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Danish, Estonian, English: Variations on a theme

Markus A. Pöchtrager, University of Vienna, Sensengasse 3a, 1090 Vienna, AT, markus.poechtrager@univie.ac.at

Danish stød (a laryngealisation) is usually said to signal the second mora in odd-numbered syllables, counting from the right (Basbøll 1985; 1988; 2005). While descriptively adequate (with appropriate qualifications), such a statement leaves several questions unaddressed: Is that distribution an idiosyncratic quirk of Danish? What is special about the second mora? Why should ordinal numbering of syllables matter? This paper argues that the distributional pattern is neither restricted to Danish nor to stød. The same format of representation that can explain the distribution of length in Estonian and English lends itself to the analysis of the seemingly unrelated phenomenon of stød. Where the languages differ is in the exact nature of the relations contracted within those representations. This not only positions Danish within the larger context of phonological theory, but also explains why the distribution takes the form it does.

1 Introduction

Danish stød, exemplified in (1) and customarily marked by [ˀ], is a kind of laryngealisation on sonorants (for detailed phonetic studies cf. Fischer-Jørgensen 1987; 1989; Grønnum & Vazquez-Larruscaín & Basbøll 2013). (1a) gives examples where stød occurs on a long vowel (more precisely: on the second half of the vowel); in this case the nature of the following consonant (or whether there even is one) is immaterial. In (1b), on the other hand, stød occurs on a sonorant consonant following a short vowel. Stød will never occur on obstruents, as shown in (1c).

(1) a. *bi* [biːˀ] 'bee'
gå [gɒːˀ] 'to go'
mil [miːˀl] 'mile'
sen [seːˀn] 'late'
lys [lyːˀs] 'light'
næb [nɛːˀb] 'beak'

b. *mild* [milˀ] 'mild'
mand [manˀ] 'man'
pen [pɛnˀ] 'pen'
rum [ʁɔmˀ] 'room'
folk [fʌlˀg] 'people'
film [filˀm] 'film'

c. *gik* [gig] 'went'
digt [degd] 'poem'

In order to explain the distribution of stød, most accounts make crucial use of mora and syllable, cf. Basbøll (1985; 1988; 2003; 2005), and literature therein. According to Basbøll (1988: 133) the distribution of stød is governed by the principle in (2), to which it should be added that the syllable in question must be stressed.[1]

(2) Stød signals the second mora in odd-numbered syllables
(counting from the right).
σ_3 σ_2 σ_1
yes no yes

Several comments are in order here. Firstly, strict alternation is an idealisation as there are complicating morphological factors distorting that general picture; more on which in sections 2.5 and 5.1. Secondly, (2) captures where stød *can* occur, it does not mean that stød *must* occur. Alongside *pen* [pɛnˀ] 'pen' (1b) with stød we also find *ven* [vɛn] 'friend' without stød, even

[1] In contrast to Basbøll (1988), Basbøll (2005) focuses more on the *absence* of stød, taking its presence as the default. This is irrelevant to the distributional generalisation in (2).

though both words seem otherwise identical. What this implies for an analysis (in terms or moras or otherwise) will be explored in section 3.2, where we shall also see that there are certain subgeneralisations on where stød can or must occur. Thirdly, the wording "odd-numbered" suggests a grander scope than what we actually find: Stød never occurs before the main stress, which in turn cannot be found any further to the left than antepenultimate position (barring compounds). This also explains why the diagram in (2) does not continue beyond σ_3 to σ_4 etc. Fourthly, as for antepenultimate position, Basbøll (1988) argues that stød is the default here, as it also gets added on in the school-pronunciation of Latin words and in loans from Latin and Greek. As Fischer-Jørgensen (1989: 4) points out, however, this is not the case in native trisyllabic simplex words (of which there are very few).

Examples for all three positions are given in (3).[2]

(3)	*sen* [seːˀn] 'late'	(1st from right)
	sene [ˈseːnə]/*[seːˀnə] 'tendon'	(2nd from right)
	Latin *insula* [enˀsula] 'island', *kolera* [ˈkoːˀləʁɑ] 'cholera',	(3rd from right)
	but *helvede* [ˈhɛlvəð̞ə]/*[ˈhɛlˀvəð̞ə] 'hell'	

Reference to the mora, as in (2), seems inevitable in order to unify two contexts where stød can occur:

(4)	long vowels:	*sen* [seːˀn] 'late'	2μ
		bi [biːˀ] 'bee'	
	short vowel + sonorant:	*pen* [penˀ] 'pen'	$\mu + \mu = 2\mu$
		mild [milˀ] 'mild'	

A characterisation in terms of moras makes it possible to express the requirements for stød to arise at all, and also allows us to pinpoint the exact location of stød, which is usually said to coincide with the second mora (Fischer-Jørgensen 1987; 1989).

Both the location of the syllable (in reference to the right word edge) and its internal (moraic) make-up are crucial ingredients in an adequate description of the location of stød, but they have little to offer in the way of explanation. In particular, they leave unaddressed the questions in (5).

(5)
a. Is the particular combination of conditions on syllable number and moraic make-up in (2) a random, idiosyncratic quirk of Danish?
b. Why is stød associated with the second of two moras?
c. Why are odd-numbered syllables special?

In answer to those three question, I will present (and substantiate) the three claims in (6).

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[2] The word *helvede* 'hell' in (3) can be traced back to a compound diachronically, which is no longer transparent, though.

(6) a. The distributional pattern of Danish stød is neither specific to Danish nor to stød. (Though some language-specific quirks remain.)
b. The special status of the second “mora” can be derived.
c. The restriction to odd-numbered syllables can be derived, at least for the last two syllables. (The absolute majority of cases.)

Interestingly enough, all of this will be achieved without reference to the mora (hence in inverted commas in (6b) above). The mora is not sufficient for deriving any of the properties in (6), and it might not even be necessary.

The article is structured as follows. Section 2 remains rather descriptive and presents parallels between three languages: Danish, Estonian, and English. The latter two obviously do not have stød, but crucial aspects of their systems of *length* follow the same principles as stød. This addresses the claim in (6a). Section 3 presents a formal analysis of the representation of length in English and Estonian oxytones. This analysis will be couched within the framework of Government Phonology 2.0 (references to follow), an offspring of “classical” Government Phonology (Kaye & Lowenstamm & Vergnaud 1985; 1990; Kaye 1990; Charette 1991; Harris 1994). We will then look at the representation of stød in Danish, showing how the same structures used for English and Estonian can help us make sense of stød, while still accounting for the areas where there are differences between the three languages. This will address (6b). Section 4 takes up (6c) and shows how the same technical machinery necessary to explain the distribution of length can also be brought to bear on stød distribution in ultimate and penultimate syllables. (We will leave aside the antepenultimate position due to its somewhat unclear status mentioned above.) Section 5 looks at some further issues, such as the role of morphology, the (non-)role of the mora, and possibilities for dealing with the antepenultimate position. It also addresses two more theory-internal issues: One having to do with interdependencies between the positions in the tree-like structures that we will be using, the other with the question to what extent the obstruent/sonorant distinction is really relevant for Danish stød. Section 6 looks at some differences to the other Government Phonology account of Danish stød in existence, Larsen (1994), and concludes.

2 Parallels

We will begin with the first claim, that the distributional pattern seen in Danish stød is neither specific to Danish nor to stød. To avoid a potential misunderstanding, let me stress that I will not be concerned with the shared diachronic origin of both Danish stød and Swedish/Norwegian tones, a connection well-known in the literature (Jespersen 1913; Haugen 1976). Some accounts argue that there is still synchronic identity in distribution and representation (Larsen 1994; Morén 2005). In my view, the differences that do exist between Swedish/Norwegian and Danish make such a unification difficult—a sentiment also expressed in Grønnum & Vazquez-Larruscaín & Basbøll (2013)—, and that will not be the goal I pursue.

What I *do* claim is that the distribution of stød is strikingly parallel to that of Estonian and English overlength, more precisely the length trade-off (to be explained in the next subsection), that we find in those languages. The idea of a link between Estonian and Danish is not completely new: Jakobson (1962) assumed a sprachbund including Estonian, Danish/Norwegian/Swedish (and others), though the formal details of that remained unclear (see also Lehiste 1978). In the same fashion, Remmel (1975) talks about a possible (phonetic) equivalence between Danish stød and Estonian overlength, but again without any formal theoretical underpinnings.[3] In order to contextualise my claim, I will first discuss the length trade-off, which will then provide the necessary backdrop against which we can compare Danish.

2.1 Length trade-off: Estonian and English

Estonian is famous for its three degrees of length (short/Q1, long/Q2, overlong/Q3; with Q = quantity) in both vowels and consonants, and the literature is legion (Posti 1950; Lehiste 1960; 1965; Hint 1973; Tauli 1973; Ojamaa 1976; Prince 1980; Bye 1997; Hint 1998). In contrast, "English overlength" is not a term one is likely to come across in the literature, though the effect it refers to is well known by another name: (Lack of) "pre-fortis clipping" (literature anon). Pöchtrager (2006; 2015) argues in detail why both phenomena should be treated in the same fashion, even though mainstream accounts usually do not, and we will look at the main points here very quickly. Consider first the examples in **Table 1**.[4]

Estonian			**V**					**C**	**English**	
keeb	[ge::b]	'it boils'	Q3	○	○	○	●	Q1	*bead*	[bi::d]
keep	[ge:b:]	'cape'	Q2	○	○	●	●	Q2	*beat*	[bi:t]
kepp	[geb::]	'stick'	Q1	○	●	●	●	Q3	—	

Table 1: Length trade-off.

Table 1 gives three monosyllabic words in Estonian (examples from Ojamaa 1976: 9 and passim), which show a trade-off in length: The more room is taken up by the consonant (C), the less remains for the preceding vowel (V) and vice versa. Put differently, the difference between each pair of words lies not only in the length of the vowel, but also that of the

[3] Livonian stød as discussed in Kiparsky (2017) is phonetically similar to Danish stød, but there are several distributional characteristics that set the two apart from one another. A similar reservation holds for the short-vowel stød in certain Danish varieties (Ejskjær 1990; Iosad 2016). Neither will be addressed here.

