Stød and Length in Standard Danish: Experiments in Laboratory Phonology

Nina Grønnum[†] and Hans Basbøll[‡]

† University of Copenhagen, ‡ University of Southern Denmark

e-mail: ng@cphling.dk, hba@language.sdu.dk

ABSTRACT

Three questions in the analysis of Danish stød are addressed. (1) Vowels with stød are phonologically long; they are proposed also to be bi-moraic, with the second mora carrying the stød. We confirm the acoustic reality of length, but a moderate statistical tendency only to acoustic bi-partition. (2) In a perceptual experiment vowels with stød were judged to resemble long stødless vowels by eight subjects, whereas eight other subjects paired syllables with stød, irrespective of vowel length. (3) In a visual analogue scaling experiment, 81 subjects were asked to fix the point in time in the vowel where stød begins. They could not.

1. INTRODUCTION

Stød is laryngealization, a kind of creaky voice which characterizes certain syllable rhymes under certain conditions. Its phonetic properties have been treated in depth in [8, 9], its phonology and inflectional morphology in [1-3] and recently in a completely new perspective in [4]. Traditionally, potential for stød is a question of phonetic stødbasis. A stressed syllable with a long vowel or with a short vowel succeeded by a non-syllabic sonorant has stødbasis. In *mono-morphemic* words the occurrence of stød can be charted as in Table 1. (The transcription is very broad throughout. For more phonetic detail, see [10].)

	no stødbasis	stødbasis
monosyllables	no stød: [blus] *blus* 'flame'	stød: [luːˀs] *lus* 'louse' [pulˀs] *puls* 'pulse'
disyllables	no stød: [ˈluseŋ] *lussing* 'slap in the face'	no stød: [ˈbluːsə] *bluse* 'blouse'

Table 1: Stødbasis and segmental structure.

The generalization is that syllables with stødbasis have stød, though not in disyllables. This is over-simplified, but sufficient for the present purpose, and the simplification does not affect the observation that consonant length is not an issue in the traditional account.

When inflected and derived words are admitted into the analysis, stød is unquestionably and abundantly contrastive on the surface, cf. minimal pairs like

[ˈhenən ˈhenˀən ˈviːsʌ viːˀsʌ] *hinden* 'the film,' *hinden* 'the hind,' *viser* '(instrument) hand,' *viser* 'shows (v).'

However, under a sufficiently sophisticated morphophonological analysis it is possible—to a very large extent—to predict the presence or absence of stød in Danish words, cf. particularly [4].

[2-5] assume moraic structure in Danish syllables, and thus *stød is a property of certain bi-moraic syllables*. In phonetic support of his analysis, inter alia, Basbøll quotes the observation in [8] and [9] that the laryngealization tends to begin about halfway through the vowel if it is long, or near its offset if it is short, which makes stød-syllables bi-phasal. With yet a reservation about over-simplification, "mono-moraic" can be substituted for "no stødbasis" and "bi-moraic" for "stødbasis" in Table 1. The principles for mora-counting in standard Danish then are:

(1) Any syllable with a long vowel is bi-moraic, like [koːˀ muːˀs biːˀl] *ko, mus, bil* 'cow, mouse, car'.

(2) Open syllables with a short vowel are mono-moraic, like [du ʁæsyˈme] *du, resumé* 'you, summary'.

(3) Syllables with short vowels succeeded by a non-sonorant consonant are mono-moraic, like [kad hʌf] *kat, hof* 'cat, court'.

(4) If stød and moraic structure are indeed associated, closed syllables with a short vowel come in three sets:
(a) If succeeded by a sonorant consonant and a second consonant they are bi-moraic (they always have stød), like *hals, amt* [halˀs ɑmˀd] 'throat, county';
(b) If succeded only by a sonorant consonant:
(i) some syllables are bi-moraic (they have stød), like [halˀ sœmˀ] 'hall, nail';
(ii) others are mono-moraic (they do not have stød), like [tal sœn] 'number, son'.

