

Symbolic vs. Gradient Phonemes

Chao Han¹, Ryan Rhodes², William Idsardi³, Arild Hestvik¹

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



Funded by NSF DDRI Linguistics
Grant Number: 2041266

Summary

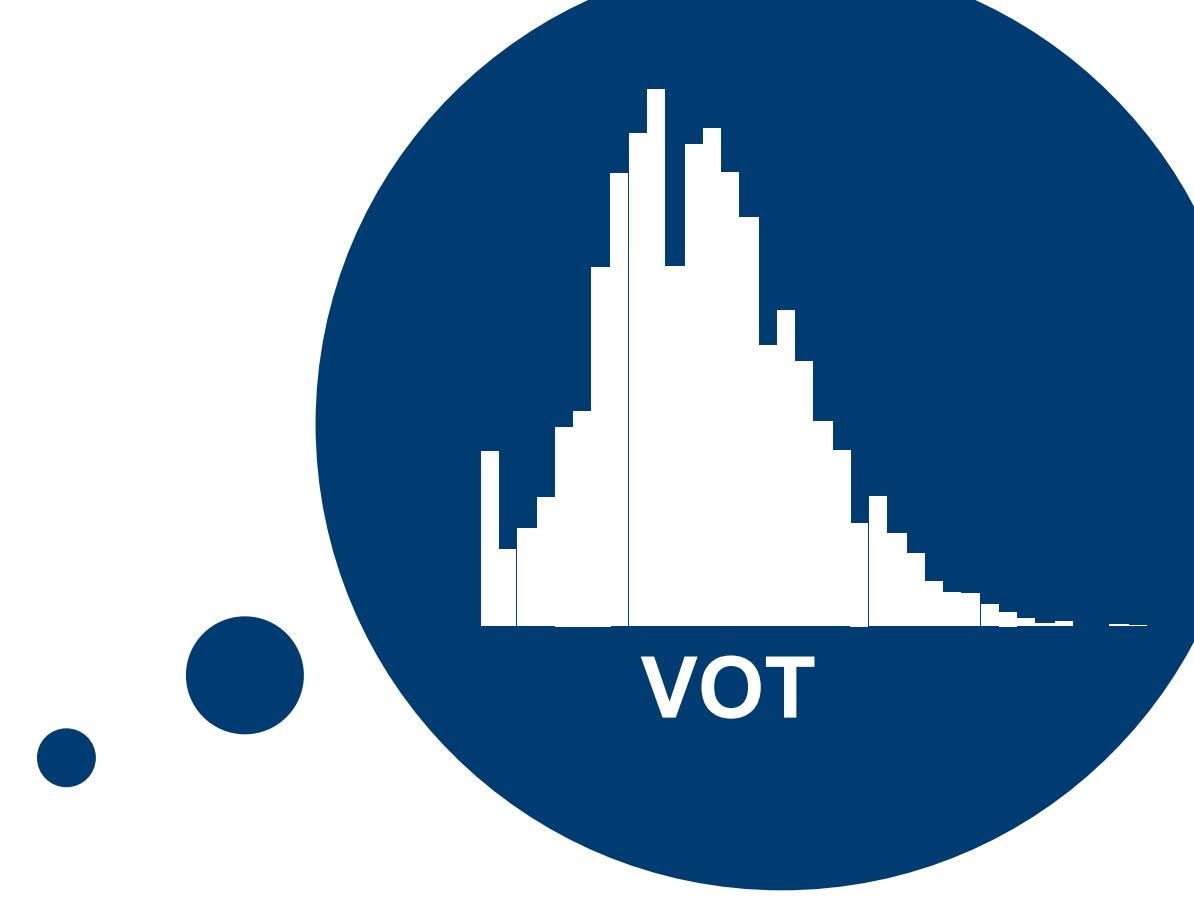
Question: Does a phoneme representation contain phonetic information?
Main Finding: Yes.

Background: Competing views

Phoneme is symbolic.
(e.g., Substance-free Phonology^[1])

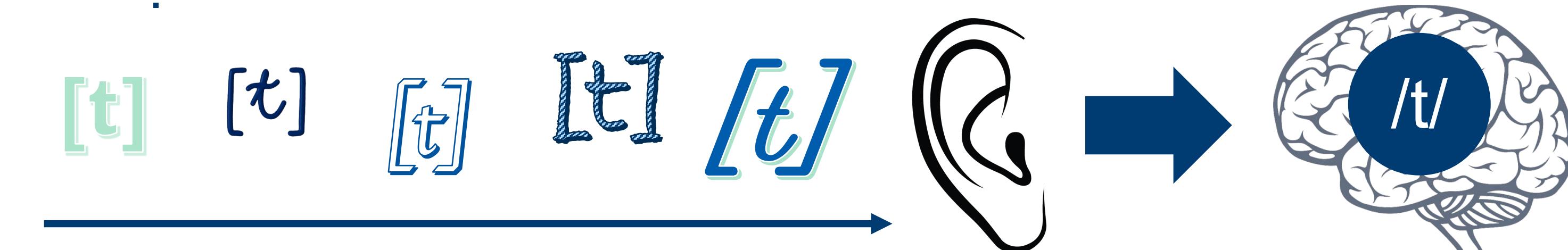


Phoneme is gradient.
(e.g., Stochastic phonology^[2])

