

Soft d in Danish: Acoustic characteristics and issues in transcription

Chloe Brotherton & Aleese Block*

Abstract. Danish, like closely related Swedish and Norwegian, has descended from Old Norse (Haugen 1976). While the three contemporary languages are variably mutually intelligible, Danish has phonologically diverged from the other Scandinavian languages (Gooskens 2006). This is caused by extensive consonant lenition and vowel reduction within Danish (Basbøll 2005). The lenition of <t> and <d> in syllable coda positions into a sound that Danish linguists have called soft d is seemingly unique to the Danish. In most phonological descriptions, it is transcribed using the phonetic symbol /ð/, a voiced interdental fricative. We assert that this is not accurate; not all phonologists agree that the soft d is a fricative. Some describe it as an alveolar semi-vowel (Haberland 1994), while others transcribe it as a velarized, retracted, and lowered alveolar approximant (Basbøll 2005). Many observe that the sound resembles lateral /l/, a distinct phoneme of Danish (Wells, 2010). Through acoustic analysis of tokens taken from the DanPASS corpus (Grønnum 2016) we show that the acoustic properties (HNR) of soft d are indeed not the same as a fricative, but rather that of an approximant or vowel. Therefore, the use of /ð/ to transcribe this symbol is inaccurate and does not align with the goals of the International Phonetic Association.

Keywords. phonetics; transcription; international phonetic alphabet; Danish; lenition

1. Introduction. 1.1 DANISH AND SOFT D. Danish is a Germanic language spoken in Denmark. One of the Scandinavian languages, it is descended from Old Norse and its sister languages include Norwegian, Swedish, Icelandic, and Faroese. The Scandinavian languages are split into two groups: insular (e.g., Icelandic and Faroese) and continental (e.g., Danish, Norwegian, and Swedish). In modern times, the level of mutual intelligibility between the languages varies, with the continental languages retaining a relatively high level of mutual intelligibility that has been diminished compared to the insular languages (Gooskens 2006).

The mutual intelligibility between Norwegian, Swedish, and Danish has been shown to be asymmetrical. Namely, speakers of Danish have a much easier time understanding spoken Norwegian and Swedish than vice versa (Schüppert 2011). The difficulty of understanding Danish is attributed to a variety of both linguistic and extralinguistic factors. The linguistic factors include numerous phonological changes that the language has undergone in the past couple of centuries that have caused it to drift from its sisters to the north: (1) vowel reduction, (2) adoption of a uvular <ɾ> pronunciation, and (3) lenition of <t> and <d> (von Ommen et al. 2013; Goblirsch 2014). In the case of vowel reduction, most of the time, low [a] reduces to either [ɛ] or [ə]. The adoption of uvular [ɣ], or *skarre-r* in Danish, is thought to be due to its proximity to Germany and borrowing the sound from German. These two, coupled with the lenition of <t> and <d> cause words such as *hader* (hate) to be transcribed as [hɛðɣ] (Grønnum 1998).

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rating previous descriptions by Grønnum and Basbøll¹. This led us to decide to perform an acoustic analysis of soft d to investigate its manner of articulation.

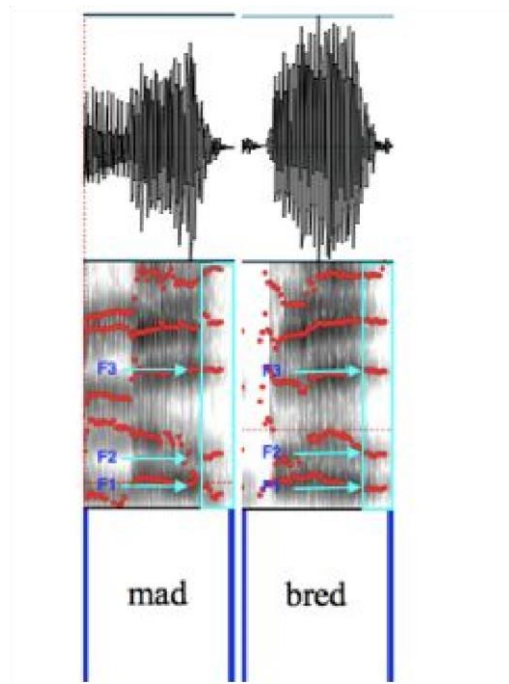


Figure 1. Spectrograms of /mεð/ and /bʁεð/

An acoustic analysis was carried out on recordings taken from DanPASS (Grønnum, 2016), a corpus of spontaneous Danish speech that has been phonetically and phonologically annotated. For this analysis, tokens were taken from six speakers (one female, five male); all speakers were from the Copenhagen area of Denmark and spoke Standard Danish (*rigsdansk*). Four categories of tokens (n=200) were taken: (1) voiced fricatives (some realizations of /v/, /ʁ/, and /ɣ/) (2) approximants (/j/, /l/, some realizations of /v/ and /ɣ/), (3) soft d, and (4) vowels. These categories were chosen as they represent a gradient of periodicity in which we hoped to place soft d.

