

Stød and Length: Acoustic and Cognitive Reality?

Nina Grønnum[†] & Hans Basbøll[‡]

[†]Department of General and Applied Linguistics, Copenhagen University
[‡]Institute of Language and Communication, University of Southern Denmark
 and The Danish Institute for Advanced Studies in Humanities
 ng@cphling.dk, hba@language.sdu.dk

Abstract

Three questions in the analysis of Danish stød are addressed. (1) We try and establish an acoustic reality behind a proposed phonological analysis of consonants with stød as long (moraiic) in opposition to short stødless (non-moraiic) consonants and fail. (2) Vowels with stød are phonologically long; they are proposed also to be bi-moraiic, with the second mora carrying the stød. We confirm the acoustic reality of length, but a moderate tendency only to acoustic bi-partition. (3) In a perceptual experiment vowels with stød were paired with long stødless vowels by half the subjects, whereas the other half paired syllables with stød, irrespective of vowel length. This is a good point of departure for an experiment to find out whether vowels with stød are cognitively bi-partite.

1. Introduction

Stød is a laryngealization which characterizes certain syllable rhymes under certain conditions. Its phonetic properties have been treated in depth by [6, 7], its phonology and inflectional morphology by [1-3]. [12] is the pioneer treatment of its grammatical aspects.

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 sonorant consonant has stødbasis. In *mono-morphemic* words the occurrence of stød can be charted as in Table 1.¹

Table 1: Stødbasis and segmental structure.

	no stødbasis	stødbasis
monosyllables	no stød: [blus] <i>blus</i> 'flame'	stød: [lu:ʔs] <i>lus</i> 'louse' [pulʔs] <i>puls</i> 'pulse'
disyllables	no stød: [luseŋ] <i>lussing</i> 'slap in the face'	no stød: [blu:sə] <i>bluse</i> 'blouse'

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. The affinity between stød and Swedish Accent I is obvious, with minor distributional differences, cf. [11].

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

[ˈhɛnən ˈhɛnʔən ˈvi:sʌ ˈvi:ʔsʌ]

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, though not entirely—to predict the presence or absence of stød in Danish words.

[2] and [3] assume moraiic structure in Danish syllables (though of a less proto-typical kind than in, e.g., Japanese, cf. [14]), and thus *stød is a property of certain bi-moraiic syllables*. In phonetic support of his analysis, inter alia, Basbøll quotes the observation in [6] and [7] 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-moraiic" can be substituted for "no stødbasis" and "bi-moraiic" for "stødbasis" in the chart above. The principles for morai-counting in standard Danish then are:

- (1) Syllables with a long vowel are bi-moraiic, like [mu:ʔs] *mus* 'mouse.'
- (2) Open syllables with a short vowel are mono-moraiic, like [nu] *nu* 'now.'
- (3) Syllables with a short vowel succeeded by an unvoiced consonant are mono-moraiic, like [kat] *kat* 'cat'. (Similar syllables are bi-moraiic in standard Norwegian and standard Swedish, cf. [13] and [15].)
- (4) Syllables with a short vowel succeeded by a sonorant consonant and a (tautomorphemic) second consonant are bi-moraiic, like [həlʔs] *hals* 'throat.'
- (5) If stød occurs only in bi-moraiic syllables, it follows that certain mono-syllables with a short vowel succeeded by one sonorant consonant must be bi-moraiic, others not—under otherwise identical conditions, cf. [dɑj təl sœn vīð] *dig, tal, søn, vid* 'you, number, son, wit' without stød vs. [dɑjʔ həlʔ tœnʔ vīðʔ] *dej, hal, tynd, hvid* 'dough, hall, thin, white' with stød.

¹ The transcription is broad throughout. For more phonetic detail, see [8].

The crux of the matter is in (5) and in (1):

(5) If consonants with stød are longer than stødless consonants, their interpretation is uncontroversial. If stød-consonants are not longer, moricity in consonants must be given a more abstract interpretation.

(1) If vowels with stød are as long acoustically as long vowels without stød they can reasonably be analysed as bi-moraic, an interpretation which will be further justified if they 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.

In other words, vowel and consonant duration hold the key to a phonological enigma.

2. Consonant duration

2.1 Long stødless consonants?

There is an abundance of stød vowels and corresponding long stødless vowels, as in

[[?]bɛ:nəð] *benet* ‘the bone;’ [[?]bɛ:nəð] *benet* ‘bony’
[[?]mɔ:sʌ] *moser* ‘mashes (v);’ [[?]mɔ:sʌ] *moser* ‘bogs.’

There are also plenty of examples to show that vowel length may remain when stød is absent, as in the first part of a compound or derivative

[so:[?]l] *sol* ‘sun;’ [[?]so:lbʁæ:l] *solbriller* ‘sunglasses’
[bi:[?]l] *bil* ‘car;’ [[?]bi:lvʌsk] *bilvask* ‘car wash.’