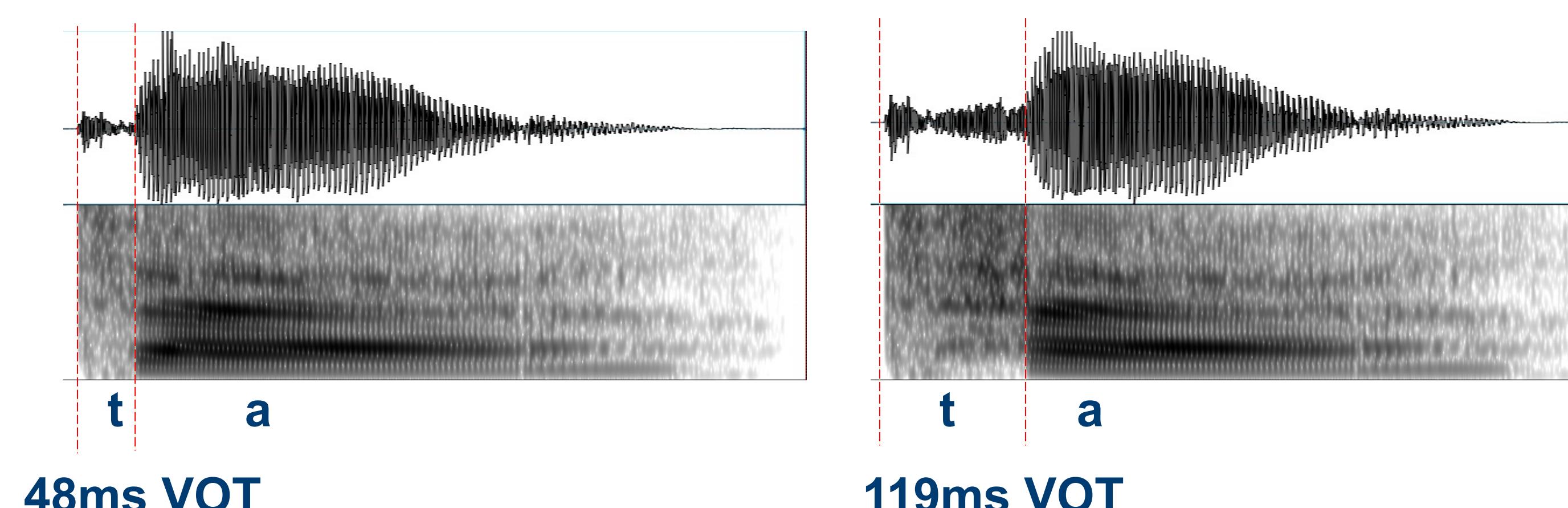


How to test them?

- MMN reflects a difference between a deviant and the memory trace of standards.
- The “various-standard” oddball paradigm: Varying standards belonging to the same category elicits a categorical representation.
- When standards are [ta]s with different VOTs, the elicited categorical representation is the phoneme representation /t/ [3].



Stimuli: [ta] with different VOTs^[4]



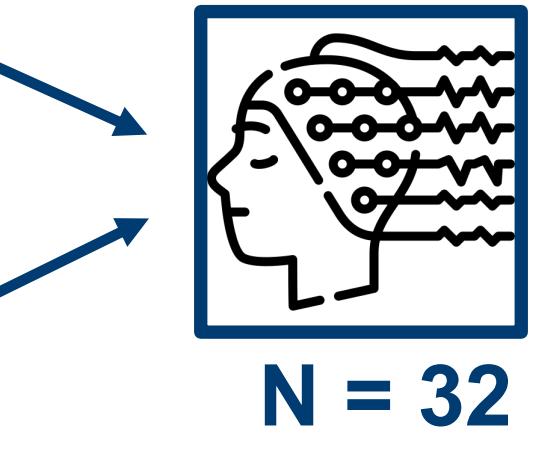
Experiment 1

Roving-standard block (control)

19 119 119 119 119 119 19

↓

MMN?



