Articulation of the Danish soft d:
A pilot study using electromagnetic articulography

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In a historical process known as stop gradation, the unaspirated Danish stops /b d g/ weakened dramatically in postvocalic positions before schwa. /d/ has become a semivowel usually referred to as the 'soft d', typically transcribed as [ð] although lately increasingly transcribed as [ɤ̞] (see e.g. Grønnum 1998; Schachtenhaufen 2023). In spite of the [ð] notation, there is broad agreement that the sound in question is not a fricative. For example, Basbøll (2005: 59) refers to the sound as an 'alveolar non-lateral approximant'. He suggests that [ð̞ˠ] would be a more suitable narrow transcription, indicating that it is also velarized. Anecdotally non-native listeners very often confuse the sound with a lateral approximant (Brotherton and Block 2020). Little articulatory or instrumental acoustic research has been dedicated to the soft d, and its phonetic nature remains uncertain. A pilot study using ultrasound tongue imaging suggested that the tongue dorsum is more active in soft d articulation than the tip (Siem 2019), and Juul et al. (2016) report formant measures suggesting that the soft d acoustically resembles a centralized back vowel.

On the phonological side, stop gradation is often considered a synchronically active phonological process in Danish, whereby semivowels are allophones derived from underlying stop consonants through the application of a series of rules (e.g. Rischel 1970; Basbøll 1975). Horslund et al. (2022) argued that that parts of this account are psychologically implausible, due in part to the great phonetic dissimilarity between the proposed allophones. They considered it an open question whether there is a synchronic phonological relationship between /d/ and the soft d, largely because the phonetics of the soft d are underdescribed; without concrete knowledge about the articulation of the soft d, it is not clear whether the addition of a [+continuant] feature to /d/ could plausibly derive a soft d.

In order to assess whether phonetic evidence is compatible with a phonological derivation of the soft d from /d/, we examine three questions: 1) Is the tongue tip significantly involved in the production of the soft d? 2) Is the tongue dorsum significantly involved? 3) Is the soft d purely a central consonant, or does its articulation also have a lateral component?

We examine these questions using electromagnetic articulography (EMA). In our experimental setup, we position five sensors on the tongue, as schematized in Fig. 1: three along the center of the tongue (tip, mid, and back), as well as two parasagittal sensors on both sides of the tongue. Each sensor captures movement in three dimensions. Participants are recorded producing real and nonce words with syllabic soft d after different vowels in carrier phrases. In order to probe the extent of coronal and dorsal approximation as well as a potential lateral component, words with soft d alternate with words with /n/ and /l/, and the next word in the carrier phrase always starts with a /g/.

We report results from a pilot study with three participants. Early analyses suggest that the soft d involves both coronal and dorsal components (see Fig. 2). The tongue body is uniformly lowered and fronted during the soft d, suggesting a very open approximation (which is unusual for consonants), and involvement of the tongue tip (which is unusual for vowels); fronting of the tongue tip without approximation to an articulator along the roof of the mouth is very unusual cross-linguistically. We also find evidence of significant lateral grooving, which is in line with the common observation that the soft d sounds lateral. While the involvement of the tongue tip in soft d articulation suggests some phonetic similarity between the /d/ and the soft d, a phonological account assuming that the soft d is derived from /d/ would have to account for several phonetic quirks in the soft d; thus, the addition of a [+continuant] feature does not seem sufficient to derive the soft d from /d/.

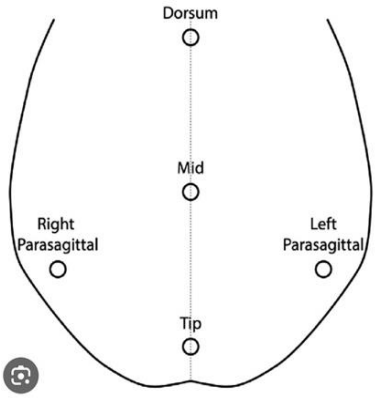

Fig. 1: Schematic overview of the positions of tongue sensors.

