

What's in a name? An investigation of first and second language speakers' productions of Danish *stød* prosody using forms of the word *navn* 'name'

Sabine Gosselke Berthelsen¹

¹ Centre for Languages and Literature, Lund University, Lund
sabine.gosselke_berthelsen@ling.lu.se

Abstract

Stød is a well-known and widely studied prosodic feature of Danish, typically realised as laryngealisation. Previous studies have shown that first language (L1) users are highly sensitive to the phenomenon in perception whereas second language (L2) users are not. However, little is known about L2 users' *stød* production. In a small but systematic pilot study of two forms of the early-acquired word *navn* 'name', this study, therefore, qualitatively and quantitatively investigates how second language users at different proficiency levels produce words with alternating *stød* prosody. Examples of both absence and presence of canonical, L1-like *stød* in L2 production are presented, and a quantitative analysis of rime duration, pitch, intensity, and harmonics-to-noise-ratio (HNR) reveals expected and unexpected differences as well as similarities between L1 and L2 speakers. Overall, the study provides the first systematic evidence of *stød* production by L2 users of Danish and highlights differences in how L1 and L2 speakers manipulate acoustic parameters to express *stød*.

Introduction

Danish *stød* is a cross-linguistically rare prosodic phenomenon. It is characterised by the use of laryngealisation throughout the language's lexicon and morphophonology (Basbøll, 2015; Grønnum, 2005). In terms of its acoustic realisation, *stød* is a relatively complex cue which has been argued to differ intra- and even interpersonally (Fischer-Jørgensen, 1989; Ringgaard, 1960). In particular, three acoustic features are typically involved in *stød* production: pitch, intensity, and aperiodicity. *Stød* has been argued to consist of two phases of which the first is characterised by modal voice, high pitch and high intensity, while the second phase (*stød* proper) features a drop in pitch and intensity as well as an aperiodic (or biperiodic, see Hansen, 2015) speech signal (Fischer-Jørgensen, 1989). For *stød* to be realised or perceived, not all of these features need to be manipulated simultaneously and differences in *stød* realisation and distribution have been observed for speakers of different regional varieties, for instance Aarhus Danish, where the *stød* is more tonal and less reliant on aperiodicity (Ejskjær, 1990; Siem, 2023).

Those who grow up with Danish as a first language (L1) are highly sensitive to *stød*. This becomes visible in studies in which Danish L1 listeners react to unexpected *stød* patterns both with respect to overt response behaviour (Clausen & Kristensen, 2015; Gosselke Berthelsen & Kristensen, 2025; Hjortdal et al., 2022) as well as brain responses (Hjortdal et al., 2022). Specifically, L1 users of Danish exhibit surprise when the use of *stød*-prosody does not adhere to established morphophonological rules. In fact, they tend to treat words with incorrect *stød* assignment as pseudowords even for cases where the morphophonology is highly complex (Vies & Gosselke Berthelsen, 2023). This knowledge around *stød* and its rules is probabilistic (Høeg, 2026) and leads to a strong and intuitive handling of *stød* by L1 speakers of Danish.

Given the high frequency of occurrence of *stød* in the L1 lexicon and morphophonology, it is not surprising that the phenomenon – despite its complexity – is acquired remarkably early in L1 acquisition. In fact, already at age 2, Danish L1 children have been observed to reach 95% accuracy in *stød* production (Jørgensen, 1978).

This stands in stark contrast to the thus far observed *stød* handling of L2 users of Danish. The only L2 production study that systematically analysed *stød* was conducted on six young Icelandic learners of Danish who had completed five years of Danish classes in an Icelandic school. All were reported to fully omit *stød* in their elicited speech production (Bjargadóttir, 2011). However, we do not know if this would be the same, for instance, for adult L2 users who are immersed in the language, for L2 users from other language backgrounds, or for L2 users at different proficiency levels. Similarly, it is unclear how the lack of *stød* was measured in the study and whether different listeners or quantitative analyses of acoustic measures related to *stød* would have come to the same conclusion as regards the presence or absence of *stød* in all instances. Very little is also known about L2 users' perception of Danish *stød*. One previous study investigated whether L2 listeners' spoken language processing was negatively impacted when they heard morphology that was not canonically associated with the *stød* prosody of the word stem. The study looked at 40 adult L2 users at four different proficiency levels (Gosselke Berthelsen & Kristensen, 2025). It found no evidence of a surprise effect and concluded that Danish L2 listeners do not naturally learn to use *stød* during speech perception despite beneficial effects of *stød* on speech processing having been observed for L1 users. Given the status of *stød* as a widely researched pronunciation phenomenon in Danish and given its crosslinguistic rarity, it is surprising that not more studies have investigated the impact this feature has on the acquisition of Danish as a second language.

