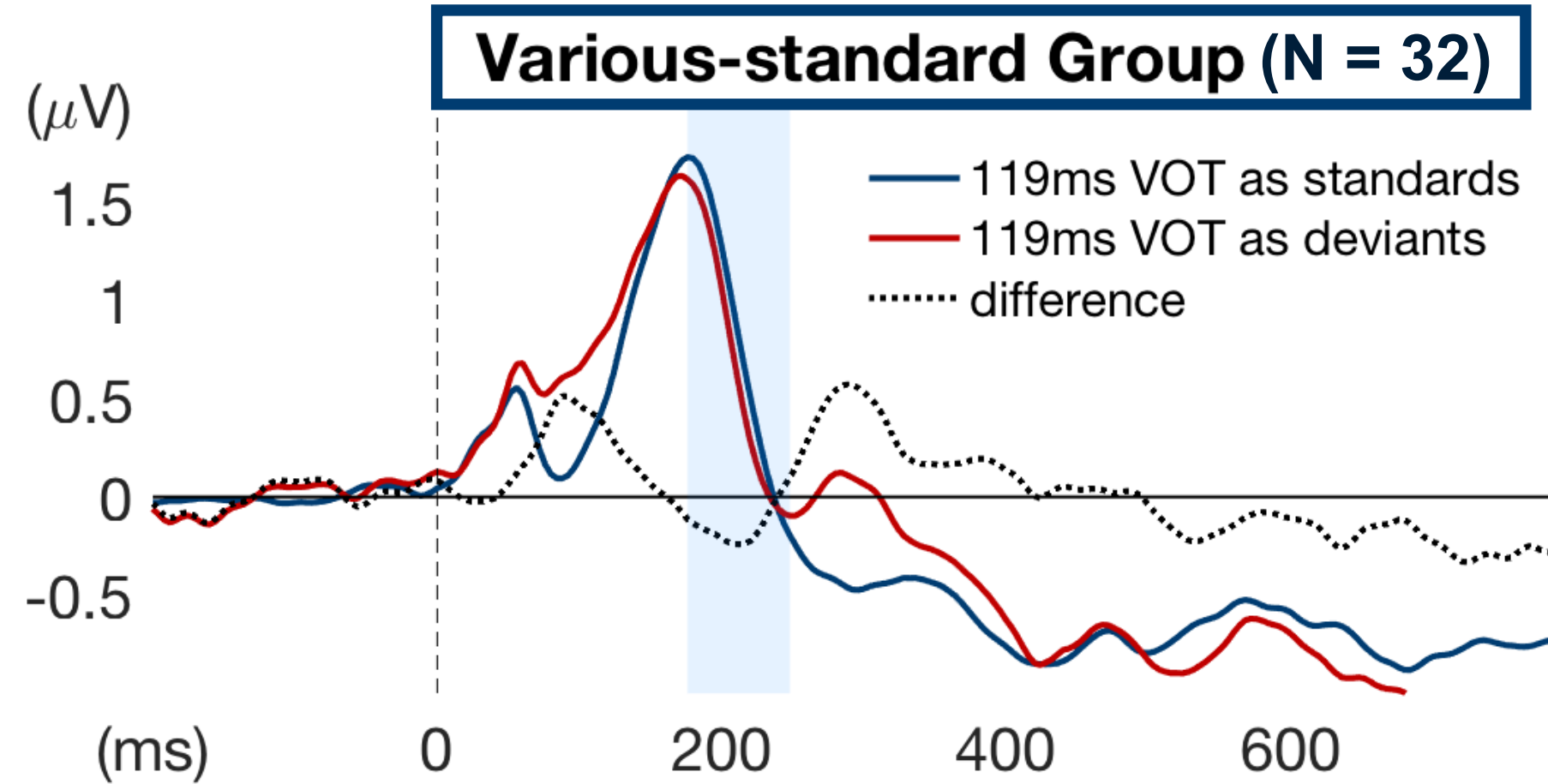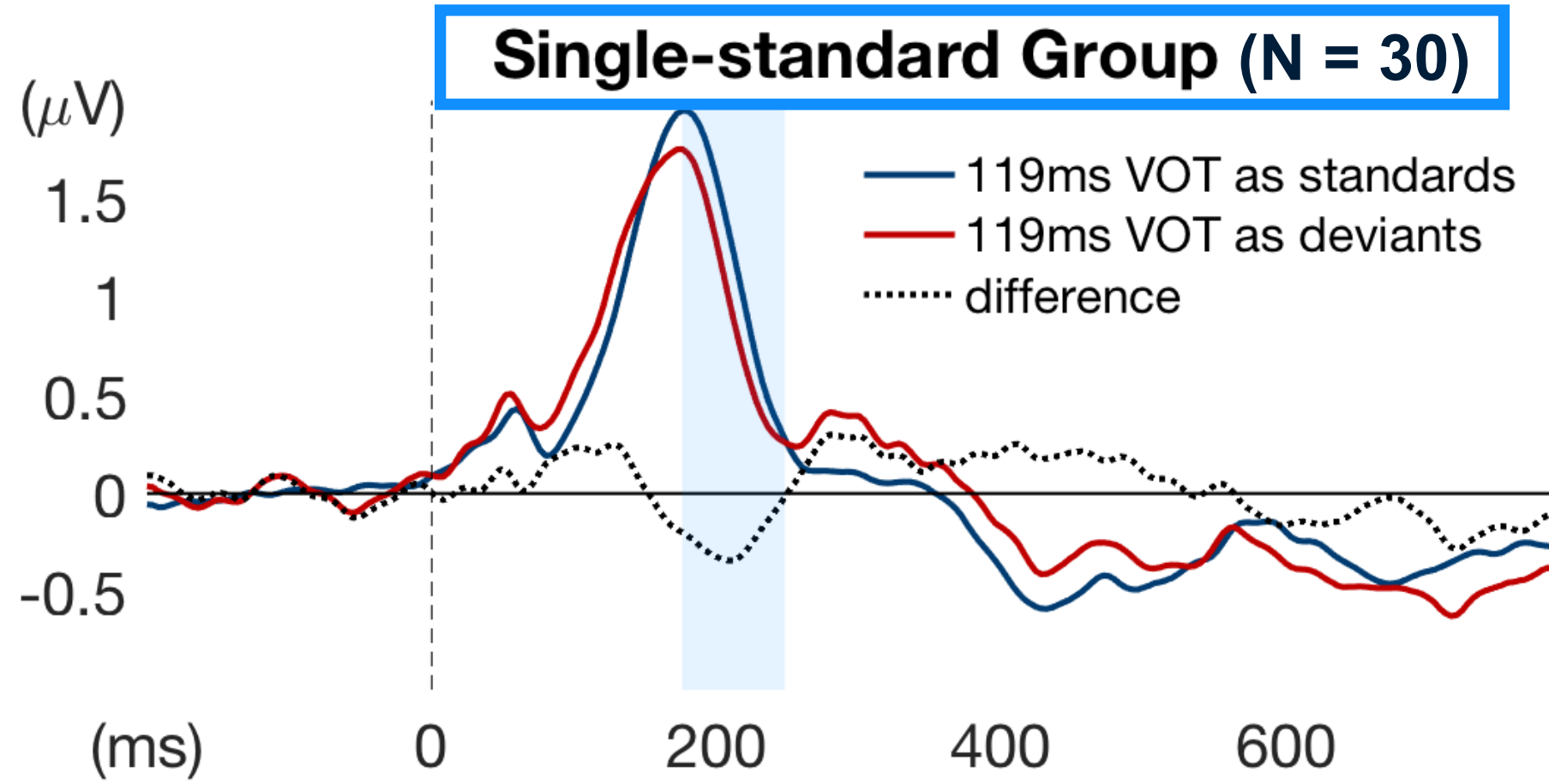
- **Interpretation:** MMN in both groups ⇒ sensitivity to phonetic details when a phoneme representation is enforced ⇒ The phoneme representation must contain phonetic information.
- **Alternative:** The various-standard MMN is due to detecting an outlier in the statistical summary of presented VOTs.
- **Follow-up:** Will there still be MMN if standards are atypical VOTs and deviants are typical VOT?