F3 VARIABILITY IN ALLOPHONES OF /l/: ACOUSTIC-ARTICULATORY RELATIONS

ANISIA POPESCU UNIVERSITÉ PARIS DIDEROT anisia.popescu@univ-paris-diderot.fr

1. INTRODUCTION

Gestural composition of syllable position allophones in English (Sproat & Fujimura 1993)

- Onsets: clear /l/ ([l])
  1. consonantal gesture: tongue tip raising
  2. vocalic gesture: tongue dorsum lowering
- Codas: dark /l/ ([ɬ])
  1. vocalic gesture: tongue dorsum retraction towards the uvular region
  2. consonantal gesture: tongue tip raising

F3 values in laterals (Recasens 2012, Stevens 1998)

- F3 is higher in dark /l/ than in clear /l/
- Difference attributed to closure fronting and front cavity configuration

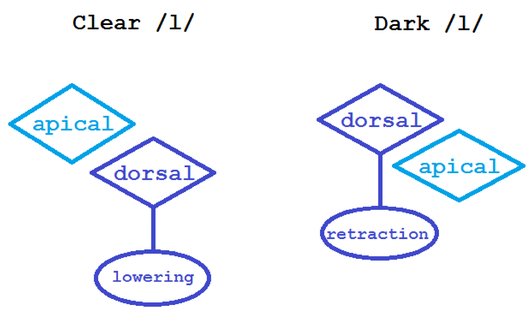


Figure 1: Gestural composition and timing of lateral allophones

- This paper proposes an explanation for higher F3 in [ɬ] based on F3 Sensitivity Functions

2. HYPOTHESIS

- Vocal tract (VT): has 8 regions, each with a distinctive acoustic behavior
- Sensitivity Functions (SF) (Iskarous 2012)
  - formant change (F1, F2, F3) as a function of constriction location in the VT
- Constrictions:
  - Dark /l/: coronal and uvular
  - Clear /l/: coronal
- 2 maxima for F3 SF: each corresponding to a constriction location (uvular and coronal)

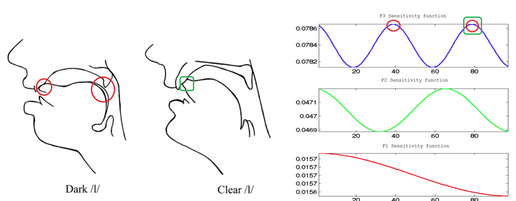


Figure 2: **Left**: Sagital sections of dark and clear /l/, **Right**: F1, F2, F3 Sensitivity Functions

- **Prediction**:
  For varieties of /l/ that have both a coronal and a uvular constriction → F3 higher

3. MATERIALS & METHODS

X-Ray Microbeam (XRMB) Wisconsin database

- Test hypothesis: Comparison of acoustic and articulatory data (M. Tiede)
- 6 speakers: 3 male, 3 female

Measures

- Formant values: taken at steady point of F3 during /l/
- Spatial coordinates of the tongue dorsum (TDx,TDy) at steady point of F3
  - TD retraction: movement along the Ox axis
  - TD proximity to the palate: movement along the Oy axis

Statistical analysis

- **Formant values**
  - Mixed effects models: Syllable position and Gender (fixed factor), Speaker (random factor)
- **Articulator Position: Spatial Coordinates**
  - Linear regression models
  - Mixed effects models

4. RESULTS

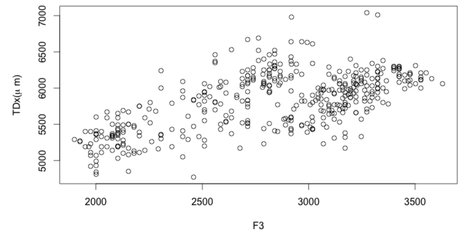


Figure 3: Correlation between F3 values and Tongue Dorsum retraction

Spatial coordinate of Tongue Dorsum (TD)

- Positive correlation (cor=0.6122177, p<2.2e16) between TD retraction and F3
  - F3 increases with TD retraction (on Ox axis)
- Linear Mixed Effects models and Linear Regression
  - strong effect of TD retraction (p<2e16)
  - no effect of TD proximity to the palate: expected because a velar constriction would lower F3

Formant values

- effect of Syllable position (p<2e16):
  - lower F3 for clear /l/
- effect of Gender (p=0.0388):
  - alltogether higher values for female speakers
- greater variability for male speakers
  - dark /l/ in onset → confirmed by F2 values

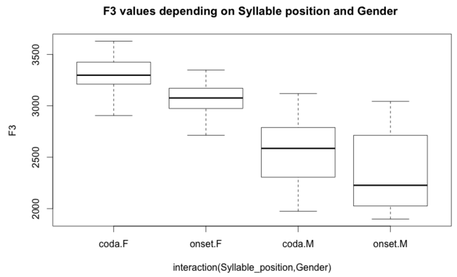
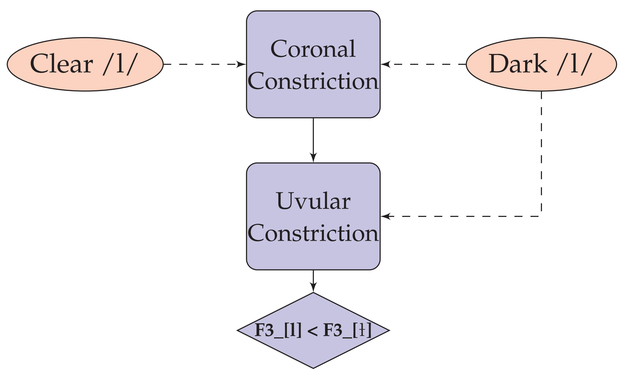


Figure 4: F3 values given Syllable position and Gender

5. CONCLUSION AND FUTURE RESEARCH



- The present study proposes an explanation for higher F3 values in [ɬ], based on F3 sensitivity functions.
- Preliminary results (6 speakers) show that F3 increases with TD retraction in the production of /l/. The comparison will be extended to more speakers from the XRMB database.
- Male native speakers exhibit greater variability in the production of laterals.
- A future perception study will test whether F3 is a perceptual cue for differentiating syllable position allophones.

6. REFERENCES

1. Fant, G. 1960, *Acoustic Theory of Speech Production*, De Gruyter, 2nd edition. 2. Iskarous, K., 2012, *Articulatory to acoustic modeling*,The Handbook of Laboratory Phonology, Oxford University Press, 472-483. 3. Recasens, D., 2012, *A cross-language acoustic study of initial and final allophones of /l/*, Speech Communication, 54, 368-383. 4. Sproat R., Fujimura O. (1993). Allophonic variation in American English /l/ and its implications for phonetic interpretation. J. of Phonetics, 21, 291-311. 5. Stevens, K.,1998, *Acoustic Phonetics*, The MIT Press. 6. Tiede, M., *Matlab mview function*, Haskins Lab.