The present study

Given the alarming lack of research on L2 users' acquisition of *stød*, this paper explores whether and how L2 users produce *stød* in familiar word forms and how this may be different or similar to L1 speakers' productions. Grouping users according to their language proficiency, the study aims to uncover how *stød* production changes over the course of L2 acquisition. The expectation was that higher proficiency users would approximate L1-like patterns more closely than beginners.

A close inspection of the recorded data together with participant background informed the selection of acoustic measures and modelling factors for a subsequent quantitative analysis based on linear mixed-effects models. Based on Fischer-Jørgensen (1989)'s detailed description of *stød*, the working hypothesis was that L1 users would have a high-to-low pitch and intensity

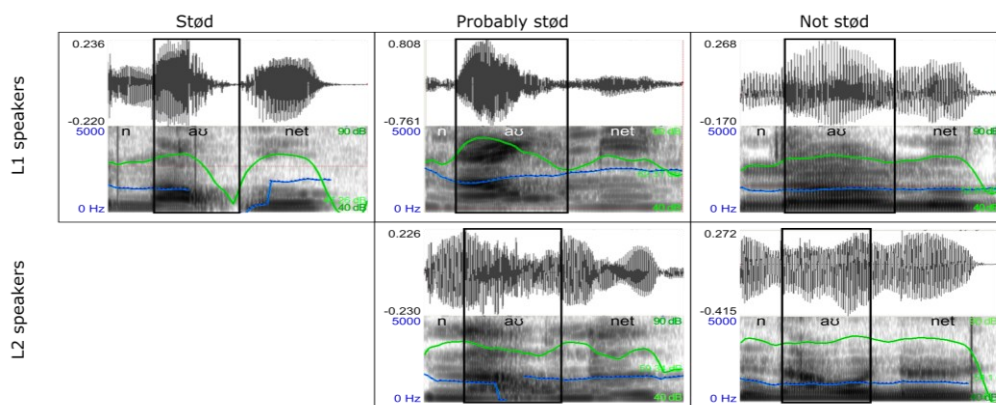


Figure 1. Example productions of the canonically stød-bearing singular target word *navnet* ‘the name’ illustrating variability in the data. Pitch is shown in blue overlaying the spectrogram, intensity in green. Black boxes mark the rime of the first syllable (canonically /aʊ/) where stød is expected to occur. The clearest example of stød on the left, less clear examples in the middle, and likely examples of nonstød on the right. L1 users above, L2 users below.

trajectory over the course of the voiced rime and increased aperiodicity in the second phase, observable in the harmonics-to-noise-ratio. Although previous L2 studies have painted a rather negative picture of L2 users’ interaction with stød, the study assumes that small, emerging shifts towards L1-like stød production may be detectable with increasing proficiency.

Material and methods

As part of a larger online study on speech perception and speech production, sentence reading data was acquired from a large number of Danish L1 speakers and Danish L2 speakers with German as L1 in an experiment built with Gorilla Experiment Builder (Anwyl-Irvine et al., 2020). All participants recorded twenty-four different sentences with stød-alternating words. This analysis focuses on the sentence pair *Jeg fik navne / navnet til jul*. ‘I got names / the name for Christmas.’ The carrier sentence is relatively neutral and can work equally well for both target words. Furthermore, it nicely separates the target words with plosives before and after the target words. This facilitates segmentation. The words themselves were chosen because they follow a frequent paradigm where the word stem canonically carries nonstød in the plural form and stød in the singular. Importantly, the word *navn* ‘name’ itself is a very frequent word that L2 learners would naturally encounter early in their Danish lessons. Speech recordings were carried out by the participants at home with their own recording equipment. Consequently, data quality varied considerably. Participants’ recordings were excluded if one or both of their sentences were unsuitable for acoustic analysis, for instance, because of missing data, background noise, or distortions in the speech signal. Data from 41 L1 speakers of Danish and 54 L2 speakers was found suitable and included in the study. Included participants (29 male, 63 female, 3 diverse) ranged in age from 18 to 56 ($M = 29$, $SD = 7$). Information on regiolect (L1 or acquired) was acquired from all speakers and the final sample contained 79 speakers of Zealand Danish and 16 speakers of other Danish variants. All L1 speakers were from North of the stød border, that is, from areas where stød is realised. The Danish L2 users self-assessed their proficiency with the help of key words from the Common European Framework of Reference (CEFR, Council of Europe, 2020) and were divided into three proficiency groups