[4] The transcription [b d g] in English and Estonian (and later also Danish) is broad and does not imply that those consonants are truly voiced, cf. Halle & Stevens (1971). The terms fortis/lenis used throughout this article cover a wealth of phonetic correlates, cf. Catford (1977: 199–208) for general discussion and Nellis & Hollenbach (1980) for exemplification.

consonant. This is of course problematic for a phonemic analysis, which was pointed out as early as Ojamaa (1976), since any two members of the triplet differ from one another in two aspects, making localisation of a phonemic contrast impossible. The fact that the lengths of vowels and consonants are less restricted in *bisyllabic* words (more precisely: paroxytones, to which we shall turn shortly) does not invalidate the mutual dependency between the vowel and the consonant in *monosyllabic* words.[5]

If looked at the right way, striking parallels can be seen in English, as the right-hand side of **Table 1** already suggests. From a phonological point of view, English *bead/beat* are usually taken as a minimal pair differing in the final consonant only. However, when looking at the phonetic realisation, two differences are discernible: Not only do these words differ in the final consonant, the vowel before the lenis consonant *d* is also much longer than that before the fortis *t*. (Put differently, the fortis consonant clips the length of the vowel, as this is usually presented.) In an account that insists on the final consonant being the only phonological difference in *bead/beat*, any difference in vowel length must be relegated to the status of "purely allophonic" and as devoid of phonological significance. But the rejection of the phoneme (and hence the distinction between phonemic and allophonic) was one of the earliest defining characteristics of Generative Phonology, cf. Halle (1959), Chomsky (1964). Government Phonology is a clearly generativist model where the phoneme/allophone dichotomy plays no role.[6] The alternative then, is to take the difference in vowel length seriously[7] and to ask why a difference in consonant *quality* has an effect on vowel *quantity*. In an account taking the fortis/lenis difference in consonants as qualitative (one series possessing a quality that the other lacks, no matter which way expressed) this is indeed puzzling. But this is only one possible interpretation of the facts, and there is an alternative, which requires that we change our traditional way of looking at things a second time. If fortis/lenis is interpreted as quantitative (as indeed it is, going by duration), with lenis the shorter counterpart of fortis, then differences in vowel length follow quite easily: We are faced with a trade-off entirely parallel

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[5] Presentations of Estonian overlength usually start with triplets of bisyllabic words which allegedly establish the phonemic contrast for consonants and vowels independently of each other. "Allegedly", because in order to qualify as minimal triplets (where the contrast can be localised in one position), certain details, such as length differences in the second (unstressed) syllable or differences in morphological structure, need to be ignored. In other words, while the members of the triplets do differ, they differ in more than one place, similar to what we see in monosyllabic words. Details later in this section, cf. also in particular Pöchtrager (2015).

[6] A reviewer takes issue with this stance since it combines and (allegedly) confuses phonetic and phonological representation. As will become clear imminently, rather than confuse things, such an approach allows to work out parallels that would otherwise be missed, viz. that the distribution of (over)length is completely parallel in two languages, even though it would count as phonemic in one and as allophonic in the other. Similar arguments (from various languages) that phonological regularities cut across the division between phonetic and phonemic levels can be found in Halle (1959) and Chomsky (1964).

[7] To my knowlegde, Chomsky (1964: 90ff), who discusses a "familiar rule of lengthening before voiced segments", was the first attempt to deal with it in the context of a *phonological* analysis. (Though I believe he was in error about the details of the rule.)

to the one in Estonian (Pöchtrager 2006; 2015). The more room is taken up by the consonant, the less remains for the preceding vowel.[8] A Q1 consonant will be preceded by a Q3 vowel, a Q2 consonant by a Q2 vowel; in both languages. In other words, a representational format that is needed independently in order to capture the length trade-off in Estonian (the left side of **Table 1**) will provide the means to handle the English facts, too.[9]

Now, what makes the issue somewhat more complex is that in English, and unlike Estonian, two different dimensions of length are distinguished, and those two dimensions need to be considered individually. The vowels in *bead/beat* are lexically long, in contrast to words pairs like *bid/bit*, where the vowels in both words are lexically short.[10] But in each pair, the vowel will be shorter before fortis *t*, independently of whether we are dealing with a vowel that is lexically long or short. The literature is quite substantial (Heffner 1937; Rositzke 1939; Denes 1955; Peterson & Lehiste 1960; Klatt 1976; Luce & Charles-Luce 1985; Crystal & House 1988). This dimension of length that is sensitive to the following material will be referred to as *phonological* length. (As the pair *bit/beat* shows, the lexical length of the vowel is not sensitive to its environment, as the consonantal environments are identical here.) The axis of lexical length intersects with the axis of phonological length, giving rise to the four-way distinction that we see in **Table 2**.[11]

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8 For length measurements of English stops cf. Lisker (1957; 1972). As Lisker (1986) and Clayards (2018) remind us, phonological categories usually have more than one phonetic correlate; "many acoustic dimensions 'make up' phonological categories" (Clayards 2018: 2). That means that as phonologists we have to decide which aspect(s) to take as phonologically relevant, and it seems to me that a quantitative interpretation of fortis/lenis is the one that makes most sense, given the quantitative adjustments in the preceding vowel. Any decision on what counts as phonologically relevant must be guided by what other aspects of grammar react to. Note also that vowel length takes on particular importance in monosyllabic words where final stops are often unreleased; for a recent demonstration (from Australian English) that the length of the vowel is the more reliable clue in perception cf. Penney & Cox & Szakay (2021).

9 Note that English, unlike Estonian, does not allow for Q3 consonants, i.e. geminates. ("Geminate" is a misnomer then, since three positions are involved, in contrast to what the etymological origin of the word suggests.)

10 In addition to terms like "lexically long/short", which relate to duration, we also find "tense/lax", referring to quality. Some authors prefer one dichotomy over the other, and sometimes both are used at the same time, such that the vowel in *beat* is tense *and* (lexically) long. I share the view that both quantity and quality are relevant, following the arguments in Pöchtrager (2020b), and I also agree that, given their troubled history, the terms "tense/lax" are not ideal to characterise the quality difference in question: Amongst other things, the alleged difference in muscular tension has been called into question time and again (Raphael & Bell-Berti 1975; Lass 1976; Bauer 1980; Durand 2005). Ladefoged & Johnson (2010: 98) acknowledge the phonetic differences between the two sets, but also reject muscular tension and treat tense/lax as "just labels" and as cover terms for a combination of qualitative and quantitative differences.

11 A reviewer queries whether transcriptions like [bɪːd] and [biːt] imply equal duration. The answer is no, since the durational effects of phonological length are more "dramatic" than those of lexical length, cf. main text for references. Given the absence of a clear and universal definition of [ː] (or [ˑ]) I have decided to use only [ː] (single or doubled), cf. also footnote 29. The difference between the two types of length is still recoverable from the choice of symbols for quality ([ɪ] vs. [i]). Such a context-dependent interpretation of [ː] is of course quite common; transcriptions like [aː] and [tː] also do not necessarily imply an equal increase in duration.

	phonologically long		final cons.	phonologically short		final cons.
lexically short	*bid*	[bɪːd]	lenis	*bit*	[bɪt]	fortis
lexically long	*bead*	[biːːd]	lenis	*beat*	[biːt]	fortis

Table 2: Two types of length in English.

The four-way distinction as such is nothing new, though it is usually interpreted differently, as we have already said. (Lexically short/long is usually interpreted as short/long and/or tense/lax; while phonologically short/long is typically ignored as allophonic.) The alternative interpretation adopted here brings out parallels between Estonian and English that would otherwise go unnoticed. As we shall see anon, the similarities go even deeper.

The discussion so far has focused on monosyllabic words, whose behaviour generalises to oxytones. What is relevant is not so much that the forms are monosyllabic but that stress is final: The trade-off in *bead/beat* could also have been illustrated by *recede/receipt*. In paroxytones the situation is slightly different, as a (line-by-line) comparison of the words in **Table 3** shows.

That is, a trade-off (and thus phonological length) is possible in oxytones (segment (a) of **Table 3**), but not in paroxytones (segment (b) of **Table 3**). Here, the literature is somewhat less extensive (Lisker 1957; Lehiste 1970; Umeda 1975; Luce & Charles-Luce & McLennan 1999). The effects that a lenis consonant has on the preceding stressed vowel are quite dramatic in oxytones and lead to length ratios of around 1 : 1.9, whereas for paroxytones the ratio is around roughly 1 : 1.1, and only unreliably so, with absolute differences often close or below the threshold of perception, cf. Lehiste (1976).

	(a) oxytones		(b) paroxytones	
(i)	*chip*	[t͡ʃɪp]	*chipper*	[ˈt͡ʃɪpə]
	teeth	[tiːθ]	*ether*	[ˈiːθə]
(ii)	*rub*	[rʌːb]	*rubber*	[ˈrʌbə]
	leave	[liːːv]	*lever*	[ˈliːvə]

Table 3: English length in oxytones and paroxytones.

The lack of phonological length in English paroxytones has a counterpart in Estonian, as can be seen in **Table 4**, whose organisation parallels **Table 3**.[12]

[12] Estonian orthography is somewhat unhelpful here, since the spelling conventions of plosives vs. the rest do not parallel each other: ⟨*pp*⟩ is consistently Q3, ⟨*mm*⟩ is Q3 or Q2, depending on (morphological) context. The same ambiguity between Q2/Q3 holds for double spellings of vowels. For extensive discussion of the phonological side with

	(a) oxytones		(b) paroxytones	
(i)	*buum* ‘boom’	[buːːm]	*teema* ‘theme’	[ˈdeːmaˑ]
(ii)	*tumm* ‘silent’	[dumːː]	*summa* ‘sum’	[ˈsumːaˑ]

Table 4: Estonian length in oxytones and paroxytones.

Segment (a) of **Table 4** presents combinations of a Q3 vowel and a Q1 consonant as well as of a Q1 vowel and a Q3 consonant in oxytones, with a trade-off just as expected based on what we saw in **Table 1**. In segment (b.i) of **Table 4** we see that the Q1 nasal *m* is not preceded by a Q3 vowel, but only by one that is Q2, and in segment (b.ii) a Q1 vowel is followed by a Q2 consonant, not by one in Q3. The lack of vowels/consonants in Q3 in paroxytones will be taken up again in sections 2.5 and 5.1. What is crucial for us is that there is such a gap with respect to Q3, just as there is in English.

Now that the table is set we can look in more detail at several parallels between the distribution of stød and that of length, while keeping in mind the crucial differences that do exist. The areas we will consider are briefly outlined in (7–8), with (7) focusing on the parallels and (8) on the differences.

(7) Parallels between the three languages
- a. Stress as a necessary ingredient
- b. Behaviour of vowel-final oxytones
- c. Behaviour of paroxytones (without analytic morphology)
- d. (Interaction with) morphology

(8) Crucial differences
- a. Behaviour of consonant-final oxytones
- b. Context sufficient for length trade-off; but only necessary for stød

This looks like a random collection of contexts and conditions. Their interconnectedness will become clear as the analysis proceeds, showing that there is nothing random about that list. Furthermore, it is possible to reinterpret the content of (8a), to be presented in section 2.6, in such a way that it can be seen as a parallel, rather than a point of difference between Danish and Estonian/English. That is, (8a) might well have to be grouped with (7). We will address this reinterpretation (and also the unclear aspects that remain) in section 5.5.

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consistent marking of quantity cf. Raun & Saareste (1965), Tauli (1973). For durational measurements cf. Lehiste (1960), Ojamaa (1976), Eek & Meister (1997). The half-length mark [ˑ] on the final vowel invites an alternative interpretation whereby Q3 is a composite phenomenon (Posti 1950), but has been a source of controversy, cf. also Pöchtrager (2015) for discussion.

2.2 Stress as a necessary ingredient

A certain amount of prosodic prominence is a necessary condition for both stød and length trade-off.[13] Thus, function words, which are usually unstressed, are not eligible for either one, cf. **Table 5**.

Danish	Estonian	English
fon [ˈfoːˀn] 'phone'	*siid* [ˈsiːːd] 'silk'	*train* [ˈtreːɪn]
vs.	vs.	vs.
fonem [foˈneːˀm] 'phoneme'	*[ˈsidiːː]	*trainee* [treɪˈniːː]

Table 5: Prosodic prominence as a relevant factor.

In Danish *fon* we find stød and stress, and in the morphologically related form *fonem*, where stress shifts to the end, stød becomes impossible on the first nucleus. The same can be said for phonological length in English, where overlength (of the diphthong in this case) requires stress. Estonian, with its main stress firmly fixed on the first syllable in the majority of cases, does not furnish a comparable example, but again, Q3 vowels or consonants are impossible in the absence of stress.

