Influences on perceived foreign accentedness: Acoustic distances and lexical neighborhoods

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Foreign Accentedness

- Foreign Accent
  - Non-native speakers of a language fail to reach native-like acoustic targets for articulatory and phonological reasons (Flege, 1980; Flege & Hillenbrand, 1984)
  - Non-native productions are different from native speaker productions on a variety of acoustic measures, e.g., word duration and formant values (Baker et al., 2011; Munro, 1993; Wayland, 1997)
  - Native listeners can detect accent in as little as 30 ms of a burst release (Flege, 1984)

Foreign Accentedness

- Acoustic distances
  - Acoustic variables predict accentedness ratings when taken as distances from native speaker acoustic values (Munro, 1993; Wayland, 1997; Porretta & Tucker, 2012)
- Lexical variables
  - Accentedness ratings affected by word frequency; higher frequency -> lower rating (Levi, Winters, & Pisoni, 2007)

- This study proposes that the perception of foreign accentedness is based on usage (cf. Bybee, 2003; Pierrehumbert, 2001)

Questions

- Which acoustic distance measures (relative to typical native productions) of Chinese-accented English influence accentedness ratings?
- Do lexical variables in addition to frequency (e.g., phonological connectivity between words) influence ratings?
- Do these acoustic and lexical variables interact?

Study

Materials:

- Wildcat Corpus of native- and foreign-accented English (Van Engen et al., 2010)
- 40 monosyllabic words from word list
- Perception study
  - 10 male speakers (1 English, 9 Chinese)
- Acoustic reference
  - 6 separate male English speakers

Study

Acoustic Measurements:

- Word duration
- Vowel duration
- Midpoint formant values (F1 – F3)

Acoustic Variables:

- Log normalized formant values
- Vowel-to-Word ratio
- Conversion to distance measures
  - Acoustic reference (mean measurements from 6 native speakers)
  - Absolute value of talker subtracted from acoustic reference

Study

Lexical Variables:

- Lexical frequencies from COCA (Davies, 2008)
- Phonotactic probability (Vitevitch & Luce, 2004)
- Number of phonological neighbors from the English Lexicon Project (Balota et al., 2007)
  - Words with a one-phoneme difference, e.g., /bæt/ is neighbors with /sæt/ and /mæt/
- Clustering coefficient (cf. Chan & Vitevitch, 2009)
  - Graph theory was used to quantify the connectivity among phonological neighbors

Study

Accentedness Ratings:

- 30 native English-speaking raters
- 400 items (40 stimuli spoken by each of the 10 talkers)
- Scale: 1 (no foreign accent) to 9 (very strong foreign accent)
- Mean item rating calculated
  - Correlated with global accent rating for each talker in the Wildcat Corpus (R^2=0.8995)