based on their listening proficiency¹: beginners (A1 & A2; $N = 15$), intermediates (B1 & B2, $N = 27$) and advanced users (C1 & C2, $N = 12$).

For the acoustic analysis, all 190 target words were segmented into syllables in Praat (Boersma, 2001). The first syllable was further segmented into onset (/n/) and rime, canonically /aʊ/. When L2 users ($N = 10$) produced different rimes (most frequently /av/ or /a:/), these remained in the analysis since the segmental realisation of the words was not thought to affect the prosody.

The data were initially considered qualitatively. All recordings were carefully studied to better understand the data and detect possible trends and patterns which could inform the selection of measures and background factors to consider in the statistical analysis. This is particularly important in a context as complex as stød where many different parameters influence when and how it is realised. Including a qualitative step ensures that the quantitative analysis targets the most relevant acoustic measures and that they are divided into reasonable steps in consideration of patterns present in the data.

Based on the careful data inspection and evaluation, several parameters were automatically extracted with the help of a Praat script: duration of the rime of the first syllable as well as with the mean pitch, mean intensity, and mean HNR for the first half and the second half of the rime. The majority of these parameters (pitch, intensity, HNR) are frequently considered in the context of stød research (e.g., Fischer-Jørgensen, 1989; Gosselke Berthelsen & Kristensen, 2025; Hansen, 2015; Hjortdal et al., 2022) and were noticeably present in the production dataset. Duration, on the other hand, was extracted to ensure that potential compensatory strategies in prosody perception would be observable. Interactions with L2 users of Swedish suggested that the tonal prosody of Swedish word accents is often mapped onto durational measures. In order to ensure that this type of compensatory mapping would not be missed in the analysis, duration was extracted and analysed.

For the statistical analysis, linear mixed-effects model analyses were carried out via the LME4 package (version 1.1.29; Bates et al., 2015) in the RStudio environment (version 2021.0.2.382; RStudio Team, 2021) in R (version 4.1.2; R Core Team, 2021) in order to investigate which factors most strongly modulated different acoustic measures related to stød. Models were fitted for

seven acoustic measures: rime duration, mean pitch height in the first and second half of the rime, mean intensity in the first and second half of the rime, and mean harmonics-to-noise-ratio in the first and second half of the rime. All models included the deviation-coded variable Word (singular vs plural), the continuous variable Age, and the 4-level variable Listening Proficiency (LP; L1, advanced, intermediate and beginner) with L1 as reference level as well as an interaction of Word and LP, as well as an interaction of Word and Regiolect (Zealand vs Other). Finally, all models included random effects for Participant. Automatic multi-model inferencing was then carried out with the MuMIn package (version 1.46.0; (Burnham & Anderson, 2002) to compare and rank models based on Δ values for the corrected Akaike Information Criterion (AICc) and to compute Akaike weights (w). While all models with Δ values <7 were considered potential candidates, only the highest ranked model will be discussed in detail in the results section.

Results

Initial qualitative analysis

The qualitative analysis revealed several important insights. First, it confirmed that location of *stød* generally coincided with the rime of the first syllable. L1 users' timing appeared highly consistent: Laryngealisation (*stød* proper) started approximately in the middle of the rime. In (rare) cases where *stød* was easily observable in L2 productions, the timing was less precise. In two cases, some degree of laryngealisation occurred on the suffix instead of the stem. The consistent timing in the L1 group and the less clear patterns in the L2 groups motivated the decision to analyse the rime in two halves for the quantitative analysis.

