

# Acoustic distinctiveness of Danish and Swedish vowels

Jan Vanhove<sup>a</sup>, Therese Leinonen<sup>a</sup>, Vincent van Heuven<sup>b</sup> & Charlotte Gooskens<sup>a</sup>

<sup>a</sup> University of Groningen, <sup>b</sup> Leiden University

## 1. Introducing the research question

- Danish and Swedish are mutually intelligible.
- But Danes understand Swedes better than vice versa. (Maurud 1976, Bø 1978, Delsing & Lundin Åkesson 2005)
- Danish pronunciation is popularly cited as one of the causes. (see also Grønnum 2003)
- Is Danish pronounced less accurately than Swedish?
- Focus of this study: vowel pronunciation.

## 2. Research question

- Can Danish vowels as accurately be categorised as Swedish vowels can by means of a mathematical classification procedure (linear discriminant analysis) using acoustic data and vowel duration as its input?

## 3. Methodology

### (a) Materials

Danish:

- 555 vowels occurring in isolated words (4 male speakers)
- 181 vowels occurring in semantically unpredictable sentences (3 male speakers)

Swedish:

- 614 vowels occurring in isolated words (4 male speakers)
- 189 vowels occurring in semantically unpredictable sentences (3 male speakers)

### (b) Annotation

- Each vowel segment labelled on the basis of pronunciation clues in *Svenska språknämndens uttalsordbok* and *Politikens Nudansk Ordbog*.

### (c) Acoustic and durational data

- Principal component analysis (PCA) on bark-filtered vowel spectra (from 2 to 17 bark)
- Segment duration extracted as well.
- Speaker-specific z-normalisation of PC1, PC2 and duration for cross-speaker comparison.

### (d) Classification procedure

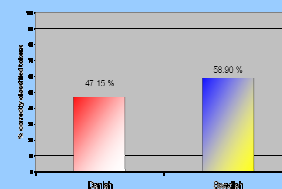
- Linear discriminant analysis (LDA) with PC1, PC2 and duration (all z-normalised).
- Percentage of correctly classified tokens as measure of acoustic distinctiveness.

## Selected references

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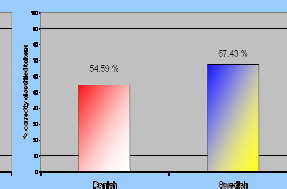
## 4a. Results

All vowels



$t(1537) = 4.65, p < 0.001$

Vowels in isolated words



$t(1167) = 4.53, p < 0.001$

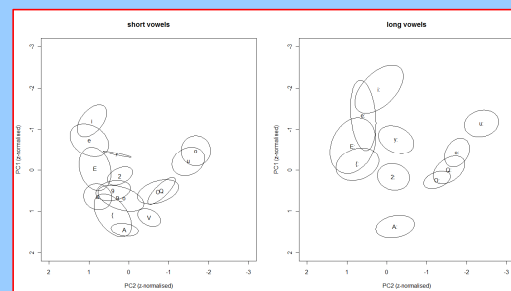
- Lower classification scores for Danish than for Swedish.
- Possible cause: Danish *stød*, a phonologically distinctive kind of creaky voice known to influence vowel quality (Fischer-Jørgensen 1989).
  - Splitting up the Danish data set according to presence or absence of *stød* did not significantly enhance the Danish score: 2.89 pp improvement for vowels in isolated words [ $t(1108) = 0.97, p = 0.33$ ]

## 5. Conclusion

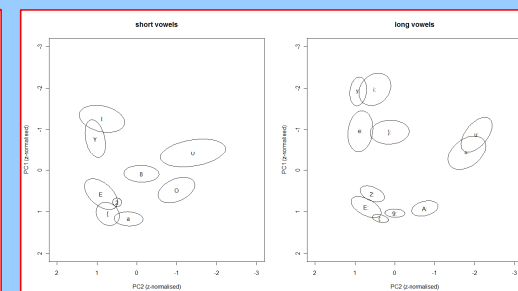
- Danish vowels are acoustically less distinct than Swedish vowels.
- Difference cannot be ascribed to *stød*.
- Differences in acoustic distinctiveness can now be considered as a possible factor in Danish-Swedish mutual intelligibility.

## 4b. Vowel plots

Danish (isolated words)



Swedish (isolated words)



- Ellipses cover 1 sd.
- Clearly more overlap for Danish vowel ellipses than for Swedish vowel ellipses.
- Plotting the vowels in PC1xPC2 planes confirms visually the results of the classification procedure.