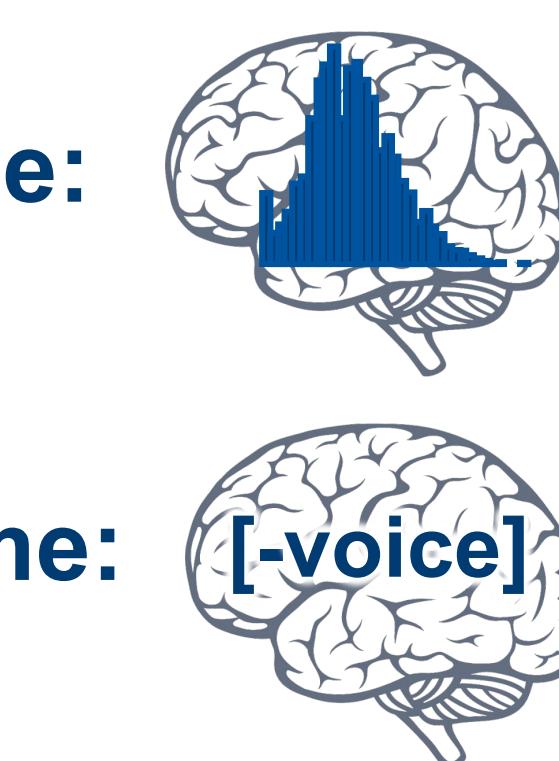
N = 32

Various-standard block

42 55 48 42 48 119 55

Predictions

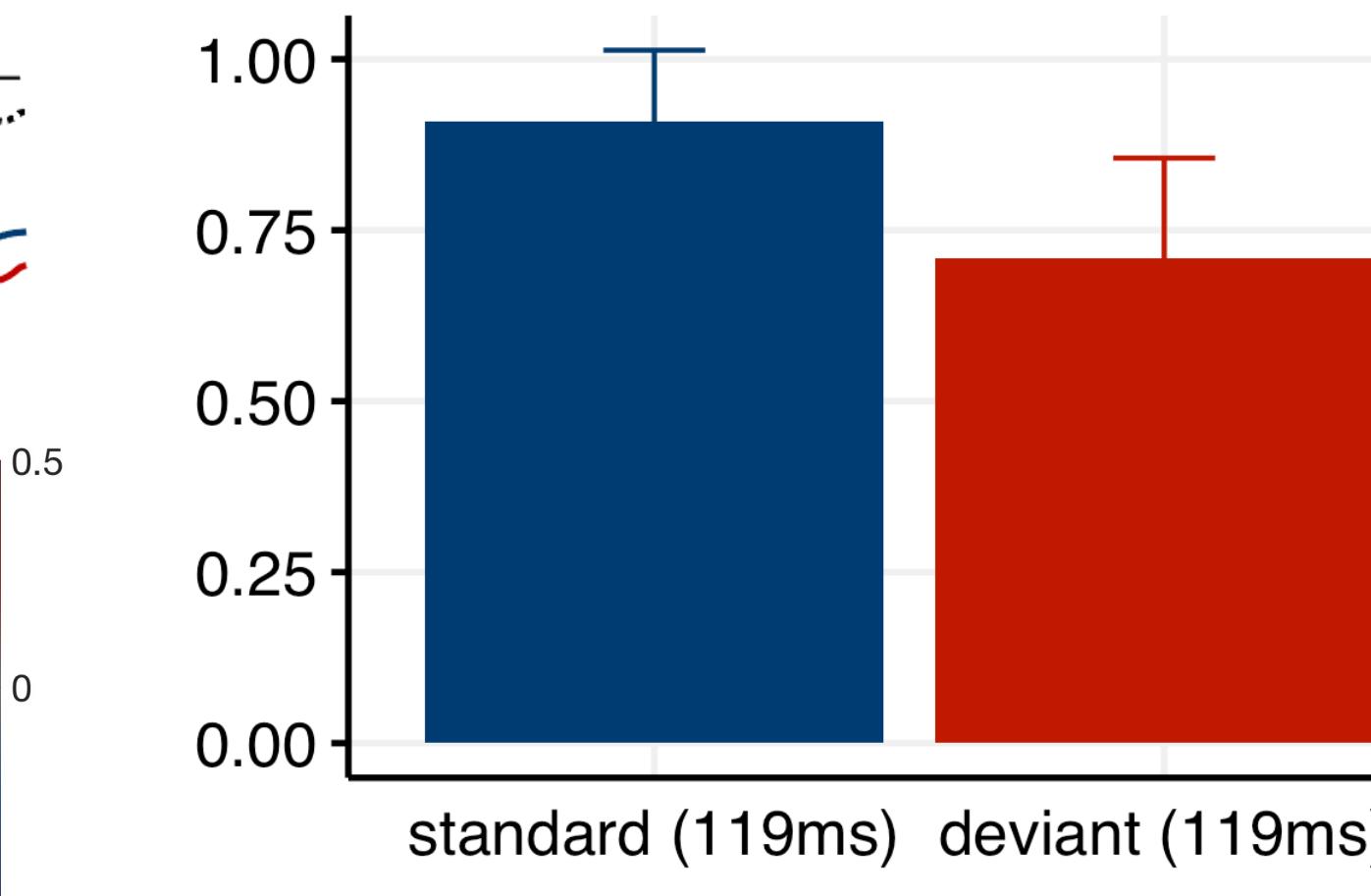