2.3 Behaviour of vowel-final oxytones

Oxytones ending in a vowel are overlong/take stød, as shown in **Table 6**.[14]

Danish	Estonian	English
bi [biːˀ] 'bee'	*tee* [deːː] 'road'	*bee* [biːː]

Table 6: Vowel-final oxytones.

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[13] "A certain amount" for Danish means at least secondary stress, as argued in Basbøll (1988). This means that forms like *sofaen* [ˈsoːˌfæːˀn̩] 'sofa DEF.' (Basbøll 2005: 318), to be discussed in section 5.1, must be treated as a sequence of a syllable with main stress immediately followed by one with secondary stress.

[14] The vocalisation of former (single) consonants (still recognisable in the orthography) has led to sequences (either long vowels or centering diphthongs) that sometimes violate this generalisation: *kar* [kɑː] 'tub, vessel', *smør* [smœɐ̯] 'butter', *hav* [hɑu̯] 'sea' etc. That is, such cases behave (and therefore must be analysed) as if they ended in a short vowel plus sonorant *consonant*, where we also sometimes find stød lacking (cf. also section 2.7). The traces left by former *r* in particular are also problematic in other contexts (establishing underlying vowel qualities) and are furthermore open to more than one interpretation: Basbøll (1985: 11–12) and Basbøll (1988: 149) assume that former *r* preceding a voiceless consonant is to be interpreted as an (historically devoiced) obstruent (!) in order to make sense of forms like *mark* [mɑːg] 'field' and *vært* [væɐ̯d] 'host' that should have stød because of their long vowel/diphthong. (The final stops are immaterial here, of course.)

For Danish, this is of course in accordance with (2) since we are dealing with an odd-numbered syllable. Words of this type must have a long vowel which is then automatically accompanied by stød. For Danish and English there is no trade-off to speak of (since there is no following consonant), and the vowel by itself is overlong. The lack of a final consonant as a confounding factor (cf. section 2.7) makes this case ideally suited for understanding the nature of stød, as section 3.1 will show.

2.4 Behaviour of paroxytones (without analytic morphology)

Paroxytones do not allow stød and do not show a length trade-off, provided that they are morphologically simplex, or that they involve non-analytic morphology (Kaye 1995) at most (**Table 7**).[15]

Danish	Estonian	English
vane [væːnə] 'habit' vs. *væn* [vɛːˀn] 'fair'	*sooni* [soːni] 'cut in! IMP.' vs. *toon* [doːːn] 'tone'	*lunar* [luːnə] vs. *loon* [luːːn]

Table 7: Paroxytones (without analytic morphology) VS. oxytones.

For Danish, this is of course the condition in (2) that only odd-numbered syllables qualify. Crucially, the same restriction applies in English and Estonian when it comes to where overlength is possible, as we saw in the discussion in section 2.1.

2.5 Interaction with morphological structure

Taking morphological structure into consideration is crucial for both stød and overlength. Consider the apparent minimal pairs in **Table 8**, where round brackets indicate the relevant grouping. "Apparent", in that the examples are not only distinguished by the presence/absence of stød/overlength, but also differ in their morphological structure.

Danish	Estonian	English
((*mus*)*en*) [muːˀsən] 'mouse DEF.'	((*moos*)*i*) [moːːsi] 'jam PAR. SG.'	*Take* ((*Grey*) *to*) *London* [ɡɹeːːɪtə]
((*muse*)*n*) [muːsən] 'muse DEF.'	(*moosi*) [moːsiˑ] 'jam GEN. SG.'	*Take* (*Greater*) *London* [ɡɹeɪtə]

Table 8: Interaction with morphological structure.

[15] Non-analytic morphology refers to morphology that forms one single domain with its base, i.e. where the resulting form is indistinguishable from a morphologically simplex form. We will look at that in more detail in sections 2.5 and 5.1.

For each language two paroxytones are compared. In the English example, taken from Abercrombie (1964), *to* is interpreted as a clitic attaching to the preceding word. One member of each pair shows stød/overlength, which is not what we expect given what have been saying about paroxytones and how they differ from oxytones. As the bracketing already suggests, morphological structure plays a crucial role, in that a pair like Danish [muːˀsən]/[muːsən] is really to be treated as oxytone plus suffix versus paroxytone plus suffix. What is crucial for us at this stage is that the deviation goes in the same direction in all three languages: We find stød/overlength in the same unexpected position (paroxytone) under the same circumstances (i.e. when the paroxytone is the result of morphological concatenation).

Not controlling for morphological structure in Estonian leads to claims such that a classic example like *lina* [lina] 'linen', *linna* [linːa] 'city GEN.SG.', *linna* [linːːa] 'city PAR.SG.' would be minimal triplets establishing an independent quantity contrast between Q1, Q2, and Q3 in paroxytones. That this is problematic has already been suggested in footnote 5. Firstly, the length of the unstressed vowel is not constant, and we could also write [linaˑ]/[linːaˑ]/[linːːa] (one, if not the first to point out the significance of this, was Posti 1950). This already makes the triplet non-minimal. Secondly, cases with a Q3 consonant in a paroxytone, like the last form [linːːa], are always morphologically complex, while paroxytones with Q2 may or may not be.[16]

So far we have looked at aspects where the three languages show similarities. Any analysis capitalising on those will have to make sure that the differences that do exist are also accounted for. We will look at two important differences in the next two sections.

2.6 Behaviour of consonant-final oxytones

As we saw in section 2.1, both in English and Estonian oxytones, the (phonological) length of the vowel depends (to some extent) on the nature of the final consonant or cluster. (Of course this is not the case for lexical length in English, as in *bit/beat*, at least not in words ending in a single consonant.) This relationship can be seen as a trade-off in length, on the condition that the fortis/lenis contrast is reinterpreted as quantitative, instead of qualitative. The phonological length of the vowel then correlates inversely with the quantity of the final consonant: Q1 (lenis) or Q2 (fortis) or, in the case of Estonian (cf. footnote 9), Q3 (geminate).

[16] The issue is even more complicated and the reader is referred to Pöchtrager (2006) for detailed discussion. Let me just point out two issues: There are words like *mööbel* 'furniture' with a Q3 vowel and *pappel* 'poplar' with a Q3 consonant, even though they are paroxytones and presumably not morphologically complex. However, they lose their unstressed vowel under suffixation, suggesting that they are not really bisyllabic at every level of representation. Secondly, proparoxytones like *muuseum* 'museum' with a stressed vowel in Q3 are interesting in that they parallel the Danish example of Latin *insula* with stød in example (3); we will return to this in section 5.3.

Here, Danish differs in two aspects: For one thing, the fortis/lenis distinction, to the extent that anything is left of it, does not seem to have an effect on stød. Before a stressed vowel, Danish shows a contrast in stops (*pil* [piːˀl] 'arrow'/*bil* [biːˀl] 'car') and (some) fricatives (*falk* [falˀg] 'falcon'/*valg* [valˀ(j)] 'choice').[17] Nearly all of that is gone post-vocalically, with many obstruents having lenited into approximants. And even in cases where a (very non-minimal) contrast can be constructed, such as *chef* [ɕɛːˀf] 'boss' (ending in a fortis consonant) vs. *sen* [seːˀn] 'late' (ending in a lenis consonant), the nature of the final consonant has no effect on the occurrence of stød; both words have it. This is also illustrated by several of the words in (1a). The important factor is of course the long vowel, which guarantees that the syllable is bimoraic.

This leads naturally to the second aspect where Danish differs from the other two languages: In case the vowel is short (monomoraic), the nature of the following consonant *does* become relevant. But here it is the distinction between sonorants and obstruents that plays a role. Only a sonorant can provide the second mora that stød requires; an obstruent never can, as already illustrated in (1) with several examples. The contrast between Danish and the other two languages is tabulated in **Table 9**.

<table>
<tr><th>Danish</th><th>Estonian</th><th>English</th></tr>
<tr><td>lam [lamˀ] 'lamb' vs.
lap [lab]/*[labˀ] 'rag'</td><td>siid [si::d] 'silk' vs.
*[si::d:]</td><td>bead [bi::d] vs.
beat [bi:t/*[bi::t]</td></tr>
<tr><td>Obstruent/sonorant
relevant (mora)</td><td colspan="2">Fortis/lenis (i.e. length)
relevant</td></tr>
</table>

Table 9: Type of final consonant.

Even though it seems blatantly obvious that the distinction between obstruents and sonorants is relevant for Danish stød, we will have to reappraise the issue in section 5.5.

2.7 Stød possible vs. necessary

Let us finally address one remaining issue that clearly sets apart Danish on the one hand from English and Estonian on the other. That is the question to what extent stød is fully predictable, as opposed to the trade-off in length. While the latter must happen (if the conditions are met), the former can: An English/Estonian oxytone ending in a single Q1/lenis consonant will be preceded

[17] Whether (all of) this is a fortis/lenis contrast has been controversial. Basbøll & Wagner (1985: 75) treat Danish [f]/[v] as voiceless/voiced *and* fortis/lenis, with the latter distinction all but gone in Basbøll (2005). Grønnum (1998) takes all stops as lenis and voiceless, the contrast being one of aspiration only. Aspiration is also the main distinction for stops in Basbøll & Wagner (1985) and Basbøll (2005), since both series are voiceless. For the general vagueness of the terms fortis/lenis cf. footnote 4.

by a vowel that is (phonologically) long. On the other hand, a Danish oxytone with a short vowel and a sonorant consonant can or cannot have stød, as shown in **Table 10**. Note that [ð̞] is an approximant and thus a sonorant.

stød			**no stød**		
pen	[pɛnˀ]	'pen'	*ven*	[vɛn]	'friend'
kind	[kinˀ]	'cheek'	*trin*	[trin]	'step'
bal	[balˀ]	'dance'	*tal*	[tal]	'number'
lam	[lamˀ]	'lamb'	*kom*	[kʌm]	'come! IMP.'
bid	[bið̞ˀ]	'bite, snack'	*sted*	[stɛð̞]	'place'
nav	[nɑʊ̯ˀ]	'hub'	*nav*	[nɑʊ̯]	'hub'

Table 10: Stød in oxytones possible, not necessary.

In final position, Danish has laid waste to many of its consonantal contrasts and many former obstruents have turned into approximants (thus sonorants). In addition, preceding vowels have often been shortened (when not short to begin with). Earlier *liv* [liːˀv] 'life', for example, has been all but replaced by modern [liʊ̯ˀ] (Brink & Lund 1975). These changes, along with the loss of *r* (footnote 14), have increased the number of examples that could be added to **Table 10**, on either side. In some cases there is even variation, as in the last example.

2.8 Interim summary

The parallels in previous sections 2.2–2.5 taken together suggest that the analysis of English/Estonian can shed light on Danish. Stød and overlength seem to share a common property at some level of abstraction that would explain the similarities in distribution, while at the same time making sure that the differences in sections 2.6–2.7 are adequately accounted for. Having addressed the first claim in (6a), viz. that the distributional pattern of Danish stød is neither specific to Danish nor to stød, we will now move on to the second claim in (6b), that the location of stød (the special status of the mora) can be derived.

This requires that we look at how stød is actually represented, which is the subject matter of the next section.