The potential controversy is in (1) and in (4b):
If **vowels** with stød are as long acoustically as long vowels without stød they can reasonably be analysed as bi-moraic. The interpretation will be further justified if vowels with stød can be shown to be long also cognitively. The analysis gains in viability if the creaky voice is contained within the latter half of the vowel, and even further if this bi-partition is a cognitive reality for speakers and listeners.

If **consonants** with stød are longer than stødless consonants, their moraic status is uncontroversial. If not, other interpretations are required, cf. [4, 5].

2. VOWEL DURATION, STØD ONSET TIMING AND COGNITIVE REALITY

2.1 Vowel duration

The phonological distinction in vowel length is unambiguously reflected in duration, both acoustically and perceptually. Long vowels without stød are 50-70% longer than short vowels, depending on speech style, cf. [6, 7]. The literature is not unanimous, however, about stød vowel duration. [8] and [9] give stød vowels approximately 75% of the duration of long stødless vowels (measured in words in citation form), whereas [14] finds that the two are of equal duration (measured in words in more natural sentences). Our data leave no doubt that, outside of citation forms, vowels with stød are as long as long vowels without stød, cf. [11, 12]. Different speech styles can probably be made responsible for the different results, see further [11].

2.2 A first perceptual experiment

Before we address the putative bi-phasal nature of vowels with stød, we must establish whether they are indeed perceived as long, in accordance with their acoustic duration, or if perhaps syllables with stød are identified with each other, irrespective of their segmental composition.

Stimuli

We need to know whether, e.g., [ˈtiːˀlən] is more similar to [ˈtiːlən] than to [ˈtilən] or if maybe the resemblance to [ˈtilˀən], another type of word with stød, is stronger than either of those. There are therefore four types of stimuli to compare, namely words with stød vowels, words with long stødless vowels, words with short vowel and stød in the consonant, and words with no stød at all, cf. Table 2.

type	I	II	III	IV
	V:ˀ	V:	VCˀ	VC

Table 2: Segmental structure of the stressed syllable rhymes of the four stimulus types.

Since type II occurs only in disyllables, cf. above, we are restricted to disyllables throughout. There are few semantically meaningful perfect quadruplets in the language, so nonse words were required. This is actually not undesirable, since subjects are not side-tracked by lexical properties but, per force, react to naked sound structure. We had ten different instantiations of each type, illustrated by type IV:

[ˈtilən ˈbɛməð ˈstɛnəð ˈmyləð ˈgøləð ˈsølən ˈstulən ˈtɔməð ˈkylən ˈtyməð].

The authors recorded a material which was made as semantically and pragmatically natural and coherent as possible, given the nonse nature of the words. The words were excised from their context and stored in the computer.

In an ABX-test X was to be judged most similar to either A or B. A, B, and X were always different. Triads were combined in all 24 possible ways for each instantiation of the four types, yielding 240 stimuli for each of the two speakers, i.e. 480 total. Stimulus interval in the triad was 1 second. For further details about the test, see [12,13].

Results

Responses from five subjects were not significantly different from chance. The remaining sixteen reveal two different, well defined response patterns, with eight subjects in each, cf. Table 3.

similarity between types:	I=II	III=IV	I=III	II=IV	I=IV	II=III
Group 1, N =	443	523	292	305	194	168
percentage	69	82	46	48	30	26
Group 2, N =	300	358	459	461	185	157
percentage	48	54	72	71	29	25

Table 3: Number of responses from two groups of eight subjects and the percentage of the 640 potential maximum in each cell.