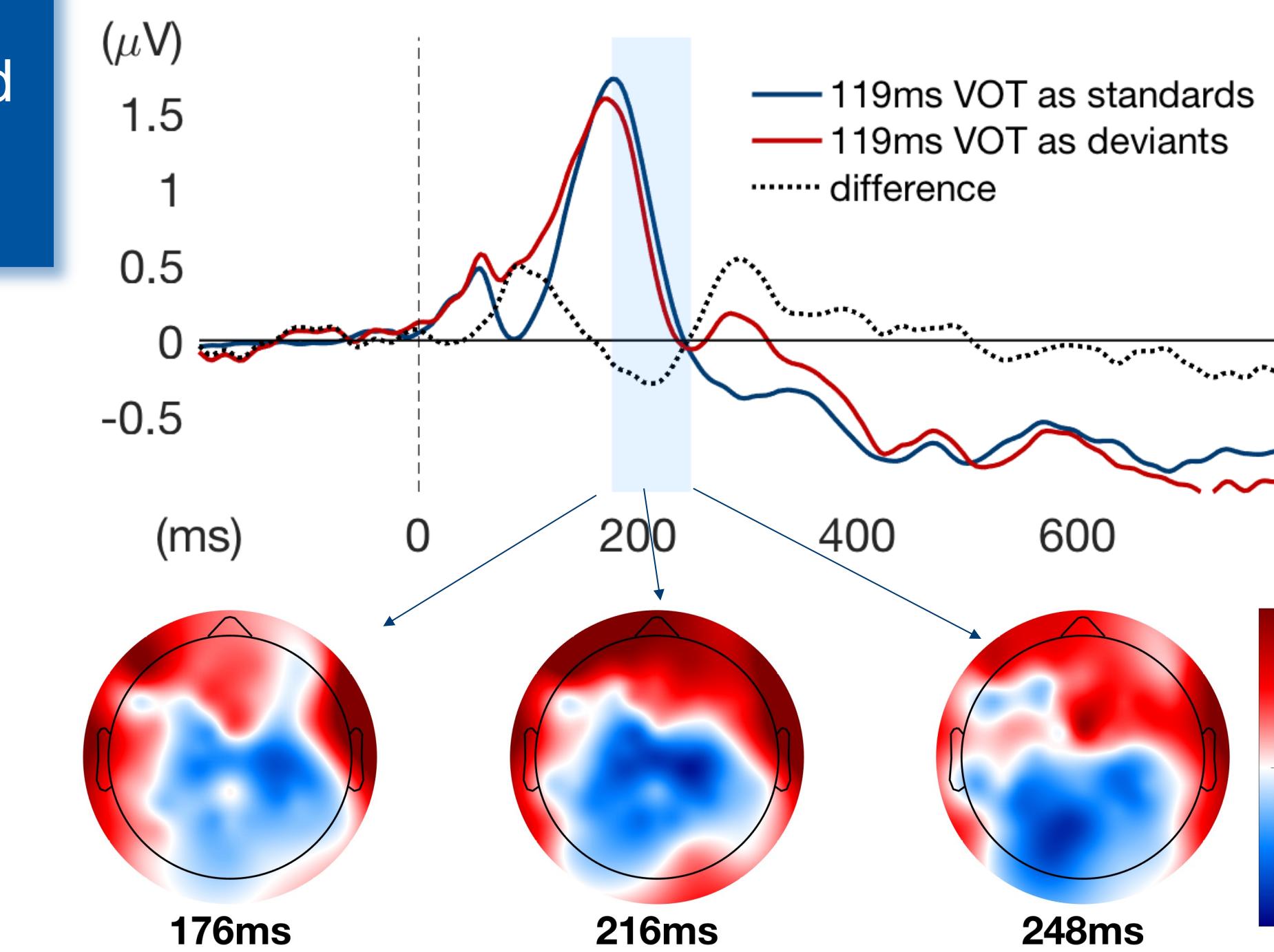
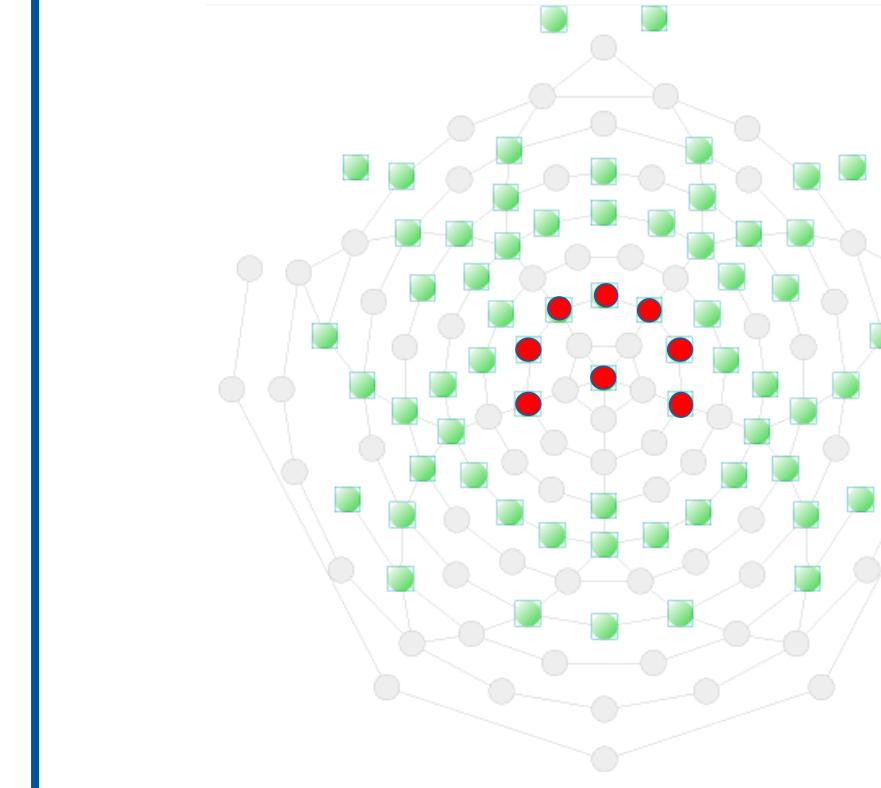
Gradient phoneme: + 119 → MMN