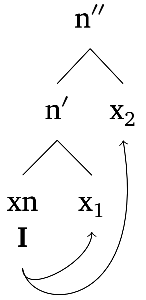
3 The formal representation of stød

The previous section demonstrated that there are a fair number of parallels between Danish on the one hand, and Estonian and English on the other, suggesting that this is not a mere accident. This section will present a discussion of the formal representation of stød in contrast to (over)length. The latter has already received an in-depth formal analysis: Pöchtrager (2006), starting from a more or less traditional Government Phonology (GP) background, tackled the representation of length and the length trade-offs in Estonian and English. The then current versions of the theory treated the fortis/lenis contrast in a language like English as a qualitative property expressed by the element **H**, which was assumed to be present in the fortis series, and absent in the lenis series.[18] As a result, it was impossible to adequately represent the trade-off formally, for reasons outlined in section 2.1: There is no connection between a melodic property (presence/absence of **H**) and a structural property like length. A reinterpretation of the fortis/lenis dimension as quantitative required a major change in the (sub)theory of constituent structure. At the same time, an analysis of Estonian also required a revision of constituent structure, since the theory could not deal with overlong vowels and consonants. (There were *some* ways to represent them, but none that would explain their behaviour and distribution.) Both strands of research together led to the creation of an offspring of GP, dubbed GP 2.0 (Pöchtrager 2006; 2015; 2020b; Kaye & Pöchtrager 2013). For reasons of space, our discussion here we will have to stick to the absolute minimum in presenting that theory, however. The reader is referred to the aforementioned literature for a more complete analysis of English and Estonian. That being said let us now look at Danish.

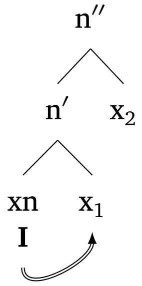
3.1 Stød as a relational concept

We will begin with the simplest cases, and come back to the fortis/lenis contrast later when discussing English in section 4.1. As we saw in section 2.3, vowel-final oxytones always show overlength and stød, with some qualifications as given in footnote 14. The representations in (9) contrast the relevant parts (i.e. the nuclei) of English *bee* (with an overlong vowel) and Danish *bi* [biːˀ] (with a long vowel and stød).

(9) a. (Relevant part of) English *bee* [iːː]



b. (Relevant part of) Danish *bi* [biːˀ]



In both examples the stressed vowel has the nuclear head xn at its core. This head xn is annotated with the element **I**, since we are dealing with a high front vowel. Heads combine with other

[18] Elements in GP are the building blocks of melody and correspond to phonological features of other theories. They are privative in nature and their number is usually small (single-digit number), though the exact number of elements employed differ by researcher. Useful overviews can be found in Harris (1994), Harris & Lindsey (1995), as well as Backley (2011).

material (the terminals x_1 and x_2 in this example, projections of other heads in later examples) to form x-bar like structures that express constituency. The head xn expands to its maximal size, n″, which for Estonian is true of all stressed nuclei and for English of vowel-final oxytones.[19]

The arrows in (9a) indicate *melodic command* (or m-command for short), which ensures that the m-command*ee* receives the same interpretation as the m-command*er*.[20] Since xn m-commands both x_1 *and* x_2 all three positions receive the same interpretation and we get an overlong, high front vowel. Exactly the same could be said about an Estonian word like *pii* 'tooth (of a comb)'.

Danish differs, and I submit that there are two differences. Firstly, there is no m-command from xn to x_2. I will assume that this is linked to the generally weak status of the word-final position in Danish, cf. section 2.6 and footnote 14: The position is still there, but it is not made use of. (That it is still there will become relevant in just a moment.) Secondly, there is also no m-command going from xn to x_1. Instead, what we find is a relationship called *control*. This relationship is what is responsible for stopness in consonants (Pöchtrager 2006; 2021c), and here it is extended to express laryngealisation in vowels, an equivalence established in Backley (2011: 122–124) (for the old stop element **ʔ**, though). The positions xn and x_1, together with the relationship of control holding between the two, gives us a long (but not overlong) vowel with stød. As we shall see in section 4.2, long vowels *without* stød also comprise two positions. The particular representation chosen for a long vowel with stød in (9b) captures that fact that long vowels with and without stød are of the same duration (Basbøll 1988: 121); each kind involves two skeletal positions. At the same time, the relational nature of control allows us to make sense of why stød occurs in the second half of the vowel: x_1 (which represents this second half) is on the receiving end of an asymmetric relationship with the nuclear head xn to its left; stød is the audible realisation of x_1 being controlled. The special status of Basbøll's "second mora" falls out. We will return to the notion "mora" once again in section 5.2.

Let us look at control in a bit more detail. Control is very local in that it can only hold between a head and its sister; this is obviously met in (9b). In contrast, m-command is not limited to sisters of heads, as can be seen in (9a) and in several examples later on. In addition, there is a weird property of control in that it is *only* possible if the specifier position is available. "Available" here means (i) that it is present (rather self-explanatory) and (ii) that it forms part of the same syllable. The relevance of the first condition will become clearer in the next section, 3.2, where we will look at what happens when there is no specifier. The second condition will be of key importance in section 4.2, since it not only captures the

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[19] There is a way to generalise this to *all* stressed nuclei, in both Estonian *and* English, cf. footnote 29.

[20] M-command has nothing to do with its syntactic namesake (where the *m* refers to the maximal projection). It is not a relationship defined on the geometry of the tree. M-command is also (slightly) different from spreading in autosegmental accounts: m-command is a relationship between positions. Unlike spreading, it does not depend on there being melody in the m-commander. A position without melody can m-command, but there can be no spreading if there is nothing to spread. A detailed discussion and justification is found in Pöchtrager (2006: 67ff, 80–84).

conditions under which stød can occur in oxytones, but also predicts that stød is not found in paroxytones. This condition, that the establishment of a relationship between a head and its sister should depend on yet a third position, the specifier, seems surprising, but it is also true of consonants; cf. Pöchtrager (2006: 2.3.2.) and (in particular) Pöchtrager (2021c), as well as section 5.4, where we will return to that issue for stops and affricates and see that once again control between head and complement depends on the availability of a specifier. At this point, this connection between head, complement, and specifier is a poorly understood axiom of the theory, but one that will get us a long way, also in Danish: Many further aspects of stød can be derived from it. We will turn to consonant-final oxytones next to illustrate this. To make things more manageable we will divide up that group into cases with (at least a potential for) stød and those without.

3.2 Stød: extension to consonant-final oxytones

The basic x-bar structure in (9b) affords us three positions to utilise: head, complement, and specifier. In the last section we looked at vowel-final oxytones like Danish *bi* [biːˀ] and saw how the specifier remained empty (despite being present), with stød ensuing as a result of a control relationship between head and complement. This leads us to expect that any time the specifier is present we should find stød.

Now, in consonant-final oxytones (such as *skib* 'ship' [sgiːˀb] or *film* 'film' [filˀm]), consonants will also have to fit into this basic scaffolding. The (nuclear) head will always represent a short vowel or the first half of a long one, which still leaves us with two other positions, the complement and the specifier. If the vowel is long (i.e. takes up the head and the complement), then any final consonant can only sit in the specifier. If the vowel is short and there are two consonants following, then one will sit in the complement and the other in the specifier. This is the maximum for (most) Danish oxytones that are morphologically simplex, which is of course similar to what we find in other Germanic languages.[21]

In this way, our basic x-bar structure provides an upper cap for the complexity of phonological structures. (This limit is expressed in terms of a familiar notion in linguistic theory, rather than an arbitrary numerical maximum on mora counts.) At the same time, we make predictions about

[21] Take English *peak* (long vowel plus single consonant) or *pink* (short vowel plus two consonants). All three languages allow structures exceeding that limit, on the condition that at least one coronal (often *s*) is involved, with various additional restrictions giving rise to complex subpatterns (Pöchtrager 2010; 2013; 2021c). This leads to structures with a long vowel/diphthong plus a cluster of two consonants, or alternatively a short vowel plus three consonants, and in some extreme cases (German) to even longer sequences: English *fiend*, *saint, text*, German *Mond* 'moon' (long vowel), *Herbst* 'autumn' (short vowel), Danish *falsk* 'false', *mulkt* 'fine', *takst* 'rate' etc. Morphologically complex forms can also give rise to unusually long sequences (English *six-th-s*, Danish *skarp-t-s* 'of a sharp one N. GEN. SG.', German *Herbst-s* 'of the autumn GEN. SG.'; and some of the forms that now seem simplex of course go back to morphologically complex forms, too.) For a general discussion of these forms cf. Fudge (1969), Halle & Vergnaud (1980), Selkirk (1982); for an analysis within GP 2.0 cf. Pöchtrager (2010; 2013; 2021c).

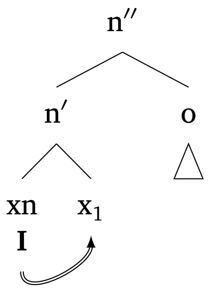
the occurrence of stød, since (at least in Danish) the presence of a specifier guarantees control between a head and the complement. With this in mind, consider (10), which shows all the logical possibilities for consonant-final oxytones with (at least the potential for) stød: If the vowel is long (coded as V + V), only one consonant is possible (in the specifier). If the vowel is short and there is a (sonorant) consonant in the complement, then the specifier can be filled or not.

(10)	a.	V + V + any C	always stød	*bil* 'car'[biːˀl], *skib* 'ship' [sgiːˀb]
	b.	+ son. C	stød or none	*pen* 'pen' [pɛnˀ] ≠ *ven* 'friend' [vɛn]
	c.	+ son. C + any C	always stød	*folk* 'people' [fʌlˀg], *film* 'film' [filˀm]

What stands out is that stød is guaranteed when both complement and specifier are used up as in (10a, c). This is exactly what we predict.[22] In (10b), where there is only a single sonorant following a short vowel, there are lexical differences. It might not be obvious yet, but (10b) can be made to follow from our account as well. Let us walk through a representative example for each type.

In the type represented by (10a) we have a long vowel (head and complement positions) and a single consonant, which must sit in the specifier. We correctly predict stød, as shown in (11), giving the relevant part of the word *skib* 'ship' [sgiːˀb]. The 'o' stands for the final stop, whose internal structure is irrelevant at the moment.[23] Note that it is also irrelevant whether the final consonant is an obstruent, as in *skib* 'ship' [sgiːˀb], or a sonorant, as in *bil* 'car' [biːˀl]. What matters is that it can only sit in the specifier position given that the preceding vowel takes up two positions.

(11) *skib* 'ship' [sgiːˀb]

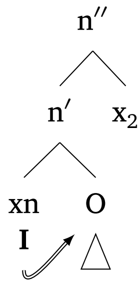


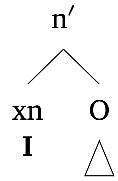
Next let us take type (10b), where we see lexical variation. I propose that (the relevant part of) a word like *pen* 'pen' [pɛnˀ] (with stød) has the representation in (12a), while (12b) gives *ven* 'friend' [vɛn] (without stød).

[22] Certain loans, such as *cool* 'cool' [kuːl] or *pink* 'pink' [peŋk] violate this generalisation, as does the (dialect) word *træls* 'annoying' [tʁals]. They remain unaccounted for for the time being. The reader is also reminded of footnote 14 on the problems with vocalised (historical) *r*.

