

# Stød and Vowel Length: Acoustic and Cognitive Reality?

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## Abstract

*In this sequel to Grønnum and Basbøll (2001a) two 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 and a tendency, though only moderate, to acoustic bi-partition. (2) 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.*

## Introduction

For a brief overview of stød and syllable types in Danish the reader is referred to our contribution to last year's meeting and/or Grønnum and Basbøll 2001b.

Basbøll (1988, 1998) assumes moraic structure in Danish syllables (though of a less prototypical kind than in, e.g., Japanese, cf. Nagano-Madsen, 1992), and thus *stød is a property of certain bi-moraic syllables*. In phonetic support of his analysis, inter alia, Basbøll quotes the observation in Fischer-Jørgensen (1989a,b) 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. The principles for mora-counting in standard Danish are:

- (1) Syllables with a long vowel are bi-moraic, like [mu:<sup>2</sup>s] *mus* 'mouse.'
- (2) Open syllables with a short vowel are mono-moraic, like [nu] *nu* 'now.'
- (3) Syllables with a short vowel succeeded by an unvoiced consonant are mono-moraic, like [kat] *kat* 'cat'. (Similar syllables are bi-moraic in standard Norwegian and standard Swedish, cf. Kristoffersen 2000, and Riad 1998.)
- (4) Syllables with a short vowel succeeded by a sonorant consonant and a (tautomorphic)

second consonant are bi-moraic, like [hal<sup>2</sup>s] *hals* 'throat.'

- (5) If stød occurs only in bi-moraic syllables, it follows that certain mono-syllables with a short vowel succeeded by one sonorant consonant must be bi-moraic, others not—under otherwise identical conditions, cf. [daq tal sæn við] *dig, tal, søn, vid* 'you, number, son, wit' without stød vs. [daq<sup>2</sup> hal<sup>2</sup> tøn<sup>2</sup> við<sup>2</sup>] *dej, hal, tynd, hvid* 'dough, hall, thin, white' with stød.

The subject matter of this paper is in (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 duration holds the key to another phonological enigma, consonant duration having been treated in our two 2001 papers.

## Vowel duration, stød onset timing and cognitive reality

### 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. Bundgaard (1980) and Fischer-Jørgensen (1955). The literature is not unanimous, however, about stød vowel duration. Fischer-Jørgensen (1989a,b) gives stød vowels approximately 75% of the duration of long stødless vowels (measured in words in citation form), whereas Riber Petersen (1973) 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 Grønnum and Basbøll (2001b).

### 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-moricity. This is an empirical issue, and speakers/listeners may comport themselves differently in this respect.

## 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.

### Stimuli

We need to know whether, e.g., [ˈtiːˀlən] is more similar to [ˈti:lən] than to [ˈtilən] or if perhaps the resemblance to [ˈtilˀən], 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 1.

Table 1. Segmental structure of the stressed syllable rhymes of the four stimulus types.

type	I	II	III	IV
	V:ˀ	V:	VCˀ	VC

Since long stødless vowels (type II) occur only in disyllables, we are restricted to disyllables throughout. There are few semantically meaningful perfect quadruplets in the language, so nonse words were required. That being the case, we avoided real words altogether. This is not as undesirable as it may appear, since we can be reasonably certain that subjects are not side-tracked by lexical properties but, per force, react to naked sound structure. To diminish the repetitiveness of the listening task we had ten different instantiations of each type. Here they are in very broad transcription, represented by type IV:

[ˈtilən ˈbɛmɛð ˈstɛnɛð ˈmyləð ˈgələð ˈsələn  
ˈstulən ˈtɔməð ˈkɪrələn ˈtɛrɛmɛð]

The authors recorded a material which was made as semantically and pragmatically natural and coherent as possible, given the nature of the (nonse) 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.

## 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 (Grønnum et al.). However, preliminary statistics reveals two clear response patterns, from eight subjects each, cf. Table 2.

Table 2. Number of responses from two groups of eight subjects each and their percentage of the total 640 potential maximum in each cell

similarity:	I=II	III=IV	I=III	II=IV	I=IV	II=III
Gr. 1, N =	443	523	292	305	194	168
%	<b>69</b>	<b>82</b>	46	48	<b>30</b>	<b>26</b>
Gr. 2, N =	300	358	459	461	185	157
%	48	54	<b>72</b>	<b>71</b>	<b>29</b>	<b>25</b>

Percentages above 67% will be interpreted as similarity between types, and below 33% as non-similarity—both rendered in bold type in Table 2. 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.

## 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, cf. Grønnum and Basbøll (2001b). 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-moricity. 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 ( $V: = VC$ ) actually increases the likelihood of a cognitive bi-partition of vowels with stød, since VC sequences indubitably are bipartite: we need now to proceed and design that

test. If the results are positive, the mora analysis is greatly strengthened. If they are negative the mora cannot be a physical and cognitive reality in any direct sense. Subjects may not behave in a uniform fashion in this respect, cf. the results 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 Basbøll (1988, 1998) 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.

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