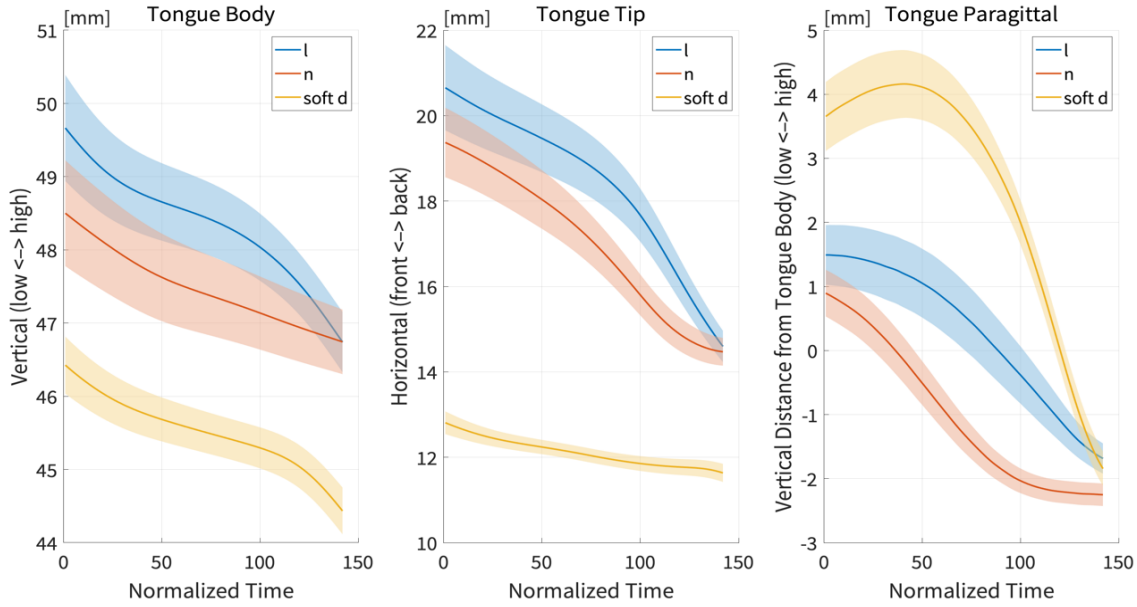

Fig. 2: Average time normalized tongue sensor trajectories during production of /l/, /n/, and the soft d from one subject. Left to right: vertical position of the tongue body sensor (corresponding to the low–high dimension); horizontal position of the tongue tip sensor (corresponding to the front–back dimension); and vertical distance between the tongue body and tongue sides (corresponding to laterality).

References

Basbøll, H. (1975). On the phonological interpretation of the falling diphthongs in Danish. *Annual Report of the Institute of Phonetics, University of Copenhagen*, *9*, 49–108. https://doi.org/10.7146/aripuc.v9i.130971

Basbøll, H. (2005). *The phonology of Danish*. Oxford University Press.

Brotherton, C., & Block, A. (2020). Soft d in Danish. Acoustic characteristics and issues in transcription. *Proceedings of the Linguistic Society of America*, *5*, 792–797. https://doi.org/10.3765/plsa.v5i1.4739

Grønnum, N. (1998). Illustrations of the IPA. Danish. *Journal of the International Phonetic Association*, *28*(1/2), 99–105. https://doi.org/10.1017/S0025100300006290

Horslund, C. S., Puggaard-Rode, R., & Jørgensen, H. (2022). A phonetically-based phoneme analysis of the Danish consonant system. *Acta Linguistica Hafniensia*, *54*(1), 73–105. https://doi.org/10.1080/03740463.2021.2022866

Juul, H., Pharao, N., & Thøgersen, J. (2016). Moderne danske vokaler. *Danske Talesprog*, *16*, 35–72.

Rischel, J. (1970). Consonant gradation. A problem in Danish phonology and morphology. In H. Benediktsson (Ed.), *The Nordic languages and modern linguistics* (pp. 460–480). Vísindafélag Íslendinga.

Schachtenhaufen, R. (2023). *Ny dansk fonetik* (2nd ed). Modersmål-Selskabet.

Siem, A. B. (2019). *An articulatory account of the Danish soft d* [Master's thesis]. Aarhus University.