We do not similarly have long stødless consonants. There are no long stødless consonants in stressed syllables in standard Danish. Thus we have correspondences like

[[?]hɛnʌ] *hænder* ‘hands’ ~ [[?]hɛnʌ] *hænder* ‘happens’ - not
* [[?]hɛn:ʌ]
[[?]kʌmʌ] *kommer* ‘comes’ ~ [[?]lʌmʌ] *lommer* ‘pockets’ - not
* [[?]lʌm:ʌ].

Nor do we ever get long consonants when stød is absent due to derivation, cf.

[[?]tʌmʌ] *tom* ‘empty;’ [[?]tʌmheðʌ] *tomhed* ‘emptiness’ - not
* [[?]tʌm:heðʌ]
[ul[?]] *uld* ‘wool;’ [[?]ulʌɕjə] *uldrøje* ‘woolen cardigan’ - not
* [[?]ul:ʌɕjə].

In brief, where stød vowels may recur as long vowels in spite of the absence of stød, we never—in the standard language—get (contrastively) long consonants when a syllable with a short vowel “loses” stød.

2.2 Long stød consonants?

[6, 7] and [16] find consonants with stød to be systematically longer than consonants without stød. However, we have a number of reservations about the analyses in [16]; and the results in [6, 7] cannot perhaps be generalized from more to less artificial speech styles and/or to present-day Copenhagen Danish; see further [9]. Furthermore, it is not our impression that consonants with stød are perceptibly longer than

consonants without stød, whereas stød vowels generally sound longer than short stødless ones. When—for structural reasons—stød is absent it never leaves a long consonant behind. This is crucial: in stressed syllables without stød Danish simply does not have tautosyllabic long consonant sounds.

To sum up: the existence of phonologically long consonants in Danish depends on the existence of measurably longer consonants with stød than without stød in comparable positions.

2.3 The acoustic investigation

A fairly comprehensive corpus was designed and recorded in the laboratory, and although the recordings are not of non-scripted speech, the sentences were at least semantically and pragmatically fairly natural. Recordings from five speakers were analysed. For reasons of space we summarize only the core of the results here. See [9] for a complete account.

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 an unstressed vowel

This is the crucial position because no extrinsic factors can be made responsible for differences in duration: Consonants with and without stød are equally long.

By and large, we believe long stød consonants to be phantoms in normal running speech, at least where word medial position before an unstressed vowel is concerned, and most certainly in utterance final position. 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.

3. Vowel duration, stød onset timing and cognitive reality

3.1 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. [4, 5]. The literature is not unanimous, however, about stød vowel duration. [6] and [7] give stød vowels approximately 75% of the duration of long stødless vowels (measured in words in citation form), whereas [16] 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. For a general discussion about speech style and duration in this context see [9].

3.2 Stød onset timing

Variability in the onset of laryngealization, measured from

vowel onset, is very considerable, with time lags ranging between 1 and 13cs. It averages around 6cs. The authors diverge in the interpretation here. NG believes 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. But HB believes that the tendency towards bi-partition of the prototypical stød-syllable may be an essential auditory characteristic of bi-morcity. This is an empirical issue.

3.2 A perceptual experiment

Before we address the rather complicated task of investigating empirically the cognitive reality of a putative bi-phasal nature of vowels with stød, we need to know 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.

3.2.1 Stimuli

We need to know whether, e.g., [ˈtiːˀløn] is more similar to [ˈti:løn] than to [ˈtiløn] or if perhaps the resemblance to [ˈtiːløn], another type of syllable with stød, is stronger than either of those. There are therefore four types of stimuli to compare, namely syllables with stød vowels, syllables with long vowels without stød, syllables with short vowel and stød in the consonant, and syllables with short vowel and no stød in the consonant, cf. Table 2.

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

type	I	II	III	IV
	Vːˀ	Vː	VCˀ	VC

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 nonsense words were required. That being the case, we avoided real words altogether. To diminish the repetitiveness of the listening task we had ten different instantiations of each type. Here they are, represented by type IV:

[ˈtiløn ˈbæmæð ˈstænæð ˈmyləð ˈgələð ˈsələð ˈstuløn ˈtəmæð ˈkæløn ˈtæamæð].

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

An ABX-test was designed in which the X-word 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.

Two mutually exclusive sets of 240 stimuli were created by randomly choosing for each ABX triad whether it was to be presented with speaker NG or speaker HB. Subsequently the

sets were manually adjusted for speaker bias, so that a given word would not appear fewer than two or more than four times in any position (zero would be minimum, six maximum).

Subjects were recruited according to availability and with no other requirement than that Danish be their mother tongue and that they have no known hearing impairment. 22 subjects participated.

The test ran on-line on a laptop hooked up to a central server, with professional quality ear-phones. The instruction to subjects was given on the computer screen; one or two brief trial runs were administered to familiarize them with what we deemed to be a rather difficult task. Subjects responded by clicking on the appropriate symbol on the screen. They could take as long as they wished to respond, and only then would a new triad, introduced by a short beep, be presented to them. They took the test in two 120-triad sessions, lasting about 20 minutes each.

3.2.2 Results

Responses from five subjects were not significantly different from chance and they were excluded from further analysis. The detailed statistical analysis is still in progress and the complete account in preparation ([10]). However, preliminary statistics reveals two clear response patterns, from eight subjects each, cf. Table 3.