Secondly, the thorough inspection of the production data revealed that the acoustic cues traditionally associated with *stød* (i.e., pitch, intensity, aperiodicity) were not always present simultaneously in every realisation. In Figure 1, the top middle realisation of the *stød*-bearing word *navnet* 'the name' shows a clear dip in intensity and increased aperiodicity in the waveform but no strong reduction in pitch. This may impede the quantitative investigation of *stød* and reduce the likelihood that some acoustic measures reach significance at the group level.

Finally, examining the production data in combination with the participant background data suggested a possible influence of speakers' regional background on *stød* production. It appeared that particularly speakers who (predominantly) acquired a language variety other than Zealand Danish, either as L1 or L2, produced *stød* less consistently. For this reason, regiolect information was included in the quantitative analysis. Due to relatively low numbers of speakers from dialects beyond Zealand, the variable was not split further into L1 and L2 users but all speakers who had acquired a regiolect other than Danish (both as L1 and L2) were grouped together.

Quantitative analysis

Duration

For rime duration, two models passed the predefined Δ criterion as competitors for best fit ($w = .359, .634$), both best fit candidates featured all factors and interactions but differed with respect to whether Age was included.

However, only LP was an individual significant predictor in the best fit model. L1 users' rime durations were shorter than those of beginner ($\beta = 53.65, SE = 11.25, t(90) = 4.77, p < .001$) and intermediate ($\beta = 19.83, SE = 8.47, t(90) = 2.34, p = .021$) L2 users; see Figure 2.

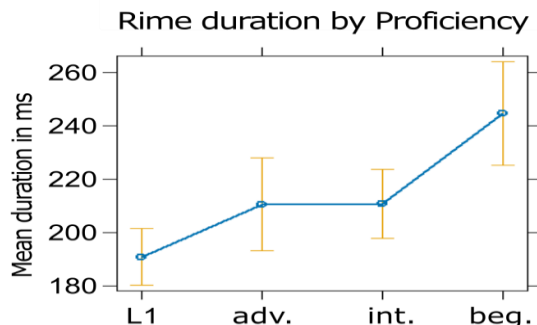
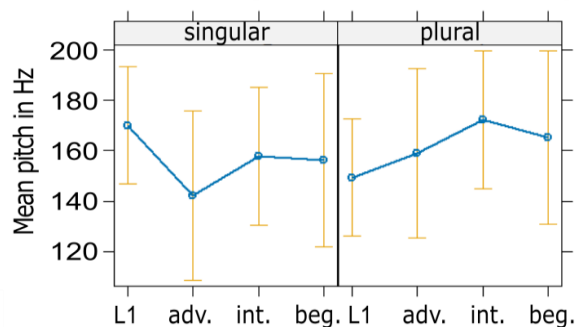


Figure 2. Model output for the duration of the rime of the first syllable as predicted by Listening Proficiency.

Pitch height

Just as for duration, two models each for pitch height performed best and passed the Δ criterion for the first ($w = .323, .671$) and second ($w = .387, .610$) half of the rime. In these models, all factors and interactions were included except for Age, which was included in one competitor model but not the other. However, only Word (higher pitch for singulars) and an interaction of Word and LP were individually significant predictors for both the first ($\beta = 53.65, SE = 11.25, t(90) = 4.77, p < .001$) and the second ($\beta = -26.48, SE = 6.10, t(90) = -4.32, p < .001$) half of the rime. The interaction was driven by differences between L1s and advanced and intermediate speakers in the first half and L1s and all L2 levels in the second. In all cases, pitch was higher for singular words (*stød*) than for plurals in the L1 group, Figure 3.

1st Half: Pitch by Word and Proficiency



2nd Half: Pitch by Word and Proficiency

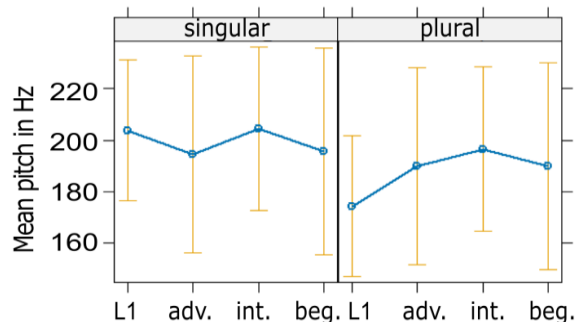


Figure 3. Model output for mean pitch level for the first (top) and second (bottom) half of the first syllable rime as predicted by Word and Listening Proficiency.