Group 1 appear to base their similarity judgements on vowel length: (words with) long vowels resemble each other, irrespective of the presence of stød (I=II: 69%); and (words with) short vowels resemble each other, irrespective of the presence or absence of stød in the succeeding consonant (III=IV: 82%). Group 2 base their judgements on the presence or absence of stød, i.e. (words with) stød syllables resemble each other, irrespective of vowel length (I=III: 72%), and (words with) stødless syllables likewise resemble each other (II=IV: 71%). Both groups reject any resemblance between (words with) syllables which are different with respect to both stød and vowel length (I=IV: 30%/29%; II=III: 26%/25%). Preference for one or the other strategy seems to be an individual feature. There are Copenhagen and regional speakers in both groups.

In brief: to half of our subjects stød vowels unambiguously resemble long stødless vowels. To the other half syllables with stød resemble each other, irrespective of the segmental composition. This does not necessarily imply that stød vowels are not long for them also, only that the presence of stød overrides any other similarity between the words.

2.3 Acoustic stød onset timing

Variability in the onset of laryngealization (when it can be determined at all, cf. 2.4), measured from vowel onset, is very considerable, with time lags ranging between 1cs and 13cs. It averages around 6cs, cf. [11]. The authors diverged in the interpretation here. NG believed that the dispersion in the measurements is too comprehensive to permit a characterization of vowels with stød as consisting of two parts, an initial one without and a final one with stød. HB believed that the tendency towards bi-partition of the prototypical stød-syllable may be an essential auditory characteristic of bi-moricity. This is an empirical issue which we are going to address next.

2.4 The perception of stød onset

Stimuli

From the material recorded for [11], we excised 20 disyllabic words with stød, four from each of five speakers. They are instances of [ˈdiːˀsən ˈspiːˀsʌ ˈviːˀsʌ ˈpiːˀbʌ ˈgyːˀsʌ ˈlɛːˀsʌ ˈlɛːˀnʌ] *disen (2), spiser (3), viser (1), piber (1); gyser (3); læser (8), læner (2)* 'the fog, eats, shows, whines, shudders, reads, leans'. Two words with high vowels ([iːˀ] or [yːˀ]) and two words with [ɛ] were selected from each speaker. Stød was unmistakably audible in all but two items where it was faint. Stød does not have to be audibly faint, however, to be hard to detect in either spectrograms or F0 tracings. So we attempted a further bi-partition of stimuli: two items by each speaker had visible stød and two did not. The words were randomized, and two of them doubled as initial and final dummies, i.e. there was a total of 22 words to be responded to; but the first and the last were disregarded in the subsequent analysis. Each word was presented three times with one second intervals between repetitions and five second pauses before new words. The test totalled just under 4 minutes. The task was a visual analogue scaling, where listeners had to mark, on 22 individual sheets of paper, on a 10cm long line, where they thought the stød began. The test was performed in class rooms, over professional quality loudspeakers, with first year students of linguistics, audiologopedics and English, respectively, and with a group of graduate students. That way we obtained valid data from 81 listeners who all have stød in their own speech and who provided us with a comfortable safety in numbers.

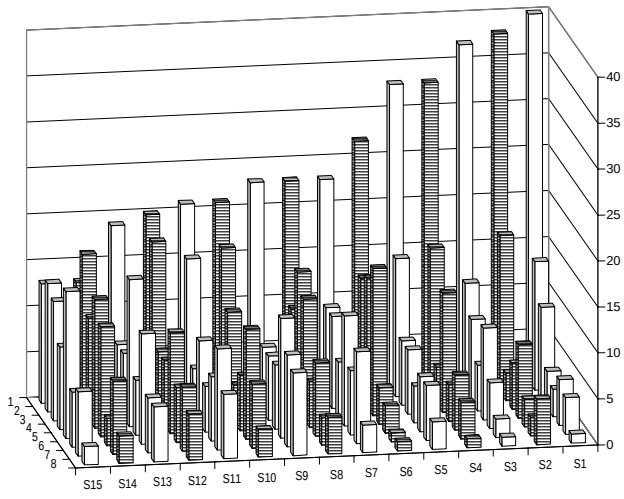

Figure 1: 1210 responses in 8 categories to 15 stimuli.

