Acoustic distinctiveness of Danish and Swedish vowels

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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

Becker-Christiansen, C., ed. (2001). *Politikens Nudansk Ordbog med etymologi*, 2nd edn, Politikens Forlag, Copenhagen.

Bø, I. (1978). *Ungdom og naboland: en undersøkelse av skolens og fjernsynets betyding for nabospråksforståelsen*, Rogalandsforskning, Stavanger.

Delsing, L.-O. & Lundin Åkesson, K. (2005). *Håller språket ihop Norden? En forskningsrapport om ungdomars förståelse av danska, svenska och norska.* Nordiska ministerrådet, Copenhagen.

Garlén, C., ed. (2003). *Svenska språknämndens uttalsordbok*, Svenska språknämnden & Norstedts, Stockholm.

Grønnum, N. (2003). 'Why are the Danes so hard to understand?', in H. Galberg Jacobsen et al., eds., *Take Danish – for instance. Linguistic studies in the honour of Hans Basbøll on the occasion of his 60th birthday 12th July 2003*, Odense University Press, 119-130.

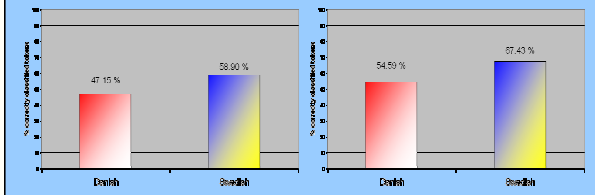
Fischer-Jørgensen, E. (1989). *A phonetic study of the stød in standard Danish*, University of Turku.

Maurud, Ø. (1976). *Nabospråksforståelse i Skandinavia: en undersøkelse om gjensidig forståelse av tale- og skriftspråk i Danark, Norge og Sverige.* Nordiska rådet, Stockholm.

Vanhove, J. (2010). *Acoustic distinctiveness of Danish and Swedish vowels*, unpublished MA thesis, University of Freiburg.

4a. Results

All vowels *Vowels in isolated words*

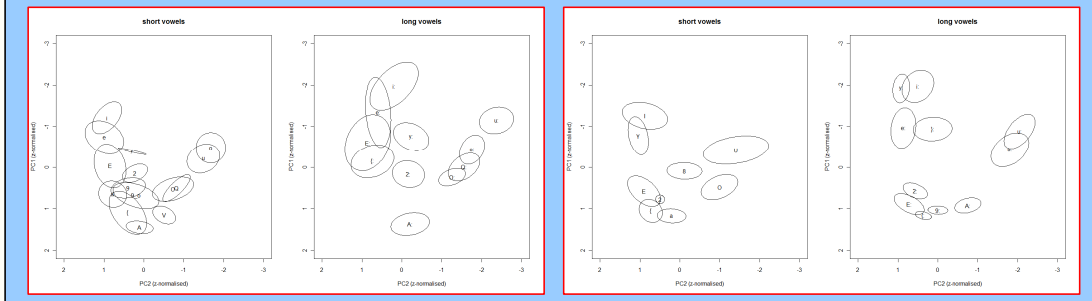


t(1537) = 4.65, p < 0.001 t(1167) = 4.53, p < 0.001

- 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]

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.

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.

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