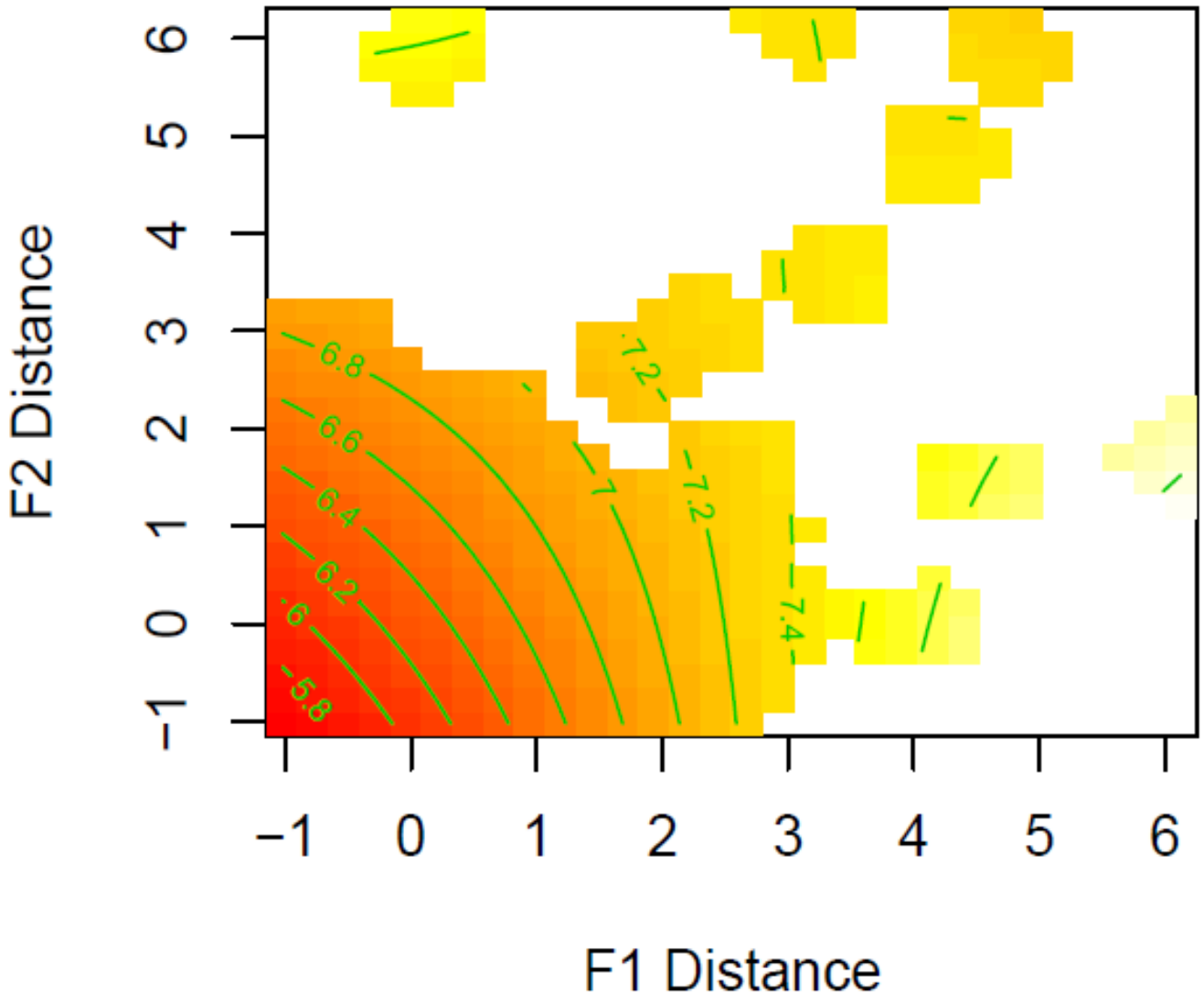
Analysis

Generalized additive mixed modeling (Wood, 2006)

- Response variable
  - Mean item rating
- Predictor variables (standardized/collinearity checked)
  - Word identity
  - Vowel-to-Word ratio Distance
  - Log F1 Distance, Log F2 Distance
  - Phonotactic probability
  - Log word frequency
  - Degree (Neighborhood density)
  - Clustering Coefficient
  - Random effects for Word and Talker