As the materials in the DanPASS are heavily annotated, tokens were chosen based upon if they were annotated as the segment of interest and if these spectral characteristics matched the annotation. For example, tokens annotated as voiced but lacking spectral indications of voicing (e.g., a voice bar) were not included in the voiced fricative category. Similarly, if a segment labelled as a fricative had no obvious frication in the spectrogram, it was excluded from the voiced fricative category.

2.2. MEASUREMENT AND ANALYSIS. For each class of token, the harmonics-to-noise ratio (HNR) was measured using Praat (Boersma & Weenink 2018). This is a measurement of the periodicity of a sound, expressed in dB (Styler 2013); a higher HNR is indicative of a more periodic sound. For this reason, voiced fricatives have lower HNR measures than approximants and vowels. Fricatives were measured from the start of turbulent energy on the waveform to the vocalization of the following vowel. Vowels were measured from the beginning of periodic

¹ Descriptions taken from their respective transcription practices.

voicing and formant structure to the cessation of these. We used formant transitions to distinguish the boundaries between vowels and approximants. The HNR measurement was taken for the entire duration of the segment.

HNR measurements were averaged across speakers and tokens for each category and two-sample t-tests were carried out to investigate the statistical significance of between-group differences. We chose this method of statistical analysis in order to tell us if there were significant differences in the HNR between soft d and the other categories.

3. Results. Soft d ($n=50$, $\bar{x} = 13.9$ dB) was shown to have a significantly higher ($p<0.01$) HNR than voiced fricatives ($n=50$, $\bar{x} = 6.93$ dB). It was also shown to be significantly ($p=0.011$) higher than approximants ($n=50$, $\bar{x} = 9.95$ dB). However, soft d did not exhibit a significant ($p=0.76$) difference from the vowel ($n=50$, $\bar{x} = 14.14$ dB) category. These differences can be seen in Figure 2.

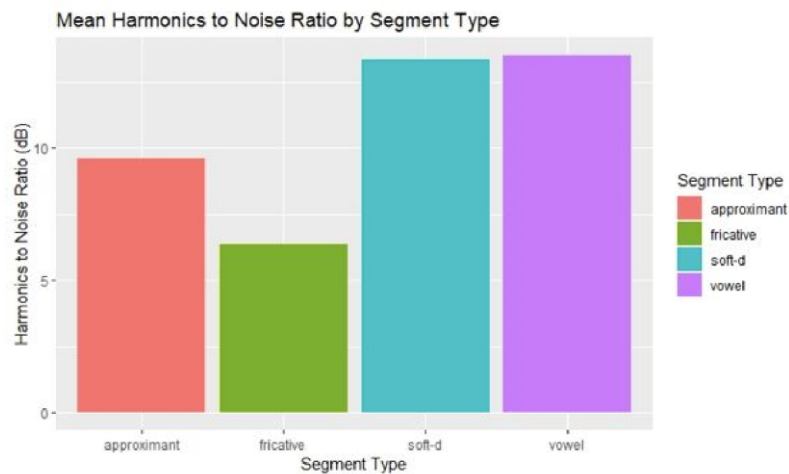


Figure 2. Average HNR values for each type of segment (approximant, fricative, soft d, vowel)

4. Discussion. These results show that the past descriptions of soft d as a voiced interdental fricative are indeed inaccurate based on its acoustic characteristics. Both the spectrogram and acoustic measures (HNR) show an absence of frication. In addition to showing that this sound is not a voiced fricative, as it is often called, this data also provide some information about its articulation. While we can not necessarily use a measure like HNR to explain the place of articulation of the sound, we can use it to describe the likely manner. It was hypothesized that if the sound was not a voiced fricative but rather something closer to an approximant or semi-vowel, this would be reflected in the HNR, a measure of periodicity, and approximants and vowels would have a higher value. The HNR value of soft d was significantly ($p<0.01$) higher than voiced fricatives and approximants, showing that these sounds are more periodic than either of these types; the values had a slightly lower average than vowels, but were not significantly different, indicating that their periodicity is more in line with these. As stated before, these three categories (voiced fricatives, approximants, vowels) were meant to create a gradient of periodicity, and soft d has been placed on this between approximants and vowels. These data corroborate to a certain extent the descriptions offered by Haberland (1994) that this sound is a semi-vowel or by Basbøll (2005) that it is an approximant.

Soft d's vowel-like periodicity indicates that perhaps it is undergoing vocalization. Approximants like /l/ (Lin et al. 2011) and /r/ (Ellis et al. 2006) are commonly vocalized cross-linguistically; it is plausible that soft d lenited into an approximant that is now undergoing vocalization. According to this explanation, diachronically soft d would have started as a stop, then lenited sequentially into a fricative, approximant, and now something that is more vowel-like. This fits with Danish's overall patterns of lenition and vowel reduction.

