Perception of continuous acoustic cues in speech revealed by the auditory N1 and P3 ERP components

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INTRODUCTION
What information is contained in the speech signal?

Two stages of processing:
1) Initial encoding of speech sounds
2) Classification of sounds (categorization)

Is cue encoding based on auditory features or phonological categories?
Listeners are sensitive to within-category differences, but responses reflect category structure.
Suggests that either (1) encoding is shaped by categories, or (2) behavioral tasks aren’t measuring encoding

PREDICTIONS
N1 predictions
- If encoding is based on auditory features, monotonic response
- If encoding is based on categories, nonlinear response centered on category boundaries

P3 predictions: If sensitivity to acoustic detail is maintained at late stages of processing, within-category variation in P3 amplitude

EXPERIMENT 1
Synthetic stimuli varying along two VOT continua (beach-peach and dart-tart); target detection task

ERP approach to isolate encoding and categorization
(Neumann, McMurray, Dennhardt, & Luck, 2015)

APPROACH

EEG recording
- N1: average of F3, Fz, and F4 channels
- P3: average of P3, Pz, P4 channels
- Average mastoid reference
- Impedance ≤ 5 kΩ

Stimuli varied along continuous acoustic dimensions

EXPERIMENT 2
Can we measure differences in N1 amplitude for other types of speech sounds (e.g., natural speech instead of synthetic speech)?

EXPERIMENT 3 — P3
P3 Results: Amplitude decreased with distance from boundaries for both continuants

EXPERIMENT 3 — N1
Examined different acoustic and phonological dimension — vowel differences indicated by F1 frequency

CONCLUSIONS
New tool for measuring online speech processing
Auditory N1 reflects cue encoding
P3 reflects categorization
Can be applied to various acoustic cues and classes of phonemes, and both natural and synthetic speech
However, some acoustic cue differences may not be observable in ERP response

What can this tell us about speech perception?
Continuous acoustic cues encoded independently of phoneme categories
Listeners maintain acoustic sensitivity after cue encoding
Overall, supports models that harness fine-grained acoustic information in the signal

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REFERENCES