[23] More precisely, the (lower case) 'o' stands for a projection of the head xo, responsible (roughly) for obstruents, as opposed to (upper case) 'O', a projection of xO, a head involved in (amongst other things) sonorants. The details are not important at this point, but we will come back to this in section 4.1.

(12) a. *pen* ‘pen’ [pɛnˀ] (with stød) b. *ven* ‘friend’ [vɛn] (without stød)



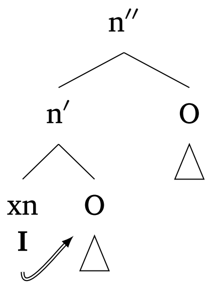


Both words end in a sonorant, abbreviated as ‘O’ (cf. footnote 23), which sits in the complement position both times. The two words differ in whether there is a specifier or not. If there is a specifier we get stød, since the nuclear head xn will control its complement,[24] otherwise we will not.

That there should be lexical differences exactly in this type is expected under our account, where we have three positions at our disposal (head, complement, specifier), but only two objects (short vowel and sonorant) to house. It is *precisely* the cases where the specifier is not needed for a consonant that there is this freedom for the specifier to be present or absent.[25]

Finally, let us address (10a), with a short vowel followed by two consonants, the first of which a sonorant, such as *folk* ‘people’ [fʌlˀg] or *film* ‘film’ [filˀm]. Again, we (correctly) predict that there will be stød since both the complement and (crucially) the specifier are taken up by the consonants. (13) illustrates this with the relevant part of *film* ‘film’ [filˀm].

(13) *film* ‘film’ [filˀm], with stød



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[24] This modifies the original version of control in Pöchtrager (2016), which only allowed for control if the complement was a simple terminal point x, as we saw in the representation of *bi* ‘bee’ [biːˀ] in (9).

[25] Words that behave like *pen* ‘pen’ [pɛnˀ] in (12a), such as *mand* ‘man’ [manˀ] or *skyld* ‘guilt’ [skylˀ], are often assumed to end in a latent consonant, e.g. in Hjelmslev (1973) or Larsen (1994: Chapter 5). This latent consonant resurfaces under (certain kinds of) suffixation, e.g. *mand-ig* ‘manly’ [man**d**i], *skyld-ig* ‘guilty’ [skyl**d**i]. The specifier in (12a) could be seen as the position for that latent consonant. I will remain agnostic on that issue, however, since I see at least two problems with latent consonants in general: Firstly, the kind of suffixations where the latent consonants resurface go together with other, clearly non-phonological changes (e.g. ablaut in *gæld* ‘debt’ [gɛlˀ] vs. *gyld-ig* ‘valid’ [**gy**ldi] or umlaut in *salg* ‘sale’ [s**a**lˀ] vs. *sælg-e* ‘to sell’ [sɛljə]). It is therefore not clear that the presence or absence of those latent consonants can be taken as purely phonologically conditioned. Secondly, some words (like *pen* ‘pen’ [pɛnˀ]) have no latent consonant to speak of, and yet they take stød. The specifier allows us to capture this without invoking anything latent.

The only difference between *film* 'film' [filˀm] in (13) and *pen* 'pen' [pɛnˀ] in (12a) is that in the former there are two consonants, the second of which has to sit in the specifier. Stød ensues automatically.

Let us contrast our results so far to the analysis given in Basbøll (1988). I will focus on the difference between (10b) vs. (10a, c), i.e. why we find a contrast like *pen* 'pen' [pɛnˀ] as opposed to *ven* 'friend' [vɛn], while words like *skib* 'ship' [sgiːˀb] or *folk* 'people' [fʌlˀg] are guaranteed stød. In Basbøll (1988) this result is achieved as follows: (i) Long vowels as in *skib* 'ship' [sgiːˀb] are always bimoraic, which automatically qualifies the syllable for stød, accounting for why long vowels have stød (10a). (ii) Sonorants between a short vowel and another consonant (e.g. in *folk* 'people' [fʌlˀg]) are assumed to be lengthened by rule and thus become moraic. Together with the mora from the preceding short vowel the entire syllable becomes bimoraic. We derive why the sonorant consonant will have stød in those cases, i.e. (10c). (iii) Sonorants that are preceded by a short vowel but are not in turn followed by a consonant are lexically marked as long or short, which in turn determines whether they are moraic or not, giving us the two subtypes in (10b).

While this derives the correct result, there are certain problematic assumptions. For one thing, the length difference assumed in (iii) is far from obvious, and attempts to measure it have failed or yielded inconclusive results at best (Grønnum & Basbøll 2001).[26] No difference in (underlying) length needs to be assumed in the present account, and the lexical variability seen in (10b) follows from considerations about the general structure of a nuclear projection, i.e. that it conforms to the x-bar format. In a slightly updated approach, Basbøll (2003) suggests that words like *ven* 'friend' [vɛn] involve extrametricality: The final sonorant (or rather: its mora) is simply ignored for moraic considerations, and since the vowels in all words are short, the two-mora minimum is never reached and stød excluded. While invoking extrametricality certainly does the trick, it remains unclear why it should play a role in exactly this case. It does not link to other differences between the two groups.[27] Again, the alternative presented here derives the existence of lexical variation from general considerations of structure.

Lastly, Basbøll's rule in (ii), similar to one expressed in Hjelmslev (1973: 23), is completely arbitrary and does not follow from any higher principle. In contrast, what the rule in (ii) achieves follows again from considerations of space in our approach: Stød is guaranteed because the specifier is the only position to host the final consonant.

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[26] In light of this, the first author of that text "strongly doubts that morae have any cognitive reality at all for Danish speakers and listeners" (Grønnum & Basbøll 2001: 49).

[27] Within GP, extrametricality is usually eyed suspiciously. Despite claims that it is "among the most well-motivated principles in phonological theory" (Hyde 2011: 1029), one has to ask whether a declaration of extrametricality is really a solution, rather than simply a statement of the problem, cf. also Kaye (1990: Section 1) and Burzio (1994: passim).

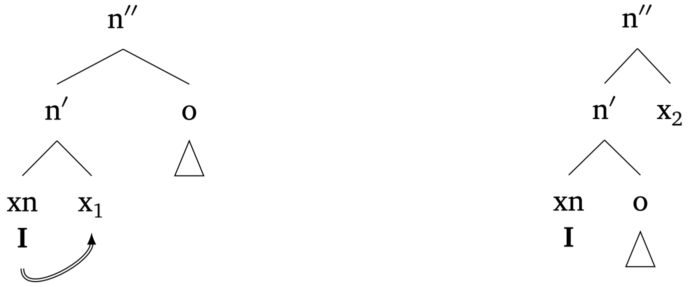
3.3 Consonant-final oxytones without stød

Let us now move on to cases where the complement position is neither the second half of a long vowel, nor is it occupied by a sonorant. In contrast to the oxytones in (10), all of which had stød, none of the ones in (14) do.

(14)	a.	V + obst. C	never stød	*gik* ‘went’ [gig]
	b.	+ obst. C + any C	never stød	*gigt* ‘gout’ [gigd]

(Note that ‘any C’ in (14b) really means another obstruent.) The two representations in (15) contrast *skib* ‘ship’ [sgiːˀb], repeated from (11), to *gik* ‘went’ [gig] (14a).

(15) a. *skib* ‘ship’ [sgiːˀb] repeated from (11) b. *gik* ‘went’ [gig]



Since (15a) has a long vowel, the consonant must sit in the specifier and stød follows as discussed before. In (15b) we have a short vowel followed by an obstruent, and this is crucial since obstruents cannot be controlled by the nuclear head xn, even though there is a specifier. That is, for control to happen, not only do we need a specifier but we also need a potential controllee of the right kind. Obstruents do not qualify, which at this point is a stipulation (the equivalent of “obstruents are not moraic in Danish” in other accounts).

One might be tempted to suggest that structures like that in (15b) be modified and have the specifier removed. If there was no specifier, control would automatically be barred, irrespective of the nature of the consonant. Such a move would still require reference to obstruents, though, since we would then have to assume that obstruents in complement position make empty specifiers impossible or at least optional, i.e. (15b) could be modified and the empty specifier removed or the structure could remain as is, with the specifier. Such indeterminacy did not exist for sonorants. That a limitation to *empty* specifiers would be required becomes clear when looking at words like *gigt* ‘gout’ [gigd] in (14b), ending in two obstruents. The second obstruent must sit in the specifier as there is no other place it could be in. In other words, not only will an obstruent in complement position coexist quite happily with a (filled) specifier, but there will also still be no control (and no stød). It is true that for (15b) the specifier could be left out without changing anything, but that does not mean that specifiers are generally impossible in this context. It thus seems that the lack of control can only be blamed on the obstruent nature of the consonant in complement position. However, as we shall see in section 5.5 the theory does provide the means to derive this property from a more general principle, allowing us to abstract away from sonorants and obstruents.

To complete the dicussion, the trees in (16) contrast two words ending in a cluster: *gigt* ‘gout’ [gigd], where both members of the cluster are obstruents, and *pulp* ‘pulp’ [pʰulˀb], where only the second one is. (As before, ‘O’ refers to a sonorant, ‘o’ to an obstruent.)

(16) a. *gigt* ‘gout’ [gigd], no stød b. *pulp* ‘pulp’ [pʰulˀb], with stød

In both examples, all positions are used up. If the first consonant is an obstruent, stød is precluded; no matter what the following consonant (if any). If the first consonant is a sonorant, and since there is another consonant following (in the specifier), we will have stød.

This concludes discussion of the second claim, that the location of stød on the second “mora” can be derived: The position representing the second half of a long vowel or the first member of a sonorant-initial cluster is on the receiving end of an asymmetric relation. Note that all of this has been achieved without reference to the mora. We will return to this in section 5.2.

We will now address the last claim, viz. that the restriction to odd-numbered syllables can be derived. This requires contrasting oxytones to paroxytones which, recall, represent the majority of cases. (Proparoxytones will be briefly looked at in section 5.3.) For this we will have to return to English and Estonian first, in order to present the machinery necessary.

4 Oxytones vs. paroxytones

4.1 Accessibility of unused positions

In section 2.1 we saw that the length trade-off we find in oxytones becomes impossible in paroxytones, in both English and Estonian. (Apparent counterexamples in both languages usually involve morphology, as we saw in section 2.5.) Incidentally, this is the same context where stød fails to occur, as seen in **Table 11**.

	σ_2	σ_1 #			
Stød	×	✓	*sen* [seːˀn] 'late'	≠	*sene* [seːnə] 'tendon'
Trade-off Engl.	×	✓	*leave* [liːːv]	≠	*beaver* [biːvə]
Trade-off Est.	×	✓	*liiv* [liːːv] 'sand'	≠	*liiva* [ˈliːvaˑ] 'id. GEN.SG.'

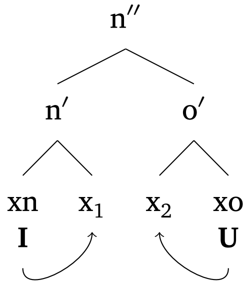
Table 11: Oxytones vs. paroxytones.

This parallel suggests that understanding one will also help us understand the other. In section 3 we saw that earlier versions of GP provided no insights into the length trade-offs in English, since they took the fortis/lenis contrast in English as a qualitative property, viz. the element **H** (present in the fortis series, absent in the lenis series). There was simply no non-arbitrary link between the absence of **H** as in the *v* of *leave* and the longer vowel, as opposed to a shorter vowel preceding the fortis *f* (containing **H**) of *leaf*. Structure (length) interacted with a melodic property (presence/absence of **H**) in a way that was not understood. The problem with Estonian was different in that the trade-off was more obvious, but the theory of constituent structure at the time provided no obvious way to express it (Pöchtrager 2006: Chapters 1,4).