Intensity

Six models emerged as good fit candidates ($w = .020-.633$) for mean intensity in the first half of the rime. All included the factor Word and all but one LP. In the highest ranked model, only Word emerged as an individually significant predictor of mean intensity (lower intensity for plurals, $\beta = -2.89$, $SE = 1.77$, $t(90) = -2.45$, $p = .016$) for all speakers, Figure 4. For mean intensity in the second half of the rime, four models passed the Δ criterion ($w = .027-.859$). All included LP and Word and three included an interaction of LP and Word and/or an interaction of Regiolect and Word. However, only the interaction of Word and Regiolect individually predicted mean intensity highlighting that the intensity in plural words was reduced in Zealand Danish speakers compared to speakers of other regiolects ($\beta = -3.29$, $SE = 1.63$, $t(179) = -2.02$, $p = .045$), see Figure 4.

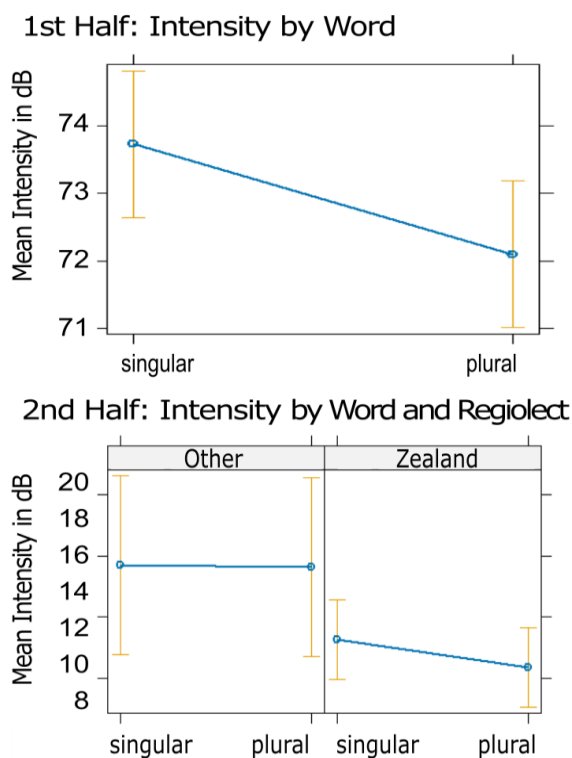


Figure 4. Model output for mean intensity for the first half (top) of the first syllable rime as predicted by Word and for the second half (bottom) as predicted by Word and Regiolect.

Harmonics-to-noise-ratio

For mean HNR in the first half of the rime, seven competitor models emerged ($w = .018-.457$). All included an effect of LP and all but one included Word. Only LP emerged as an individually significant predictor: Beginner ($\beta = 3.08$, $SE = 1.12$, $t(90) = 2.74$, $p = .007$) and intermediate ($\beta = 2.07$, $SE = 0.85$, $t(90) = 2.45$, $p = .016$) L2 users had an overall higher HNR than L1 users. For the second half, two competitor models passed the Δ criterion for HNR ($w = .334, .663$). Both included all factors and interactions except for Age, which was included only in the highest ranked model. A range of factors and interactions were individually significant predictors: Age (lower HNR for older speakers, $\beta = -0.17$, $SE = 0.06$, $t(89) = -2.75$, $p = .007$), LP (lower HNR for all L2s), Word (higher HNR for plurals, $\beta = 2.44$, $SE = 0.81$, $t(90) = 2.99$, $p = .004$), as well as interaction of Word and LP (difference between L1s and intermediate and advanced

L2s, see Figure 5) and Word and Regiolect where HNR was significantly reduced for singulars in Zealand Danish speakers compared to speakers of other regiolects ($\beta = -3.92$, $SE = 1.29$, $t(146) = -3.04$, $p = .004$); Figure 5.

