Objectives and Research Questions

Acutal methods for measuring vowel nasality are increasingly being used in the linguistic literature. Although these measures have been shown to be correlated with nasality, their variability across speakers has been largely ignored. Here, we ask three research questions:

1. Do A1-P0 and F1’s Bandwidth vary across speakers?
2. What is the nature of this variability?
3. How can we best compare nasality across speakers?

Features Examined

F1’s Bandwidth

- Found to be primary cue for the perception of vowel nasality
- A1-P0
  • Measures the amplitude of the nasal pole near 250Hz (‘P0’)
  • Very commonly used composite measure of vowel nasality
- F1’s Bandwidth
  • Was found to be primary cue for the perception of vowel nasality
  • A1 is the amplitude of the harmonic nearest to the center of the first formant in the LPC analysis
  • F1 Bandwidth decreases with increased nasality
  • F1’s Bandwidth increases with increased nasality

Feature Measurement

All features were measured automatically by script using the Praat Phonetics Software Package.

1. Hand annotate vowel boundaries in each word
2. Automatically extract two measures per vowel (at 1 and 2) using Praat

- The Nasality Automeasure Praat script (c.f. Styler 2015) was used to extract all measures
- P0 is defined as the amplitude of H1 or H2, whichever is greater
- A1 is the amplitude of the harmonic nearest to the center of the first formant in the LPC analysis
- F1 Bandwidth extracted directly from LPC analysis
- Two timepoints were used to capture both carryover and anticipatory coarticulation
- Suspect measurements were flagged and removed
- Means were compared across speakers for each phonological structure in each corpus, averaged over the two timepoints

About the Corpora

Colorado Corpus

- 3823 words in CVC, NVC, CVN and NVN quadruplets from 12 college-aged speakers at the University of Colorado. Collected in 2014 in preparation for Styler 2015.
  - Sets like “bad, mad, man”, with words including the vowels /I e I e e in a oo uu/

Michigan Corpus

- 5820 words in CVt, CVd, CVNt, CVNd quadruplets with similar NVNs from 17 college-aged speakers at the University of Michigan. Collected in 2015 for ongoing NSF grant work.
  - Sets like “bet, bed, bent, bend” with separate NVNs, with words including the vowels /I i I a/

Normalizing Nasality?

These Acoustical Nasality measures seem to act much like Vowel Formant measures in analysis:

- Within-speaker, across-condition levels and differences are safe and easily interpreted
- Values in isolation do not map onto categories across speakers (e.g. “oral” vs. “nasalized”)
- Changes usually indicate changes in nasality, but the degree of change is not interpretable

Can we “normalize” nasality using similar techniques as we use for vowel formants?

- Variation in baseline and range can be controlled within speakers by centering or Z-Scoring measurements
- More precise algorithmic normalization of nasality measures may be possible and permit safer comparisons

Conclusions

1. Both A1-P0 and F1’s Bandwidth vary considerably across speakers
2. There is variability both in terms of baseline and range
   - Speakers have different raw values for ‘oral’ and ‘nasal’
   - Speakers show different amounts of change between oral vowels and maximally nasal vowels
3. Across-speaker comparison of nasality is difficult
   - These differences confound direct comparisons of both raw values and changes across speakers
   - The problem isn’t eliminated by using mixed-effects models with random slopes by speaker
   - Scaling data to percentage of overall range can help to compare ΔNasality
   - Normalization may be possible (but imperfect)
   - Within-speaker comparisons are still the best approach

References and Acknowledgements

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