Interdependent processing of speech and background noise

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Introduction

To investigate the perceptual integration of indexical (gender, talker) and phonetic features with noise. American English listeners completed a speeded classification (Garner) task, where they were asked to attend to one dimension while ignoring another (control, orthogonal) or varied randomly (orthogonal). The results revealed that noise, phonetic and indexical features of speech cannot be completely segregated during speech processing, even when the two auditory streams are spectrally non-overlapping. Perceptual interference was asymmetric (more relevant variation in the speech dimension slowed noise classification to a greater degree than noise variation for speech classification). This suggests that context-specific information from a separate source (e.g. noise) is not perceptually integrated with individual and phonetic information conveyed by the speech signal.

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Methods

Participants & Stimuli

- 216 American English listeners
- 56 English discables (Gender/Talker conditions)
- 40 English monosyllables (Phonetic condition)

Procedure & Analysis

- Participants classified items on two dimensions: noise (pure-tone vs. white noise) and either 1) gender (male vs. female), 2) talker identity (Low vs. High) or 3) phonetic contrast (\(/p/\) vs. \(/b/\)).
- Orthogonal:
  - One value of indexical dimension consistently paired with one value of noise dimension (e.g., main male voice paired with white noise; female talker paired with the pure tone).

Results

- Baseline response speed (control RT). Did not differ as a function of spectral separation or dimension of classification.
- Significant redundancy gain and interference effects found for both noise and talker dimensions.
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Discussion & Conclusions

The current results revealed that certain indexical and phonetic features conveyed by the speech signal are perceptually integrated with noise during speech processing, even when the speech and noise signals are spectrally non-overlapping.

A general pattern of processing asymmetry emerged: noise classifications were more adversely affected by variation in the speech signal than the reverse.

Interpersonal and memory paradigms.

- Could stem from an asymmetry in the information value of the dimensions being processed, with speech-intrinsic dimensions having greater information value than speech-external dimensions.
- E.g., noise distance in classification difficulty prior work has framed [1],[2].
- For example, listeners were faster at noise classifications than talker classifications, but the noise dimension suffered greater interference from talker variation.
- These findings point to a relationship between the perceptual processes encoding indexical and phonetic information in the speech signal and the processes that encode information about extraneous noise signals.
- Perceptual interference was reduced when the level of talker or talker classification, and this suggests that temporally concurrent context specific information is automatically processed during speech perception, at least at the level of perceptual classification tapped by the present speeded classification Garner task.
- Follow-up work examines whether the interfering of the speech and noise dimensions extends beyond the initial stages of perceptual classification to the initial stages of perceptual integration.

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References


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