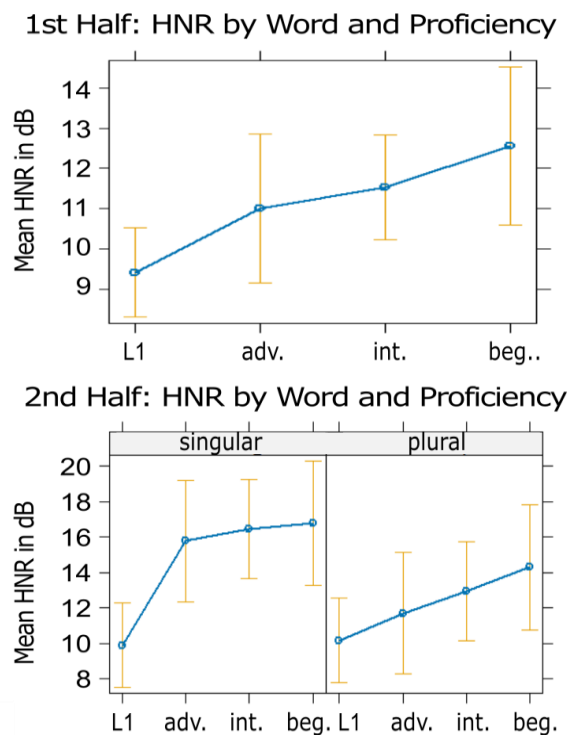


Figure 5. Model output for mean HNR for the first half (top) of the first syllable rime as predicted by Listening Proficiency and for the second half (bottom) as predicted by Word and Listening Proficiency.

Discussion

A qualitative analysis of the speech samples showed that stød was produced differently across speakers but that for many speakers, stød proper was produced on the second half of the rime. This general observation in the data roughly matches Peña (2022)'s description of stød timing and prompted a split of the acoustic measures into two halves. It also seemed as though speakers from areas other than Zealand did not always use stød in the singular word or potentially use different weightings of acoustic cues. This confirms previous descriptions of stød in Denmark and regiolect information was consequently included in the quantitative analysis.

Although duration is not necessarily strongly associated with L1 productions of stød (Fischer-Jørgensen, 1989), it was investigated as a potential acoustic measure involved in stød production in the L2 groups. While the analysis found that the rime was longer in L2 users at beginner and intermediate proficiency compared to L1 users, there was no effect of word form. In other words, L2 users likely articulated words more slowly overall at lower proficiency levels. L2 users did not appear to confound stød with a duration phenomenon and produce length differences to differentiate stød and nonstød in Danish.

As expected from the literature on regional stød differences (e.g., Siem, 2023) as well as Peña (2023)'s findings for acoustic prominence of pitch cues in stød perception, pitch emerged as the most reliable cue to distinguish word forms with and without stød in the L1 group. Specifically, stød-bearing word forms (singulars)

elicited higher pitch in both the first and the second half of the rime. The expectation was that pitch would be lower for the second half of the rime due to a pitch drop that is characteristic for the realisation of *stød* proper (Fischer-Jørgensen, 1989). However, creaky phonation led to missing pitch data which likely artificially raised the mean pitch in the average measure. In future studies, the use of average measures for *stød* proper should be carefully reconsidered. In the present study, mean pitch should be interpreted as reflecting pitch-tracking outcomes rather than the underlying acoustic pitch trajectory, as creaky phonation leads to missing pitch points. This entails a higher risk of failing to detect existing pitch difference. Despite this limitation, clear pitch differences were found in the L1 group. The L2 speakers, in contrast, did not show pitch differences for the different word conditions and no effect of increasing proficiency was observed in the pitch measure.