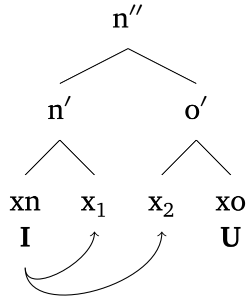
In GP 2.0 (Pöchtrager 2006; 2015; 2020b; Kaye & Pöchtrager 2013) the fortis/lenis contrast is expressed structurally: Lenis consonants have the same number of positions as their fortis counterparts, but differ in that lenis consonants have one position that is unused. This position can then be taken up by a preceding vowel (under the right conditions). In fortis consonants, on the other hand, all positions are used up. As a result, vowels before lenis consonants will be longer (since there is a position inside the following lenis consonant that they can claim) than before fortis consonants, and we derive the trade-off in vowel length.

A simple example will illustrate this. The structures in (17) represent [iːf] as in *leaf* and [iːːv] as in *leave*. The vowel in *leaf* is lexically long (Q2); that in *leave* is lexically and phonologically long (Q3). For our purposes we will focus on the vowel and the following consonant, ignoring the remainder of the representation. In both examples the stressed vowel has the nuclear head xn at its core which projects up to n″. The final consonant is embedded as a daughter of this n″, and the fact that nuclear head and following consonant are dominated by the same node allows vowel and consonant to interact, due to their structural closeness; we will get back to the importance of locality later in this section. The final labial in both words is a projection of the onset head xo. This is of course entirely parallel to the examples we have seen for Danish so far, with the only exception that for the first time we are looking at the internal structure of a consonant (which for Danish was not necessary).

(17) a. [i:f] (*leaf*)



b. [i::v] (*leave*)



(17a–b) share the same structure, but differ in crucial details in the distribution of individual positions. In both words the nuclear head xn claims its complement x_1 by m-command. This expresses lexical length. The head xn is annotated with the element **I** and both xn and its sister receive the same interpretation; that of a long, high front vowel.

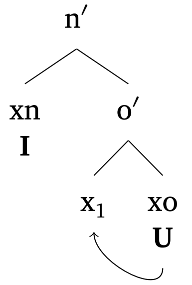
The two representations differ in their final consonants (fortis [f] vs. lenis [v]). More precisely, they differ in the distribution of positions that make up the final consonant (o′ in both cases). Here again m-command plays a crucial role. In (17a) the final consonant is fortis, since x_2 is m-commanded by xo. In contrast, (17b) has a final lenis consonant. Lenis consonants involve a non-head position (x_2 in this case) that is *not* m-commanded by their head. This position is available and can therefore be claimed by the preceding xn, which m-commands it. This allows for a non-arbitrary expression of the trade-off in length. The difference between Q2 and Q3 can be directly read off in these examples, as it corresponds to the number of positions involved in an m-command relationship.[28]

The structures in (17) illustrate two out of three logical possibilities: In (17b) xo claims no other position and xn claims two, in (17a) xo claims one other position and so does xn. The third possibility would have xo claim two positions and xn none. This is a structure that English does not have (cf. section 2.1 and in particular footnote 9), while Estonian does allow it: A short (Q1) vowel followed by an overlong (Q3) consonant. The total amount of room that is to be distributed between xn and xo stays the same; what differs is who gets how much ($0+2$, $1+1$, $2+0$). This is a natural representation of the trade-off in length.

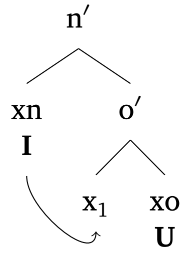
For the sake of completeness, let us look at lexically short vowels, as in pairs like *riff/give*. This case is quite comparable to the previous one; the trade-off between vowel and final consonant takes place in exactly the same way as before. The only difference is that since a lexically short vowel is shorter than a lexically long vowel, there are fewer positions for xn to manipulate. In Pöchtrager (2006) this is represented as in (18).

[28] This easy translation gets slightly more complex in the case of non-high vowels, since openness is also expressed as structural in this model. We will not go into that here; the reader is referred to Pöchtrager (2010; 2013; 2016; 2018; 2021a; c) for details.

(18) a. [ɪf] (*riff*)



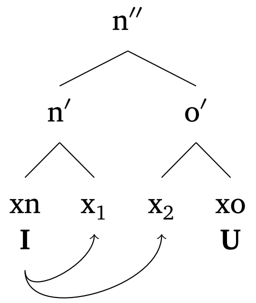
b. [ɪːv] (*give*)



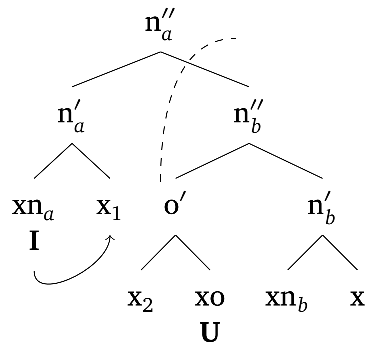
The trade-off is again a result of who m-commands x_1. There is only one non-head position, so there are two logical possibilities, both of which occur in English: In (18a) x_1 is m-commanded by xo, in (18b) by xn. The first possibility gives us a Q1 vowel followed by a Q2 consonant (i.e. fortis), the second a Q2 vowel followed by a Q1 consonant (lenis). Unlike English, Estonian has no structures like the ones in (18). This can be interpreted as a requirement on the minimal size of words which (18) does not meet for Estonian.[29]

Paroxytones behave somewhat differently, in that the effect of a lenis/fortis consonant following the stressed vowel has no (or only a negligible) effect on the length of that vowel, cf. the discussion in section 2.1. This can be derived from the theory, which assumes that the unstressed syllable of the foot is embedded *inside* the stressed nucleus. (19) juxtaposes the structure of *leave* (with a Q3 vowel), repeated from (17b), and that of *beaver* (where the stressed vowel is only Q2, i.e. lexically but not phonologically long).

(19) a. [iːːv] (*leave*)



b. [iːv] (*beaver*)



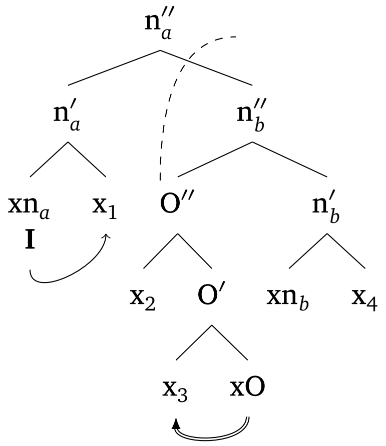
[29] Estonian also does not have lax vowels. The tense/lax distinction in English (and the lack thereof in Estonian) is not addressed here for reasons of space. Note that Q2 for English really means one of two things, cf. also footnote 11: (i) A vowel that is lexically short (which in English is lax), but phonologically long because of its righthand context, as in *give*. (ii) A vowel that is lexically long (thus tense) and phonologically short, as in *leaf*. A somewhat updated proposal that expresses those distinctions more clearly is made in Pöchtrager (2020b; 2021a). There it is assumed that the structures in (18) are too short for both Estonian *and* English. Under that reanalyis, *leave/leaf/give/riff* all have a uniform shape, that of a fully expanded x-bar structure with complement and specifier, as in (17). Lax vowels are characterised by x_1 being suppressed (technically: kept silent under the Empty Category Principle), which makes that position inaccessible and emulates the two possibilities that (18) provides. This also falls in line with the analysis of vowel-final oxytones in section 3.1.

Subscripts serve to distinguish the two nuclear heads (xn_a, xn_b) in (19b).[30] In addition, a dashed line separates the projections of the two nuclear heads from each other and also draws attention to the fact that the second is embedded in the first. Such embedding of weak syllables is not only assumed in GP 2.0, but also in other models (van der Hulst 2010; Golston 2016). This is not only a way to build metrical prominence into the representation, but also captures distributional asymmetries between stressed and unstressed position (cf. Pöchtrager 2020a: Section 7). Most importantly for us, it allows us to explain the lack of Q3 despite the presence of a following lenis consonant. In (19) the lenis consonant is grouped together with the preceding nucleus (they belong to the same "syllable"), making the unused position within the consonant available to the nuclear head xn, i.e. it can be m-commanded by it. In (19b), on the other hand, (unstressed) xn_b is closer to the preceding onset than (stressed) xn_a, where closeness can be calculated by reference to the lowest dominating node: n_b'' dominates both *v* and the following unstressed vowel, whereas we would need to travel even higher up to n_a'' for a node that covers both the stressed vowel and the following lenis *v*. As a result, intervocalic *v* is too far removed for the stressed vowel, making the empty position contained in the consonant inaccessible to xn_a. The lack of Q3 is derived.[31]

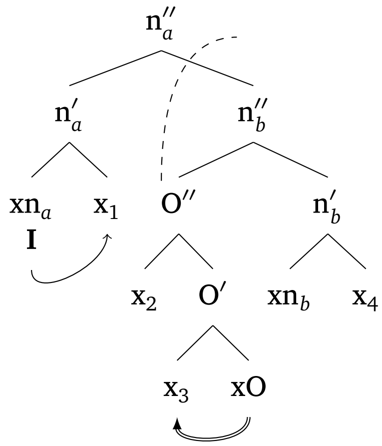
4.2 The application to Danish

We now have all the ingredients to return to Danish. In the previous section the lack of Q3 in paroxytones was derived from the unstressed syllable being embedded in the stressed one. The same kind of analysis applies to the unstressed syllable in Danish. (20) juxtaposes English *dealer* [diːlə] to Danish *mile* [miːlə] *mile*.[32]

(20) a. [iːl] (English *dealer*)



b. [iːl] (Danish *mile* 'mile')



[30] Technically, the second nuclear head is of a different type: xN, not xn. The reasons for that differentiation between two types of heads are discussed in Pöchtrager (2020b; 2021a); we will ignore it here as it does not affect our analysis.

[31] This raises the question what happens to the unused position contained in *v*. In Pöchtrager (2006) it is assumed that that position is kept silent under the Empty Category Principle by the following nucleus. This is not the most elegant solution, but it is immaterial to our concerns.

[32] The Danish consonant inventory in non-(foot-)initial position is much more limited than that of English, but the intervocalic lateral allows for an easy comparison between the two languages, even if the example words seem somewhat artificial.

The lateral contains a control relationship (between xO and x_3) since it is a non-continuant. In addition there is an unused specifier x_2 since the consonant is lenis. The two structures are the same in all relevant aspects, and the results (lack of phonological length, lack of stød) are similar, but for slightly different reasons: In English, the unused position contained in *l* is not available to the preceding nuclear head since we are dealing with a paroxytone, as discussed in the previous section. (The position is available in oxytones as in *deal*, of course.) In that respect *dealer* (20a) behaves exactly like *beaver* (19b). As for Danish, the entire specifier of xn_a (i.e. the sister to n_a') is inaccessible to xn_a since that is the domain of the following syllable. As a result, there can be no control between xn_a and x_1 (and thus no stød), but there can be a relationship of m-command: This gives us the long vowel without stød that we see in (20b).