Results

Listeners spontaneously reported, after completion of the test, that they had found it very difficult and were not really sure what they were doing, which is telling in itself. Nevertheless, there is a trend in their responses, only—as we shall see—it has nothing to do with anything that we can associate with stød as we usually identify it.

Marks on the line were converted to numerical values: within the leftmost 2cm they rate "1", within the next six 1cm intervals they rate from "2" through "7", and marks within the rightmost 2cm of the line rate "8". In five words responses were not significantly different from chance (at $p < .05$ or better). 1210 responses to the remaining fifteen are depicted in Fig. 1. There is a pronounced overall tendency towards perceived stød onset at the very beginning of the vowel, and certainly no indication of two phases in the vowel, a first half without stød and a second half with stød, which would have made responses hump in the middle, around "4" and "5".

The detailed documentation will not find room here (see [13]), but we can summarize the outcome of the analysis. Some stimuli had a more pronounced tendency towards early judgements than others, cf. Fig. 1 (and five had evenly distributed responses). Can acoustic properties in the twenty words be made responsible for these differences? They are best quantified in terms of response distribution medians which range from 3 to 6 on the 8-point scale.

In eleven stimuli it is not evident in either spectrogram, F_0 tracing, microphone signal or harmonicity-to-noise ratio (HNR; reflects aperiodicity, cf. www. praat.org) that there is any creaky voice at all, even though only two of them sounded faint (those two and two more of these eleven produced chance responses). Nine stimuli do have visibly irregular vibrations. But among those nine there are only two where we can point, with any confidence, to a clear transition between modal and creaky voice (and, surprisingly perhaps, one of those also received chance responses).

So what did listeners actually respond to, in order to produce the trend depicted in Fig. 1? We extracted a number of acoustic parameters from the comprehensive selection available in praat: HNR average across the vowel, HNR maximum, distance of HNR maximum from vowel onset; average F_0 through the vowel, F_0 maximum, F_0 minimum, F_0 range; and vowel duration. The only factor which comes out with a (modest) correlation with the median of listeners' responses is vowel duration (r=.75). And that of course is directly related to the high [iːˀ yːˀ] versus lower [ɛːˀ] distinction in the words. We take this to mean that our listeners, at a loss to do what was actually asked of them, searched for something else in the stimuli to differentiate them and found only vowel quality. Inadvertently, they bear testimony to the fact that intrinsic differences in vowel duration do not entirely bypass perception, or else why did not words with [ɛːˀ] provoke *earlier* stød judgements than words with [iːˀ] and [yːˀ]?

3. CONSONANT DURATION

We refer the reader to [11] for a complete account of our consonant data, or to the shorter edition in [12]. Here is the briefest possible summary:

Word final position
There is a tendency for stød consonants to be somewhat longer than stødless ones, by 1 to 3cs.

Utterance final position
Stød consonants are consistently and considerably shorter than stødless ones, by 2 to 5cs.

Word medial position before a consonant
Stød consonants are not consistently either shorter or longer than stødless ones.

Word medial position before an unstressed vowel
Consonants with and without stød are equally long.

Long stød consonants seem to be phantoms in normal running speech. Most certainly in utterance final position, but note also word medial position before an unstressed vowel where no extrinsic factors can be made responsible for differences in duration. This is not to say that consonants with stød cannot be longer than consonants without stød, ceteris paribus, but they are not systematically longer across positions, and they may be shorter as well.

4. DISCUSSION

Our production results are from modern standard Copenhagen Danish. Chronological, geographical and social variation could not be taken into account, and there is little doubt that the details of stød and length are highly variable in time and space. This must be borne in mind when we discuss general issues about Danish stød, and not least when our results are compared to previous findings.

We have not found any justification for considering stød consonants to be systematically long in normal running speech. Nor did anyone ever suggest that stød consonants be long cognitively. At this point in our research we have no reason to believe that to be remotely likely either.