Also in line with Peña (2023)'s findings, the L1 speakers in the present study had comparably low but uniform harmonics-to-noise-ratios for all word forms. HNR is in the present study included as a measure of the irregular voicing related to creaky voice. L2 speakers have comparably more regular voicing which, interestingly, gets more irregular with increasing proficiency such that advanced speakers are close to or indistinguishable from L1 speakers. However, unlike L1 speakers, the L2 speakers at higher proficiency levels start to produce different HNR values for the two contrasted word forms such that their voice becomes more aperiodic for the end of the rime of the canonical non*stød* plural word forms compared to the *stød*-bearing singulars. It is possible that this is proficient L2 users' way of approximating the perceived *stød* patterns in Danish. This finding is highly surprising as it is the opposite of what is known to happen with periodicity for *stød* where lower HNR tends to be characteristic for the realisation of *stød* proper. Yet, a HNR difference between word forms did not emerge in the L1 data in the present dataset. It is possible that this is due to the conflation of speakers of different language varieties as the effect of regiolect suggests. Creaky phonation is strongest in Zealand Danish (Siem, 2023) and overall not the strongest cue for *stød* perception (Peña, 2023) which would explain the lack of HNR differences in the production of *stød* and non*stød* word forms in the L1 group in the presented dataset. Yet, this does not explain the observed opposite production pattern for HNR that emerges in the L2 groups with increasing proficiency. This finding should be looked at more systematically in a larger dataset, either longitudinally to see changes as proficiency progresses or in direct comparison to the individual speakers L1 productions to ensure that individual variation between groups is not the root cause of this effect.

Finally, as expected from descriptions of *stød* realisation (e.g., Fischer-Jørgensen, 1989), the study observed a higher intensity for canonically *stød*-bearing singular word forms in the first half of the rime. Interestingly, this effect was not modulated by proficiency and occurred across L1 and L2 groups which suggests that all speakers in the current dataset use intensity in the beginning of the rime, i.e., presumably before the onset of *stød* proper, as part of their *stød* realisation. The study further found that intensity was higher in the second half of the

rime for speakers with a Zealand Danish background, regardless of language proficiency. This was surprising. *Stød* descriptions predict an intensity drop for the second syllable which was expected to lead to an overall lower intensity in the second half of *stød*-bearing rhymes, especially in Zealand participants where creaky voice rather than tonal information was expected to be the most important characteristic of *stød* production. However, it is possible that the intensity drop was preceded by an increase in intensity relative to non*stød*-bearing rimes which might have bled into the second part of the rime. An alternative interpretation is that this might be evidence of an effect that is taken out of proportion by the unequal number of participants in the two regional groups (79 vs 16).

In summary, the L2 speakers in this study were found to make use of various cues to distinguish *stød* and non*stød* in their production of the analysed pair of word forms. On the one hand, they use a high intensity cue before words with *stød*, much like L1 users. On the other hand, at increasing proficiency they were found to use reduced HNR as a marker of non*stød*. The latter strategy differs from that of the L1 users in this dataset for whom no effect of HNR was found. Instead, the L1 group used pitch as a differentiator between word forms that was not used overall by the L2 users. Essentially, this indicates that the L2 speakers in this dataset had some degree of *stød* awareness and differed in their production of word forms with alternating *stød* prosody. They mark *stød* seemingly consistently, especially at higher proficiency levels, but in a way that is different from L1 speakers of Danish. This finding might explain the low attention to *stød* cues observed in *stød* perception studies that were based on L1 productions (Gosselke Berthelsen & Kristensen, 2025). The difficult mapping of the Danish prosodic feature's acoustic characteristics onto L1 categories might have resulted in a representation of *stød* in the L2 users' phonology that differs from that of L1 users. The presented data suggests that L2 users are not necessarily *stød*-deaf but can and do produce differences between *stød*-bearing and non*stød*-bearing word stems. However, their internal concept and external realisation of *stød* is different from how *stød* is canonically described in Danish. This study did not test how the L2 users' HNR and intensity manipulations were perceived by L1 users. This would be worthwhile testing in future studies. Also, while based on a relatively large group of speakers, the presented analysis only looks at the realisation of a single early acquired word. Therefore, the findings and conclusions of the study need to be carefully scrutinised with the help of larger and more balanced learner corpora and, ideally, longitudinal testing.

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Notes

¹Listening proficiency was chosen over the CEFR's spoken measures (spoken interaction and presentation) as the latter relate mainly to speech planning and fluency. Listening assessments, instead, tap into pronunciation

and phonological awareness which is more relevant for prosody. While this methodological choice may affect the categorisation of single participants, overall differences between proficiency types were not significant.