Capitalising on the inaccessibility of the specifier means that we achieve a very streamlined account. Paroxytones like *mile* [miːlə] 'mile' lack stød for the same reason that words like *ven* lack it: There is no accessible specifier. Whether it is present but inaccessible (as in paroxytones) or simply not present at all (and then trivially not accessible) amounts to the same thing. This also means that the behaviour of paroxytones is no longer stipulated as it was in (2), but rather follows from an account originally designed to explain the distribution of length in two other languages.

5 Further issues

5.1 Morphology

As shown in section 2.4, paroxytones that seem to violate the distribution of overlength always involve morphology. A similar case can be made for Danish stød.[33] **Table 12** repeats the crucial examples from **Table 8**.

Danish	Estonian	English
((*mus*)*en*) [muːˀsən] 'mouse DEF.'	((*moos*)*i*) [moːːsi] 'jam PAR. SG.'	*Take* ((*Grey*) *to*) *London* [gɹeːɪtə]
((*muse*)*n*) [muːsən] 'muse DEF.'	(*moosi*) [moːsiˑ] 'jam GEN. SG.'	*Take* (*Greater*) *London* [gɹeɪtə]

Table 12: Interaction with morphological structure (repeated).

Danish [muːˀsən]/[muːsən] are classic examples. That we should find stød in an even-numbered syllable (counting from the right) is troubling, but removal of the suffixed definite article not only solves that problem but also immediately reveals why only one word has stød: The stem [muːˀs] 'mouse' by itself is an oxytone (its only syllable is in an odd-numbered position),

[33] Basbøll (2003: 25) presents around four potential counter-examples to the claim that stød is barred from bisyllabic monomorphemic words. I have no answer for those cases at the moment.

while [muːsə] 'muse' is a paroxytone and thus ineligible for stød. The suffix masks the relevant difference.[34]

A structurally similar argument can be made for Estonian. **Table 12** gives two inflected forms of the word for 'jam'; a monosyllabic base. The theme vowel *i* is attached within the same domain in the genitive case, but in a separate domain in the partitive, as indicated by the bracketing. Technically, we are dealing with analytic morphology in the partitive and non-analytic morphology in the genitive, following the terminology of Kaye (1995). Accordingly, the base forms a domain of its own in the partitive and behaves like an oxytone for the determination of overlength, while the genitive is a paroxyone and thus overlength is ruled out.

The same difference can be shown with words that are not related (inflectionally or otherwise). Paroxytone loans do not show Q3 consonants or vowels, cf. (21a–b) and footnote 16. Lack of Q3 cannot be blamed on their foreign origin, as the words in (21c–d), all of which loans, demonstrate.

(21) a. *summa* 'sum' [ˈsumːaˑ]
lasso 'lasso' [ˈlasːoˑ]
loto 'lottery' [ˈlodːoˑ]
foto 'photo' [ˈfodːoˑ]

b. *teema* 'theme' [ˈdeːmaˑ]
floora 'flora' [ˈfloːraˑ]
draama 'drama' [ˈdraːmaˑ]
liiga 'league' [ˈliːgaˑ]

c. *tumm* 'silent' [dumːː]
loss 'castle' [losːː]
lokk 'curl' [logːː]

d. *buum* 'boom' [buːːm]
uur 'watch' [uːːr]
kood 'code' [goːːd]

It seems natural to assume that loan words entering the language as uninflected stems have no internal morphological structure. As such, we would expect them to conform to the patterns we find in simplex words. (21) differs from **Table 12** in that the former compares unrelated lexical items, neither of which has any internal morphological structure, while the latter shows two forms that both have internal structure, but where the type of morphology differs (analytic vs. non-analytic). Both sets of data point in the same direction and show that the difference between

[34] Basbøll (2003) looks at how tightly connected various Danish suffixes are to their bases and the effect of that on stød. He links the tightness of that connection to their productivity as an independent criterion. This will not help with the Danish examples in Table 12, since both words have the same suffix (the definite article), whose different shape depends on whether the stem is vowel- or consonant-final.

oxytones/paroxytones is the relevant factor in the distribution of overlength, even if appearances are deceptive at times.

The English example in **Table 12** is taken from Abercrombie (1964). *Greater* contains a suffix and … *Grey to…* consists of two words, with *to* acting like a clitic. Given the more independent status of *to* (as opposed to a suffix), it seems correct to treat *Grey* as an independent domain separate from following *to*, hence a Q3 vowel (diphthong in this case) is to be expected. This differs from the (non-analytic) comparative suffix *-er* which forms one single domain with the base it attaches to, giving rise to a paroxytone. That comparative *-er* is non-analytic and thus forms one domain with its base can be seen in the distribution of [ŋg], which English bars at the end of domains (*long* *[lɒŋg]). Given comparatives like *long-er* [ˈlɒŋgə], in parallel with simplex *finger* [ˈfɪŋgə], we can conclude that the base *-er* attaches to does not form a domain of its own, making the suffix non-analytic and *great-er* one single domain.[35]

Let us return to Danish for a last detail related to morphology. Differences in morphological structure and their effect on stød can also be seen in a productive process of stød addition under suffixation. As a result, even stød-less forms like *ven* [vɛn] 'friend' (cf. section 3.2) can receive stød. It is clear, however, that this depends on the exact type of suffixation; contrast the forms in (22).

(22) a. *ven* [vɛn] 'friend' (base)
b. *vennen* [ˈvɛnˀn̩] 'friend DEF.' (with added stød)
c. *venner* [ˈvɛnɐ] 'friends PL.' (without the addition of stød)

There are two issues here: (i) Differences in which suffixes lead to stød addition and which do not. (ii) The formal mechanism underlying stød addition. As for (i), we can again capitalise on how loosely or tightly a suffix attaches to its base. As seen in **Table 12**, the definite article in (22b) attaches analytically, i.e. its base forms a domain of its own and, crucially, the base is an oxytone.[36] (22b) is then entirely parallel to the example ((*mus*)*en*) [muːˀsən] 'mouse DEF.' in **Table 12**. In contrast, the plural in (22c) seems to be non-analytic like the English comparative *-er*. As its base is a paroxytone, we do not expect stød.[37]

[35] In fact, things are still a bit more complex: English differs from Estonian in that for the purposes of length it treats analytic and non-analytic suffixation as one group and cliticised forms as another, cf. Pöchtrager (2006: Chapter 5). This is inconsequential to the point illustrated in Table 12, since it is still true that *Grey* with *to* cliticised onto it is a looser combination than *greater*.

[36] This raises the interesting question why the definite article should adapt at all (vowel-initial/syllabic *-en* vs. consonant-initial/non-syllabic *-n*) if the base is an independent domain. The same issue arises with regular English inflections, which are clearly analytic (Kaye 1995), and yet show epenthesis in cases like *nodd-ed*, *kiss-es* etc. For a general discussion and analysis of such cases cf. Pöchtrager (2021b); for a specific analysis of such cases in Polish cf. Gussmann & Kaye (1993).

[37] Matters are a bit more complex in that there seem to be at least two versions of plural *-er*, as also argued in Basbøll (1988: 143–145): In *hal* [halˀ] 'hall'/*haller* [halˀɐ] 'halls PL.' the plural marker leaves the stød of its base unaffected, in the same way as the definite article. Given this lack of predictability two slightly different markers (one analytic,

As for (ii), I would like to suggest the following: In section 3.2 we saw that words like *ven* [vɛn] 'friend' lack a specifier (unlike *pen* [pɛnˀ] 'pen', with stød). If we assume that affixation of an analytic suffix (as in the definite form) requires a complete x-bar structure as a base (i.e. including a specifier), and that a base not meeting that requirement is modified accordingly, we automatically get the addition of stød. As a result, both *vennen* [ˈvɛnˀn̩] 'friend DEF.' and *pennen* [ˈpɛnˀn̩] 'pen DEF.' come out the same.

This can even be extended to other cases of stød addition as in *sofa* [ˈsoːfa] 'sofa' vs. *sofaen* [ˈsoːˌfæːˀn̩] 'the sofa DEF.' (Basbøll 2005: 318). Notice how the final unstressed syllable of the base not only acquires secondary stress, it is also lengthened and receives stød. In that way it is comparable to vowel-final oxytones (section 3.1), which makes sense under our assumption that affixation of an analytic suffix makes sure that we have a complete x-bar structure as the base. Both stød addition and vowel length fall out from this, since having a complete x-bar structure means having a specifier and thus a control relationship between the nuclear head and its complement, i.e. a long vowel the second half of which carries stød.

5.2 The mora

Our account so far has not made any reference to the notion of mora, a concept which has been alien to GP in all its incarnations: Harris (1994: 277 fn. 30) argues that moraic structure, in particular the difference between moraic and non-moraic segments, complicates the statement of phonotactic regularities, i.e. it is rather a hindrance than an advantage. Even for languages where the mora seems quintessential, alternatives have been offered which make do without it. For Japanese, both S. Yoshida (1990) and Y. Yoshida (1995) have argued that heavy syllables with two moras can be reinterpreted as a sequence of two light syllables (more precisely: two CV-pairs) without any loss of explanatory power; in fact, rather the opposite. If even the poster-child Japanese can do without the mora, then possibly Danish can, too. "[I]f the ultimate goal […] is to seek for a group of principles that make up Universal Phonology, a unit such as the mora, which is indispensable in some languages but completely irrelevant in other languages, is an unwelcome innovation." (Yoshida 1990: 331).

For Danish, the mora seemed crucial as it allowed for a unification of two contexts: A long vowel is equivalent to a sequence of short vowel plus sonorant, cf. section 1. The question will then be, do we need recourse to the mora as an *additional* concept or are the notions we already have in our theory sufficient? If we do not need it, then the case for the mora becomes accordingly

one non-analytic) are required; their choice is lexically determined by the noun. (Alas, it is hard to back up the two versions of *-er* by evidence beyond stød.) A similar argument can in fact be made for the English comparative: While the sequence [ŋg] (not [ŋ]) in *long-er* [ˈlɒŋgə] can be taken as evidence for its non-analytic status, forms like *wrong-er*, where [ˈɹɒŋə] (without the [g]) is possible suggest that at least some comparatives are analytic, even though the phonetic shape of the suffix is identical in both cases.

weaker. We have already seen that the mora is not sufficient to explain the distribution of stød. (It has nothing to say about the difference between oxytones and paroxytones, for example.) At the same time it does not even seem necessary, since our proposal about stød only refers to relationships between a nuclear head and its complement, which is what we also need in order to talk about length or clusters. This means that what the mora was supposed to capture can be adequately expressed in the vocabulary already in use in GP 2.0. Now, one could object (as a reviewer has done) that the mora also plays other roles in Danish, e.g. for word-minimality, syllable structure, or stress; so let us address those in turn.

For the purposes of stød we must of course make sure that only sonorants are treated as moraic, but not obstruents. This becomes troublesome when explaining word size minima in Danish: *fib* 'goatee', *gik* 'went' or *bus* 'bus' have a short vowel (one mora) and end in an obstruent, which *ex hypothesi* is not moraic. If we treat the final sonorant in stødless words like *ven* 'friend' (section 3.2) as extraprosodic, then those can be added to the list as well. All of this suggests that Danish allows monomoraic (content) words, which is also the conclusion of Basbøll (2005: 270ff). Yet when we look for monomoraic words that end in a vowel, we find that they are not content words, but function words (including adverbs like *nu* [nu] 'now' and reduced forms of modals like *kan* [ka] 'be able to'). Both sets are treated as monomoraic, so the difference between them cannot be expressed in moraic terms. It can, however, be expressed in our terms: In words like *nu* 'now' the nuclear head has no complement whatsoever, in words like *bus* 'bus' (or *bi* 'bee') the nuclear head does have a complement. This also includes *pen* 'pen' (with stød) and *ven* 'friend' (without), both of which have a complement to the nuclear head. Reference to the complement (instead of the number of moras) draws the dividing line at exactly the point where it needs to be drawn.