Vowels with stød are indeed as long as long stødless vowels and may also safely be considered cognitively long. But the latest experiment in the series proved without a doubt that listeners do not partition stød vowels into two halves.

Accordingly, everything considered, there seems to be neither acoustic nor perceptual support for positing two phases in vowels with stød (as opposed to vowels without stød). Physically and cognitively, stød may therefore be considered a property of the syllable rhyme, rather than specifically of its second mora. In other words, the mora analysis as a physical and cognitive reality must be abandoned. Note also that morae play no role in poetic metre in Danish.

However, at more abstract levels of description, where no close affinity with phonetic surface manifestations and no explicit claim about psychological reality are postulated, a mora account of stød and its distribution may be entirely justifiable. This is indeed the analysis in [4, 5]. It embodies the claim that modern Danish has grammaticalized (phonologized) syllable weight, resulting in a linguistically relevant distinction between two classes of stressed syllables: light and heavy (containing one and two morae, respectively). Syllables with vowel length and/or stød are always bi-moraic, but no claim about two distinct phases should be made at this level of abstraction. The description in terms of morae would be relevant for historical analysis and typological comparisons.

Acknowledgements

Gert Foget Hansen competently carried out the first perceptual experiment, and Niels Reinholt Petersen gave generous advice on its design and statistical analysis.

References

[1] H. Basbøll. “Stød in modern Danish”, *Folia Linguistica*, **19**, 1985, pp. 1-50.

[2] H. Basbøll. “The modern Danish stød and phonological weight”, In P.M. Bertinetto, M. Loporcaro (eds.) *Certamen Phonologicum*. Torino: Rosenberg & Sellier, 1988, pp. 119-152.

[3] H. Basbøll. “Nyt om stødet i moderne rigsdansk - om samspillet mellem lydstruktur og ordgrammatik.”, *Danske Studier 1998, Universitets-Jubilæets danske Samfund*, 1998, pp. 33-86.

[4] H. Basbøll. *The Phonology of Danish*. Manuscript to be published by Oxford University Press.

[5] H. Basbøll. “Prosody, Productivity and Word Structure: The Stød Pattern of Modern Danish”, *Nordic Journal of Linguistics* **26**, 2003 (forthcoming).

[6] M. Bundgaard. “An acoustic investigation of intrinsic vowel duration in Danish”, *Annual Report of the Institute of Phonetics, University of Copenhagen* **14**, 1980, pp. 99-119.

[7] E. Fischer-Jørgensen. “Om vokallængde i dansk rigsmål”, *Nordisk Tidsskrift for Tale og Stemme* **15**, 1955, pp. 33-56.

[8] E. Fischer-Jørgensen. “Phonetic analysis of the stød in standard Danish”, *Phonetica* **46**, 1989, pp. 1-59.

[9] E. Fischer-Jørgensen. *Phonetic analysis of the stød in Danish.* University of Turku, 1989.

[10] N. Grønnum. “Danish”, *Journal of the International Phonetic Association* **28**, 1998, pp. 99-105.

[11] N. Grønnum and H. Basbøll. “Consonant length, stød and morae in standard Danish”, *Phonetica* **58**, 2001, pp. 230-253.

[12] N. Grønnum and H. Basbøll. 2002. “Stød and Length: Acoustic and Cognitive Reality?” In B. Bel, I. Martin (eds.), *Proceedings of the Speech Prosody 2002 Conference, 11-13 April 2002. Aix-enProvence*, 2002, pp. 355-358.

[13] N. Grønnum, H. Basbøll and G. Foget Hansen. “Vowels with stød are cognitively long but not bi-partite”, in preparation.

[14] P. Riber Petersen. “An instrumental investigation of the Danish stød”, *Annual Report of the Institute of Phonetics, University of Copenhagen* **7**, 1973, pp. 195-234.