

Comparing the acoustic distinctiveness of Danish and Swedish vowels

Jan Vanhove^a, Therese Leinonen^b, Vincent J. van Heuven^c, Charlotte Gooskens^b & Anja Schnippen^b

^a University of Fribourg (CH), ^b University of Groningen (NL), ^c Leiden University (NL)
jan.vanhove@unifr.ch

1. Introduction

- Danish and Swedish are mutually intelligible
- But, Danes generally understand Swedish better than vice versa (Mairouf 1976, 66-1978; Delsing & Lundin-Alession 2005)
- MICReLa project, Groningen: www.ling.u Groningen.nl/micrela
- "Difficult" Danish pronunciation often cited as one of the causes, (see also Gernnum 2008)
- Is Danish pronounced less accurately than Swedish?
- Focus of this study: vowel pronunciation

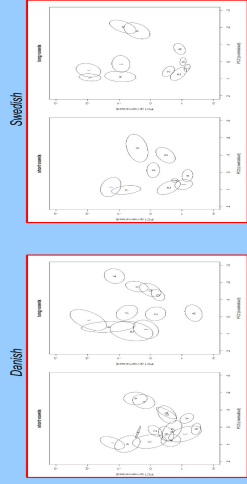
2. Research question

- Can Danish vowels be accurately be categorised as Swedish vowels on the basis of means of a mathematical procedure (linear discriminant analysis) using acoustic and durational data as its input?

3. Methodology

- (a) Materials**
 - Isolated words previously used in intelligibility experiments (Kürschner & Gooskens 2008; Gooskens et al. 2010)
 - Recorded by 4 male speakers per language
 - Total of 555 vowels for Danish and 614 for Swedish
- (b) Annotation**
 - Each vowel segment labelled on the basis of pronunciation clues in Svenska språkmyndighets uttalsordbok and Polliken's Modersk Ordg.
- (c) Acoustic and durational data**
 - Principal component analysis (PCA) on bank-filtered vowel spectra (from 2 to 17 bank)
 - (a method pioneered by Fong et al. 1967)
 - Segment durations extracted as well
 - Speaker-specific z-normalisation (PC1, PC2, duration) for cross-speaker comparison
- (d) Classification procedure**
 - Linear Discriminant Analysis (LDA) with PC1, PC2 and duration (all z-normalised)
 - Percentage of correctly classified tokens as measure of acoustic distinctiveness

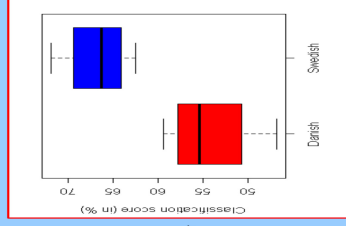
4. Vowel plots



- Ellipses covering (SD) drawn around the vowel centroids in PC1/PC2 planes clearly show more overlap for Danish than they do for Swedish.
- This suggests that a given Danish vowel is more likely to be confused with another vowel than a given Swedish vowel.

5. Results

- Even for our small sample (4 speakers per language), we found a significant difference between the Danish (M = 54.30) and the Swedish (M = 66.75) classification scores due to non-overlapping distributions (t(9) = 3.78, p = .01).
- Possible cause 1. Speech rate in Danish is higher than in Swedish (Schupert et al. 2009)
 - There was no correlation within each language between classification scores and speech rate (expressed as the number of syllables in the underlying phonology per second).
- Possible cause 2. Danish stop, a kind of phonologically distinctive creaky voice, known to influence vowel quality and duration (Jørgensen 1989)
 - Splitting up the dataset according to presence or absence of stop, re-running the LDA and subsequently calculating weighted averages did not significantly enhance the Danish classification scores (paired t(3) = 0.26, p = .81).



6. Conclusions

- Danish vowels are acoustically less distinct than Swedish vowels.
- Differences cannot be ascribed to either differences in speech rate or presence of stop.
- Differences in acoustic distinctiveness can now be considered as a possible factor affecting Danish-Swedish mutual intelligibility.

References

Böcker-Christiansen, C. et al. (2011). Polliken's Modersk. *Ortografier*. 2nd ed. Polliken's Modersk. Copenhagen.
Bl, L. (1976). Utvärdering av uttalsordboken för svenska och finska språk. Utvärdering av uttalsordboken för svenska och finska språk. Utvärdering av uttalsordboken för svenska och finska språk. Utvärdering av uttalsordboken för svenska och finska språk. Utvärdering av uttalsordboken för svenska och finska språk.
Delsing, C. & Lundin-Alession, M. (2005). *Uttalet i svenska och finska språk*. Stockholm: Carlsson.
Garnica, C. (2003). Svenska språkmyndighets uttalsordbok. Svenska språkmyndigheten & Nordiska Språkvetenskapliga Institutionen. Stockholm: Carlsson.
Gernnum, N. (2008). "Why are the Danes so hard to understand?" In H. Colgate, J. Coenen et al. (eds), *The Danish-Swedish Intelligibility Project*. Groningen: University of Groningen.
Fong, J. (1967). *Acoustic analysis of vowel spectra*. In H. Colgate, J. Coenen et al. (eds), *The Danish-Swedish Intelligibility Project*. Groningen: University of Groningen.
Mairouf, G. (1976). *Acoustic analysis of vowel spectra*. In H. Colgate, J. Coenen et al. (eds), *The Danish-Swedish Intelligibility Project*. Groningen: University of Groningen.
Peters, R., Jørgensen, L., & van Heuven, V. (2009). *Acoustic analysis of vowel spectra*. In H. Colgate, J. Coenen et al. (eds), *The Danish-Swedish Intelligibility Project*. Groningen: University of Groningen.
Schupert, A., Gooskens, C., & Vanhove, J. (2009). *Acoustic analysis of vowel spectra*. In H. Colgate, J. Coenen et al. (eds), *The Danish-Swedish Intelligibility Project*. Groningen: University of Groningen.

Note: This is a modified version of a poster presented at EuroSLA 2011, Eindhoven of March, June 18, Groningen.