What about syllable structure and the maximal size of a syllable? Let us note that marking the final mora as extraprosodic in a word like *ven* 'friend' succeeds in avoiding stød, but does not derive any other properties of the word, cf. the discussion at the end of section 3.2. In the same context we also noted that Basbøll's rule which assigns a mora to the first consonant of the clusters in both *falk* 'falcon' and *film* 'film' manages to create a position for stød. One could argue that that rule helps maintain an upper limit of maximally two moras per syllable. But it only does so by brute force, i.e. by assuming that the *second* sonorant of the cluster in *film* 'film' simply does not get assigned a mora, even though a third mora would not be detrimental at all to an account that assigns stød to the second mora. Any third mora would be superfluous, but harmless. The mora is a rather abstract notion, then, a conclusion also reached in Grønnum & Basbøll (2001); one that does not translate easily into acoustic cues.

As for stress assignment, it is also unclear whether the mora actually does a lot of work. Danish is a Germanic language and stress usually marks the first syllable of the root. That stressed first root syllable could be monomoraic (*suppe* [ˈsɔbə] 'soup') or bimoraic (*lampe* [ˈlɑmbə] 'lamp'). Also, like in most other Germanic languages, a fair number of loans has entered the language, and

Basbøll (2005: 395–400) distinguishes between a French part of the lexicon (with final stress) and the rest. That rest gets assigned stress by two rules, replicated in (23) from Basbøll (2005: 397).

(23) a. The string of segments is scanned from the left. The first /Vː/ is assigned stress.
b. If no stress is assigned according to [a.], the last /V/ followed by /C/ is assigned stress.

Note that rule (23a) refers to long vowels, which is different from a bimoraic syllable (which could also be a short vowel plus sonorant). Rule (23b) refers to a short vowel followed by *any* consonant. That consonant could be moraic (if a sonorant) or not (if an obstruent or lexically marked as non-moraic). Taken together, then, the mora does not feature in either rule.

In addition, there is an important proviso to the rules in (23) in that "[l]exemes with a stress placement different from the one predicted by the Default stress rule have underlying stress" (Basbøll 2005: 397). So not only does (23) not refer to moras, it can also be overridden when necessary. As Basbøll (2005: 397) himself points out: "The Default stress rule as given here cannot be falsified in any strict sense, since potential counter-examples can be given an appropriate underlying stress placement." Note that I do not argue for or against the validity or usefulness of (23), but simply state that the mora seems orthogonal to it.

I conclude then that not much is lost for Danish if attention is directed away from the mora. The alternative outlined here helps us to make sense of stød, word minima, and syllable structure, and as for stress in Danish, the mora does not seem to be crucial to begin with.

5.3 Antepenultimate position

The article has dealt in detail with oxytones and paroxytones and tried to establish parallels in their behaviour across three different languages. The stød principle in (2) refers to odd-numbered syllables, and that includes antepenultimate position, i.e. proparoxytones, which we have not looked at so far. The question is, should they be subsumed under the same principles as other words? Fischer-Jørgensen (1989: 4) points out that "[t]risyllabic uninflected words are very rare" and that "[t]hey generally do not have stød". This latter point changes once foreign words are taken in, such as *kolera* [ˈkoːˀləʁɑ] 'cholera'. In addition, Basbøll (1988: 135) points out that stød is assigned in the (school) pronunciation of Latin and Greek words with antepenultimate stress, thus Latin *insula* [eˀnsula] 'island'. So, proparoxytones should be considered if the entire lexicon is taken in, but the issue remains unclear with native words. Taking the simple way out and assuming that there are different strata of the lexicon would not help, because even if there are, words like *kolera* 'cholera' still need *some* representation. So let us explore likely contenders.

In section 4 I argued that paroxytones have their unstressed syllable embedded inside the projection of the stressed nucleus; more precisely in the specifier, recall *mile* [miːlə] 'mile' from (20b). Allowing proparoxytones to have both syllables embedded inside the (stressed) nucleus, say one in the complement and one in the specifier, makes two predictions: (i) Stød should be impossible (because the specifier is inaccessible for the nuclear head). (ii) Long vowels (with or without stød) in antepenultimate position should be impossible because the complement position that should provide the second half of the long vowel is needed for the middle syllable. Neither prediction is borne out and we have to reject the assumption that proparoxytones have both syllables embedded within the projection of a single nucleus.

The only alternative then seems to be that proparoxytones need to be broken down into smaller units, such as (*ko*-]) (*lera*). That would allow us to treat the first unit (*ko*-) in its own right and as an oxytone, with stød as expected.[38] It then remains to clarify *what* exactly those units are and what their internal structure is. If they are treated as feet, then the second foot (*-lera*) is somewhat unusual: It is hard to know which one of the two syllables should be the (more prominent) head position, if any. However, there is a certain similarity to the "weak foot" of Burzio (1994: 70), which shuns stress. If that is correct, then the lack of stress would also explain the lack of stød in the second foot.

It is reassuring for the comparative approach taken here that exactly the same issue arises in Estonian. The word *muuseum* 'museum' has initial stress and the vowel of the first syllable is in Q3. Again, this can be made sense of if we break down the word into smaller units, with *muu* forming a unit of its own. It would then be exactly identical to the word *muu* 'other', also with a Q3 vowel. That such smaller units (whether feet or something else) are important for the proper analysis of overlength has been argued for for a long time (Lehiste 1965; Prince 1980). What remains to be done is to integrate this thoroughly into GP 2.0, which will have to be the focus of future work.

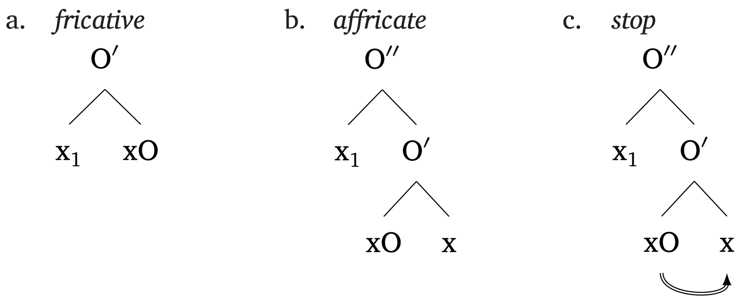
5.4 The role of the specifier

Section 3.1 made the crucial assumption that a control relationship depends on the availability of a specifier. This has allowed us to make accurate predictions about the occurrence of stød in oxytones (why words with a long vowel or a sonorant-initial cluster take stød while those with a short vowel plus sonorant may or may not) and also predict the absence of stød in paroxytones.

Despite the usefulness of this link between specifier and control, the exact reason for the connection remains unclear, however. Why would a specifier have an effect on what can happen with the complement? One could make the (rather trivial) observation that a complement counts as more deeply embedded exactly because of the presence of a specifier. But that only says something about the geometry of the tree, not about a particular relationship (control) holding between two nodes.

[38] This also shows why any attempt to deal with proparoxytones by declaring the final syllable extrasyllabic will not help, as that would only cut off the final syllable and leave *kole-* as a unit, in which case stød becomes even more mysterious.

What is somewhat reassuring is that the same phenomenon comes back elsewhere, viz. in consonants. Pöchtrager (2006) offered an analysis of the internal structure of consonants, and Pöchtrager (2021c) updated and slightly modified the account by looking at affricates and how they are set apart from other obstruents. Obstruents in this model are a projection of a consonantal head xO, which, like other heads, can project up to twice. A control relationship between head and complement encodes (complete) stopness, but such a control relationship is only possible (though not necessary) if the specifier is present. This allows for the three structures in (24), taken from (Pöchtrager 2021c: 8). The linear order of head and complement is immaterial here.

(24)


The position x_1 in all structures allows for the the encoding of the fortis/lenis contrast, as seen in section 4.1. A conceivable fourth possibility, i.e. a structure as in (24a) but with control is excluded since there is no specifier. And indeed, there is no further type of obstruent not already covered by one of the three types.

In this arrangement of structures, affricates take an intermediate position between fricatives and stops. This allows for a simple, formal characterisation of natural classes. Affricates are like fricatives in that neither one involves control (24a–b). At the same time, affricates are also like stops in that each involves two layers of projection of xO (24b–c), i.e. they are equal in size. Both groupings are relevant for phonological phenomena (Kehrein 2002; Lin 2011).

5.5 Sonorants and obstruents

GP has had a somewhat uneasy relationship with the distinction between sonorants (in particular sonorant consonants) and obstruents. Earlier versions of the theory had an element **h** which "maps onto the speech signal as aperiodic energy" (Harris 1994: 123) and characterised fricatives, affricates and (released) plosives, i.e. the class of obstruents. (Unreleased plosives pose an obvious problem since they are obstruents but lack **h** under that definition.) In the course of time, the set of elements was reduced quite dramatically, and in Kaye's User Guide (Kaye 2000) we no longer find **h**. The definition of the element **H**, already responsible for voicelessness, aspiration and high tone since the early days of the theory, was extended in Backley (2011) to cover noise as well. However, Backley assumes that this element is not found in (English) lenis stops, and therefore **H** cannot be used to characterise the class of obstruents adequately. In GP 2.0 the sonorant/

obstruent distinction is partially covered by two different kinds of consonantal heads (xO vs. xo), cf. footnote 23. But those different heads are also involved in the expression of other properties, such as coronality (Pöchtrager 2021c) and at present it remains somewhat unclear whether they provide a satisfactory characterisation of those two classes.

With a language like Danish one is paying the price for this negligence, because reference to the sonorant/obstruent divide seems crucial for a complete analysis of stød. In section 3.3 we assumed that obstruents cannot be controlled, a reinterpretation of the common stipulation that "obstruents are not moraic in Danish" in other accounts. However, by pulling together the results of sections 4.1 (on the representation of the fortis/lenis contrast) and 5.4 (on fricatives, affricates and stops) we are now able to express what the sonorant/obstruent distinction captures without reference to those notions, thus steering clear of any problems that remain in their (theory-internal) representation. In this section I will make a (still somewhat tentative) proposal how this could be achieved.[39]

Since consonant-final oxytones with a long vowel have stød irrespective of the nature of the final consonant, we will only need to consider words with a short vowel. What we want to achieve is that control can target sonorants but not obstruents. What is interesting about Danish obstruents in *final* position is that plosives are all lenis (25a), while fricatives are fortis (25b).[40]

(25) a. *lap* [lab] 'rag'
hat [hæd] 'hat'
gik [gig] 'went'

b. *tuf* [tuf] 'tuff'
bus [bus] 'bus'

As argued in section 4.1, lenis consonants contain an unused position, i.e. one that is not m-commanded by the consonantal head. In fortis consonants, however, the corresponding position is m-commanded by the head. Let us now assume that, counter to what was claimed in section 3.3, control can freely try to target sonorants *and* obstruents, instead of being restricted to sonorants. What would the consequence be? