Assessing the contribution of spectral cues to recognition of frequency-lowered consonants

Methods

Listeners match frequency-lowered fricatives across vowel contexts. Three frequency-lowering treatments differ in degree of spectral contrast.

31-2AFC task

Reference interval contains the target consonant (e.g. /θ/). Target interval contains the same consonant, but a different vowel from the reference (e.g. /aθ/).

Materials

- 4 frequency-lowering consonants [F, M, S, SH]
- 2 subjects (male and female)
- 2 weeks (1st, 2nd)

Presentation

- Headphone presentation (HD600)
- Speech-shaped noise at 20 dB SNR
- 60 dB SPL presentation in test ear
- Bandpass filtered via Hi-Q®

Training*

- 2 practice trials per session
- 2 trials (44 trials per test 4 days per week)
- 2 listeners listened to training each session
- Practice trials were designed to minimize any effects of training on performance
- Listeners were trained on the consonants before the start of the experiment

Participant

Nine participants, ages 68 to 87 (avg 74.9) years

Frequency lowering candidates

- Threshold = 45 dB HL above 4 kHz
- Threshold = 20 dB below 1.5 kHz
- Auditory angle = 35 kHz for tones in at least one ear

Participants

- Nine participants, ages 68 to 87 (avg 74.9) years
- Frequency lowering candidates
- Thresholds = 45 dB HL above 4 kHz
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Treated in better ear if both ears meet the criteria.

Treatments

- Oracle labeling
- Estimate power spectrum in 125 ms frames
- Compute power in one octave neighborhood of two peaks
- Synthesize narrowband noise components

One-fixed frequency component

- Removes spectral cues

Two-variable frequency components

- Compares spectral cues

Two fixed frequency components, with classification

- One or two components according to phoneme class
- Exaggerates spectral cues

One component

- Two components

Two w/classification

Reference interval contains the target consonant (e.g. /θ/).

Overall Performance

Performance under all treatments (including no-treatment) was highly variable within and between subjects.

Data to show no general benefit of any of the treatments relative to no-treatment...

...but this is not the only measure of benefit due to frequency lowering.

Most subjects showed substantial benefit in a frequency detection task.

Effect of spectral cue preservation

Effect of preserving or enhancing spectral cues was highly variable within and between subjects.

Statistically significant differences among treatments (based on 95% Bayesian confidence intervals) were only observed for a few subjects and consonants.

Treatments preserving or enhancing spectral cues produce fewer confusions for consonant pairs that include /θ/ than treatments that remove spectral cues.

Results

5 subjects completed all four treatments (data collection in-progress)

Data were analyzed using a hierarchical Bayesian model[2].

No effect of training - data shown is collapsed across sessions.

Hierarchical Bayesian

The latent ability variable, \( x \), was modeled as a linear function of the session number.

All terms modeled using mixed random variables, with means and variances assigned Gaussian and half-t priors, respectively, and learned from the data.

The authors gratefully acknowledge the generous assistance of Sandy Jobes, and of the participants in this study.


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