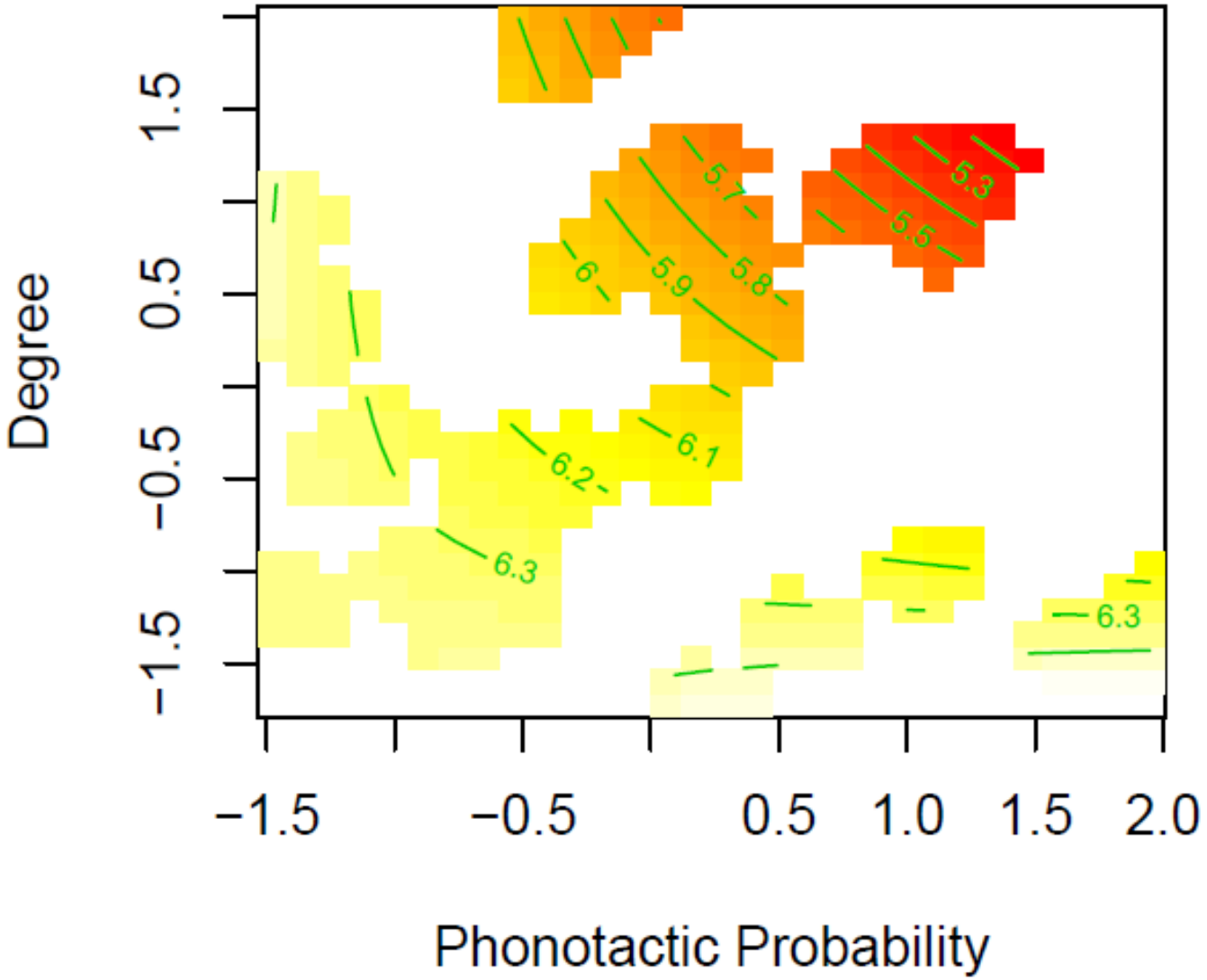
Results

Interaction between log F1 Distance and log F2 Distance



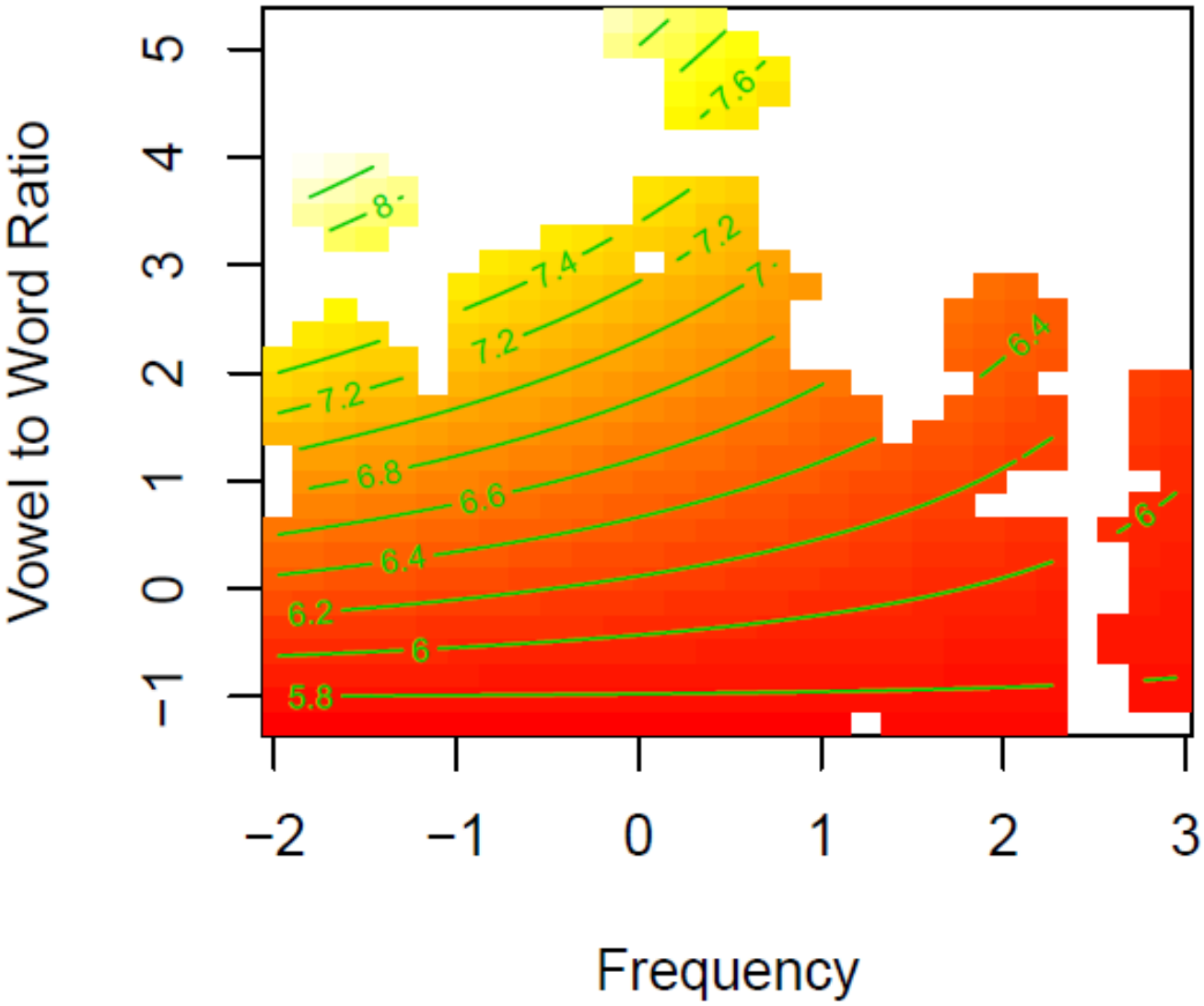
Results

Interaction between Phonotactic probability and Degree (N. Density)



Results

Interaction between Vowel-to-Word ratio Distance and log Frequency (Clust. Coef. = mean)



Summary of Results

- The interaction of the First and Second Formant Distances is correlated with higher ratings
- Neighborhood Density interacts with Phonotactic Probability such that rating decreases when the phonemic sequence is probable and many neighbors exist.
- A three-way interaction emerged between Vowel-to-Word Ratio Distance (i.e., the distance of the proportion of vowel and word durations), Frequency, and Clustering Coefficient.

Conclusions

- Spectral deviations (from typical native vowel productions) lead to higher perceived accentedness
- Denser neighborhoods may provide more targets by which to match the token when the phonemic sequence is probable
- The interaction of word frequency and temporal acoustics (vowel-to-word ratio) along with the connectivity among neighbors indicates that the properties of both the lexicon and those of the token affect perceived accentedness

Take-home message

The model suggests:

- The lexicon is highly connected
- It contains multidimensional, probabilistic and distributional information
- Listeners are likely to use this learned information for evaluating a token's "goodness of fit" within their native language
- The perception of variation (at least at the word level) is affected by acoustic distance from native-like representations as well as connections within the lexicon

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