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

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

Numbers above 67% will be interpreted as similarity between types, and below 33% as non-similarity—both rendered in bold type in Table 3. Percentages between 34 and 66% indicate indeterminacy. 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 found 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%). One speaker did not fit either pattern and is not shown here. 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 resemble long stødless vowels, to the other half syllables with stød resemble each other, irrespective of the segmental composition.

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.

At the most concrete level, we have not found any justification for considering stød consonants to be systematically long in normal running speech. Above all, word medial position before an unstressed vowel is crucial for this conclusion. But vowels with stød are indeed as long as long stødless vowels.

At an intermediate level of abstractness the authors diverge: NG would conclude that the nature of the stød and its timing relative to segment boundaries makes it more plausibly just a property of syllables rather than more specifically a property of the second mora of syllables. This is how tradition would have it and also Basbøll himself until 1986. NG finds further support for her stance in the fact that morae play no role in poetic metre in Danish. On the whole she strongly doubts that morae have any cognitive reality at all for Danish speakers and listeners.

HB conjectures that the tendency, though not strong, towards bi-partition of the prototypical stød-syllable is an essential auditory characteristic of bi-morcity. One prerequisite, namely that vowels with stød be cognitively long, has just been established for half of the subjects in the perceptual experiment. The fact that to the other half syllables with stød resemble each other ($V: \overset{?}{=} VC \overset{?}{}$) actually increases the likelihood of a cognitive bi-partition of vowels with stød, since VC sequences indubitably are bi-partite: we need now to proceed and design that test. If the results are positive, the mora analysis is greatly strengthened. If not, the mora analysis as a physical and cognitive reality must be abandoned. Subjects may not behave in a uniform fashion in this respect, cf. the results in 3.2.2. above.

Both authors agree, however, that 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. Such an analysis would embody the claim that modern Danish has grammaticalized (phonologized) syllable weight, resulting in a linguistically relevant distinction between exactly two classes of stressed syllables: light and heavy (containing one and two morae, respectively). According to [2, 3] syllables with vowel length and/or stød would always be bi-moraic, but no claim about two distinct phases would be made at this level of abstraction. The description in terms of morae would be relevant for historical analysis and typological comparisons.

5. Acknowledgement

We are very grateful to Gert Foget Hansen who competently and with great dedication carried out the perceptual experiment and subsequent analysis. We are also obliged to Niels Reinholt Petersen for generous and sound advice on test design and statistical analysis.

6. References

- [1] Basbøll, H., 1985. Stød in modern Danish. *Folia Linguistica* 19, 1-50.
- [2] Basbøll, H., 1988. The modern Danish stød and phonological weight. In *Certamen Phonologicum*, Bertinetto, P.M.; Loporcaro M. (eds.). Torino: Rosenberg & Sellier, 119-152.
- [3] Basbøll, H., 1998. Nyt om stødet i moderne rigsdansk - om samspillet mellem lydstruktur og ordgrammatik. *Danske Studier 1998, Universitets-Jubilæets danske Samfund*, 33-86.
- [4] Bundgaard, M., 1980. An acoustic investigation of intrinsic vowel duration in Danish. *Annual Report of the Institute of Phonetics, University of Copenhagen* 14, 99-119.
- [5] Fischer-Jørgensen, E., 1955. Om vokallængde i dansk rigsmål. *Nordisk Tidsskrift for Tale og Stemme* 15, 33-56.
- [6] Fischer-Jørgensen, E., 1989a. Phonetic analysis of the stød in standard Danish. *Phonetica* 46, 1-59.
- [7] Fischer-Jørgensen, E., 1989b. *Phonetic analysis of the stød in Danish*. University of Turku.
- [8] Grønnum, N., 1998. Danish. *Journal of the International Phonetic Association* 28, 99-105.
- [9] Grønnum, N.; Basbøll, H., 2001. Consonant length, stød and morae in standard Danish. *Phonetica* 58, 230-253.
- [10] Grønnum, N.; Basbøll, H.; Foget Hansen, G., in preparation. Vowels with stød are long, also cognitively.
- [11] Gårding, E., 1977. *The Scandinavian word accents (=Travaux de l'Institut de Linguistique de Lund 11)*.
- [12] Hansen, Aa., 1943. *Stødet i dansk*. København: Det Kgl. Danske Videnskabernes Selskab. *Historisk-Filologiske Meddelelser* 29(5).
- [13] Kristoffersen, G., 2000. *The phonology of Norwegian*. Oxford University Press.
- [14] Nagano-Madsen, Y., 1992. *Mora and prosodic coordination. A phonetic study of Japanese, Eskimo and Yoruba (=Travaux de l'Institut de Phonétique de Lund 27)*.
- [15] Riad, T., 1998. Towards a Scandinavian accent typology. In *Phonology and Morphology of the Germanic Languages*, Kehrein, W.; Wiese, R. (eds.). Tübingen: Niemeyer, 77-109.
- [16] Riber Petersen, P., 1973. An instrumental investigation of the Danish stød. *Annual Report of the Institute of Phonetics, University of Copenhagen* 7, 195-234.