Symbolic phoneme: + 119 → no MMN



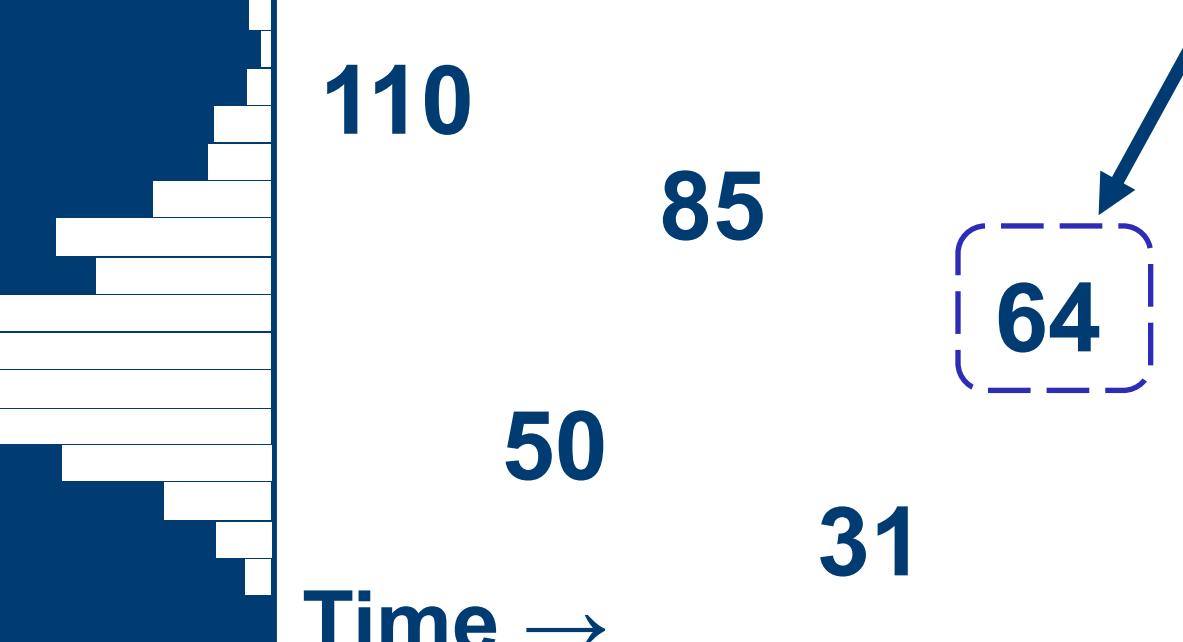
Results: MMN as ERP average over 176-248ms, and 8 frontocentral channels (delimited by PCA^[5]).



- **Interpretation:** Within-category MMN in various-standard block ⇒ 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^[6].
- **Exp 2:** Does MMN size depend on the variability of the presented VOT?