Given that the sound has been shown to not be a voiced fricative, these data reinforce our earlier assertion that /ð/ is inappropriate to use in transcriptions of Danish. We would suggest that Danish linguists choose one of two options moving forward in transcription: (a) finding a more accurate symbol that can be adjusted via diacritics to provide an accurate depiction, or, and perhaps more controversially, (b) using an entirely new symbol once the precise articulation of this sound has been found and described. One of the self-proclaimed goals of the IPA is to be able to transcribe narrow phonetic detail (International Phonetic Association 1999), phoneticians must strive to provide accurate and reliable transcriptions. Therefore, as linguists we must reevaluate the use of /ð/ for soft d.

As with any study, this is not without limitations. We analyzed only 200 tokens overall, and we grouped segments together into large categories in order to compare periodicity on a scale. Future work will involve larger sample sizes, as provided by the DanPASS corpus as well as spontaneous speech. Additionally, we will include more fine-grained categorical distinctions to provide a more precise and robust comparison of soft d to other segments. Additionally, we will investigate variation within different realizations of soft d, such as syllabic soft d and when *stød* is on a syllable with a soft d. The next step of this project is to obtain articulatory data in order to more precisely determine the place and manner of articulation of soft d. We are considering conducting ultrasound and palatography studies to begin this investigation. With these data, we hope to propose a more accurate way to transcribe soft d.

References

- Basbøll, Hans. 2005. *The phonology of Danish*. Oxford: Oxford University Press.
- Boersma, Paul & David Weenink. 2018. Praat: Doing phonetics by computer (computer program). <http://www.praat.org/>.
- Ellis, Michael, Cynthia Groff & Rebecca Mead. 2006. A rapid and anonymous study of /r/ vocalization in an /r/ pronouncing city. *University of Pennsylvania Working Papers in Linguistics* 12(1). 57–67.
- Goblirsch, Kurt. 2014. Between Saxon, Franconian, and Danish: The obstruents of Frisian. *Amsterdamer Beiträge zur älteren Germanistik* 73(1). 95–118. https://doi.org/10.1163/9789401211918_005.
- Gooskens, Charlotte. 2006. Linguistic and extra-linguistic predictors of inter-Scandinavian intelligibility. *Linguistics in the Netherlands* 23(1). 101–113. <https://doi.org/10.1075/avt.23.12goo>.
- Grønnum, Nina. 1998. Danish. *Journal of the International Phonetic Association* 28(1-2). 99–105. <https://doi.org/10.1017/s0025100300006290>.
- Grønnum, Nina. 2016. DanPASS – Danish phonetically annotated spontaneous speech (corpus). <https://danpass.hum.ku.dk/>.
- Haberland, Hartmut. 1994. Danish. In Ekkehard König & Johan Van der Auwera (eds.), *The Germanic languages*. 313–348. New York: Routledge.

- Haugen, Einar. 1976. *The Scandinavian languages: An introduction to their history*. Cambridge, MA: Harvard Univ Press.
- Hualde, José, Ryan Shosted & Daniel Scarpace. 2011. Acoustics and articulation of Spanish /d/ spirantization. *Proceedings of the International Congress of Phonetic Sciences (ICPhS)* 17. 906–909.
- The International Phonetic Association. 1999. *Handbook of the International Phonetic Association: A guide to the use of the International Phonetic Alphabet*. Cambridge: Cambridge University Press.
- Ladefoged, Peter, & Keith Johnson. 2011. *A course in phonetics*. Stamford, CT: Cengage Learning.
- Lin, Susan S., Patrice Speeter Beddor & Andries W. Coetzee. 2011. Gestural reduction and sound change: An ultrasound study. *Proceedings of the International Congress of Phonetic Sciences (ICPhS)* 17. 1250–1253.
- Maddieson, Ian, Siniša Spajić, Bonny Sands & Peter Ladefoged. 1993. Phonetic structures of Dahalo. In Ian Maddieson (ed.), *UCLA working papers in phonetics: fieldwork studies of targeted languages*. 25–65. Los Angeles: The UCLA Phonetics Laboratory Group.
- Nordvig, Asger Matthias. 2018. Personal interview with Aleese Block. December.
- Schüppert, Anja. 2011. *Origin of asymmetry: Mutual intelligibility of spoken Danish and Swedish*. Groningen, NL: University of Groningen dissertation.
- Simonet, Miquel, José Hualde & Marianna Nadeu. 2012. Lenition of /d/ in spontaneous Spanish and Catalan. *Interspeech-2012* (13th Annual Conference of the International Speech Communication Association). 1416–1419.
https://www.isca-speech.org/archive/interspeech_2012/i12_1416.html.
- Styler, Will. 2013. Using Praat for linguistic research. University of Colorado at Boulder Phonetics Lab.
<http://wstyler.ucsd.edu/praat/UsingPraatforLinguisticResearchLatest.pdf>.
- van Ommen, Sandrien, Petra Hendriks, Dicky Gilbers, Vincent van Heuven & Charlotte Gooskens. 2013. Is diachronic lenition a factor in the asymmetry in intelligibility between Danish and Swedish? *Lingua* 137. 193–213. <https://doi.org/10.1016/j.lingua.2013.09.009>.
- Wells, John. 2010. Danish. *John Wells' Phonetics Blog*.
<http://phonetic-blog.blogspot.com/2010/11/danish.html>.