References

- Anwyl-Irvine, A. L., Massonnié, J., Flitton, A., Kirkham, N., & Evershed, J. K. (2020). Gorilla in our midst: An online behavioral experiment builder. *Behavior Research Methods*, 52(1), Article 1.
<https://doi.org/10.3758/s13428-019-01237-x>
- Basbøll, H. (2015). *Morphophonology*. 826–833.
<https://doi.org/10.1016/B978-0-08-097086-8.53036-0>
- Bates, D., Mächler, M., Bolker, B., & Walker, S. (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software*, 67, 1–48.
<https://doi.org/10.18637/jss.v067.i01>
- Bjargardóttir, S. (2011). *Hvordan står det til? En undersøgelse af islandske gymnasieelevers udtale af dansk* [Bachelor thesis]. University of Iceland.
- Boersma, P. (2001). Praat, a system for doing phonetics by computer. *Glott International*, 5, 341–345.
- Burnham, K. P., & Anderson, D. R. (2002). *Model selection and multimodel inference: A practical information-theoretic approach* (2nd ed.). Springer.
- Clausen, S. J., & Kristensen, L. B. (2015). The cognitive status of stød. *Nordic Journal of Linguistics*, 38(2), Article 2. <https://doi.org/10.1017/S0332586515000141>
- Council of Europe. (2020). *Common European Framework of Reference for Languages: Language, teaching assessment—Companion volume*.
<https://www.coe.int/lang-cefr>
- Ejskjær, I. (1990). Stød and pitch accents in the danish dialects. *Acta Linguistica Hafniensia*, 22(1), 49–75.
<https://doi.org/10.1080/03740463.1990.10411522>
- Fischer-Jørgensen, E. (1989). Phonetic analysis of the stød in standard Danish. *Phonetica*, 46(1–3), Article 1–3.
<https://doi.org/10.1159/000261828>
- Gosselke Berthelsen, S., & Kristensen, L. B. (2025). That came as no surprise! The processing of prosody-grammar associations in Danish first and second language users. *Languages*, 10(8), 181.
<https://doi.org/10.3390/languages10080181>
- Grønnum, N. (2005). *Fonetik og fonologi: Almen og dansk*. Akademisk forlag.
- Hansen, G. F. (2015). *Stød og stemmekvalitet. En akustisk-fonetisk undersøgelse af ændringer i stemmekvaliteten i forbindelse med stød* [Ph.D. Thesis]. University of Copenhagen.
- Hjortdal, A., Frid, J., & Roll, M. (2022). Phonetic and phonological cues to prediction: Neurophysiology of Danish stød. *Journal of Phonetics*, 94, Article e101178.
<https://doi.org/10.1016/j.wocn.2022.101178>
- Høeg, A. (2026). Danish speakers' preference for stød in monomorphemic nonce words ending in *-en*, *-er*, or *-el*. *Phonological Data and Analysis*, 8, e3.
<https://doi.org/10.1017/S2642182826000073>
- Jørgensen, J. (1978). 'Stød' and unexpected substitutions in the speech of Danish 2-year-old children. *Annual Report of the Institute of Phonetics University of Copenhagen*, 12.
- Peña, J. M. (2022). Stød Timing and Domain in Danish. *Languages*, 7(1), Article 1.
<https://doi.org/10.3390/languages7010050>
- Peña, J. M. (2023). Effects of fundamental frequency and harmonics-to-noise ratio on the perception of Danish laryngealized phonation. In R. Skarnitzl & J. Volín (Eds.), *Proceedings of the 20th International Congress of Phonetic Sciences* (pp. 1736–1740). Guarant.
- R Core Team. (2021). *R: A language environment for statistical computing*. R Foundation for Statistical Computing. <https://www.R-project.org/>
- Ringgaard, K. (1960). *Vestjysk stød* [Ph.D. Thesis]. Aarhus University.
- RStudio Team. (2021). *RStudio: Integrated development Environment for R*. RStudio, PBC.
<https://www.rstudio.com/>
- Siem, A. (2023). *Phonetic and dialectal variation in phonological contrastive laryngealisation: A case study of the Danish stød* [Ph.D. Thesis]. Lancaster University.
- Vies, C. Z., & Gosselke Berthelsen, S. (2023). Processing Danish nouns with stød-alternating stems. In O. Niebuhr & M. Svensson Lundmark (Eds.), *Proceedings of the 13th International Conference of Nordic Prosody* (pp. 54–60). <https://doi.org/10.2478/9788366675728-003>