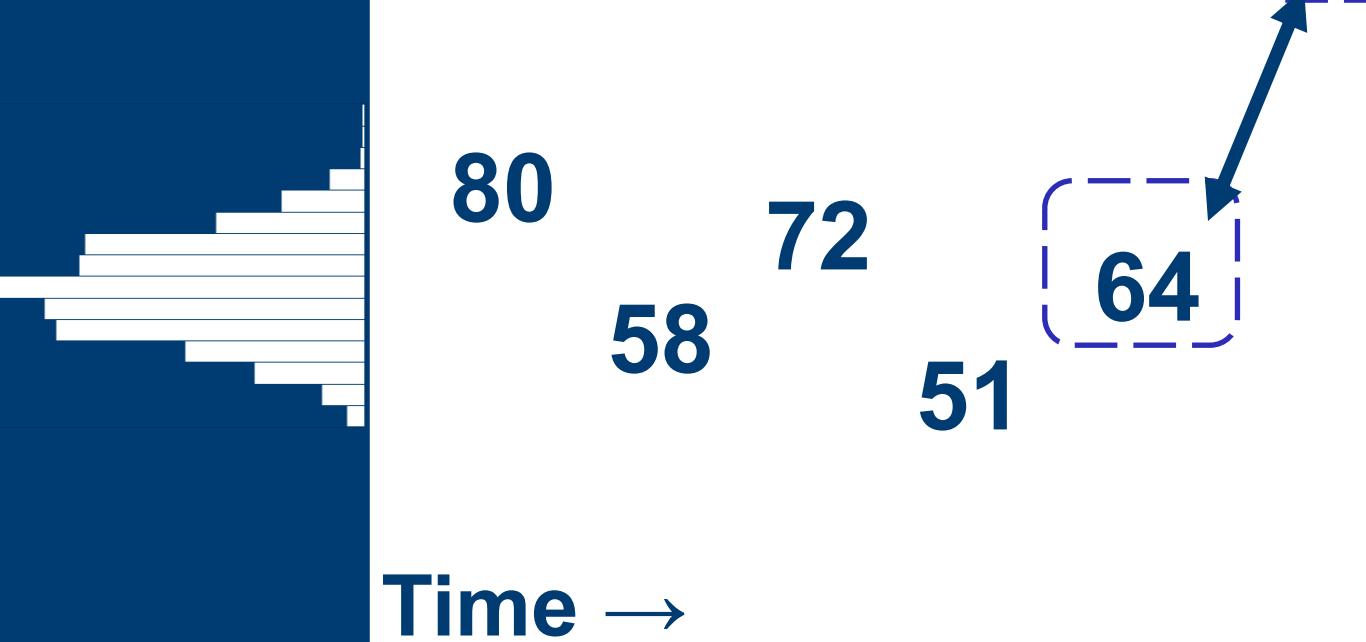
Experiment 2

Wide-distribution block (mean = 64, SD = 15)



Time →

Narrow-distribution block (mean = 64, SD = 5)

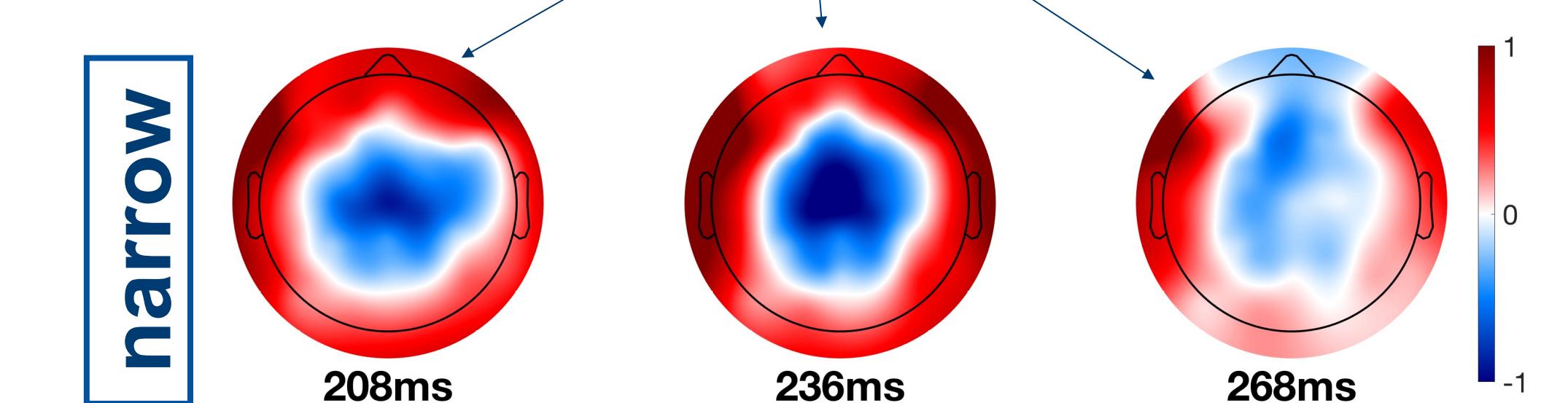
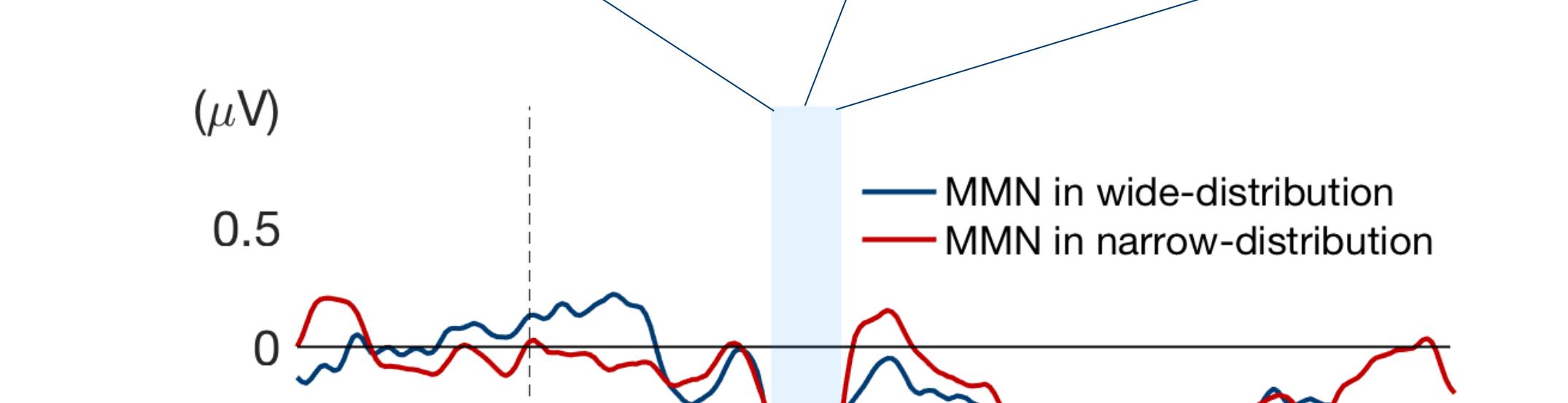
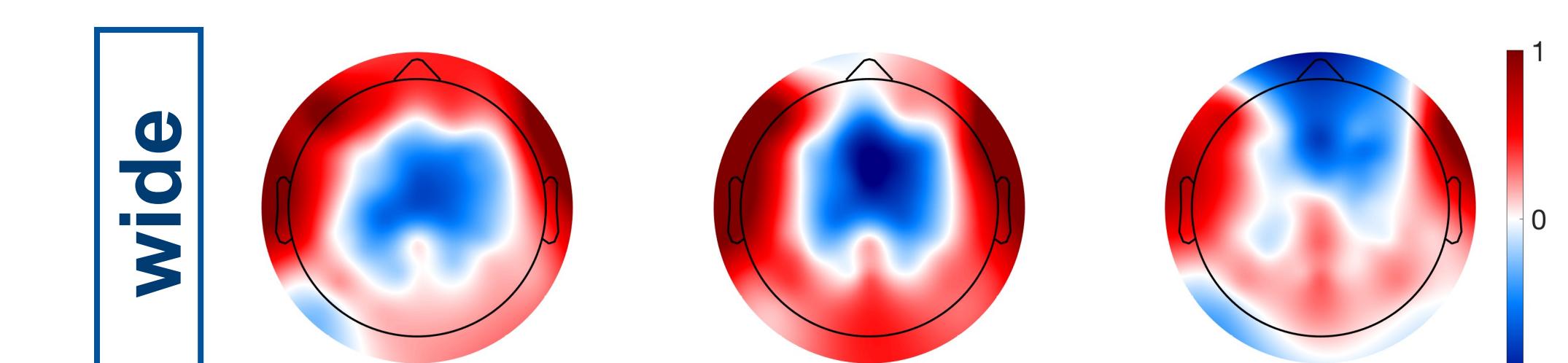
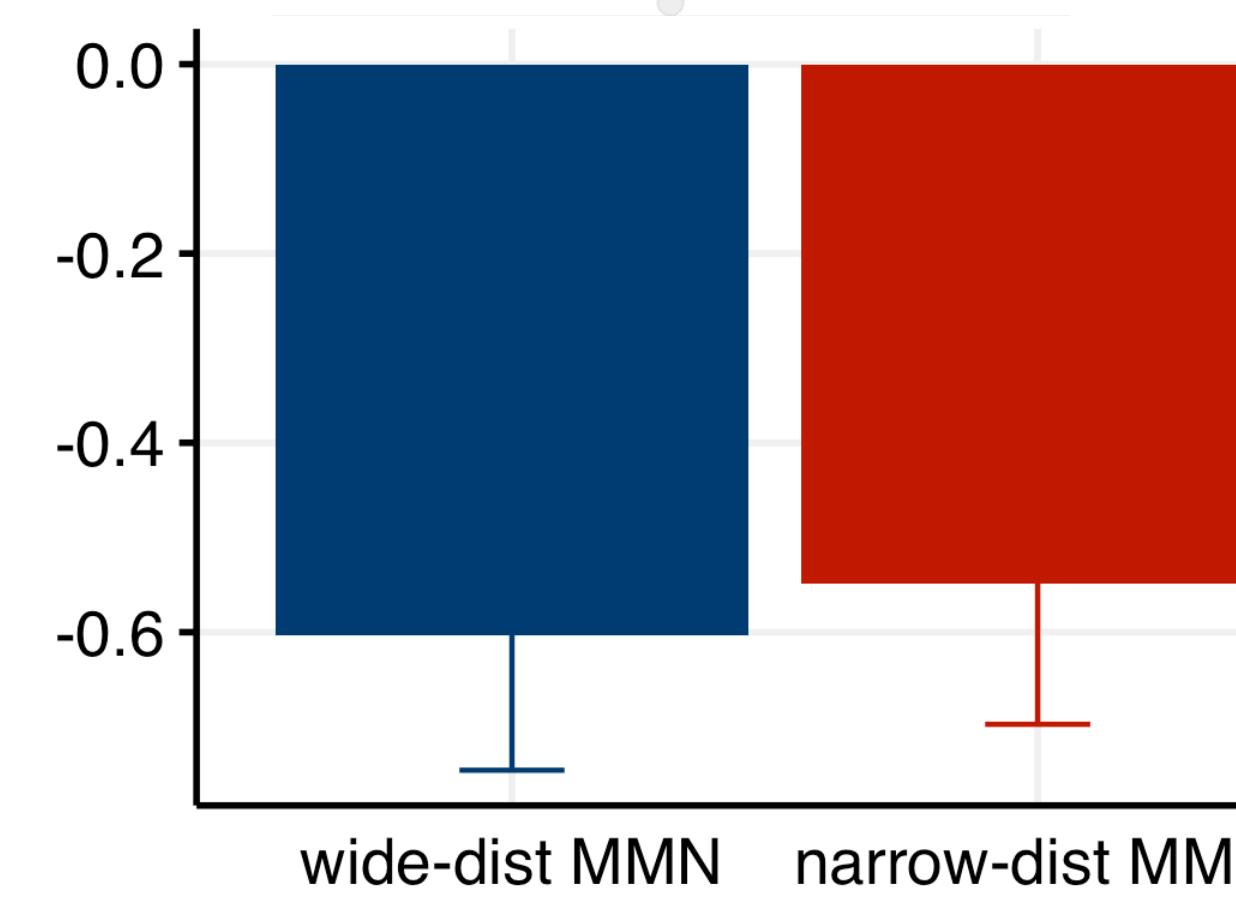
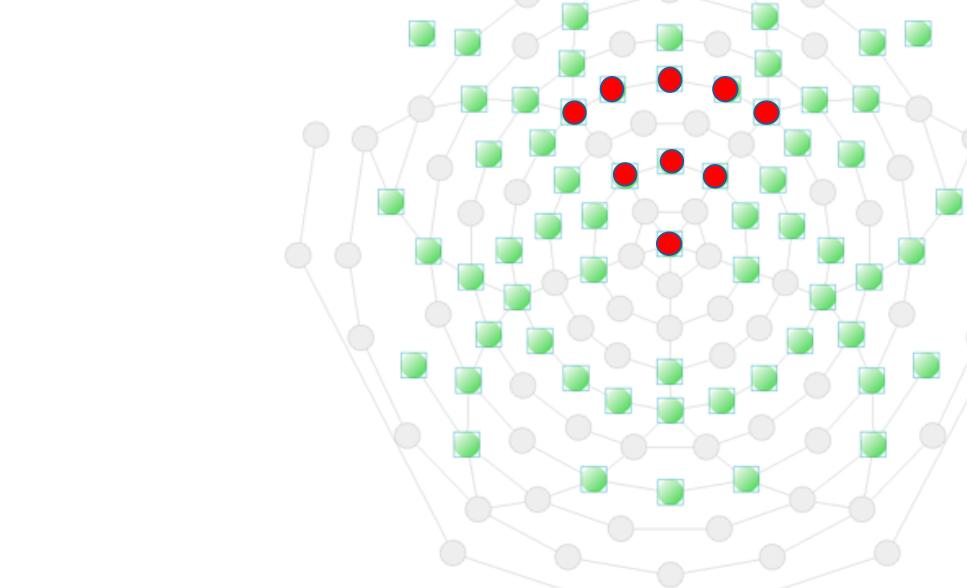


Time →

Wide-distribution Group (N = 17)

Narrow-distribution Group (N = 18)

Results: MMN as ERP average over 208-268ms, and 9 frontocentral channels (delimited by PCA).



Predictions

Statistical summary: MMN < MMN

Phonetic information: MMN = MMN

- **Interpretation:** No difference in MMN size ⇒ The within-category MMN in Exp 1 is due to phonetic information.
- **Alternative:** Ceiling effect, perceptual warping?
- **Follow-up:** Will there still be MMN if standards have an atypical VOT and deviants a typical VOT?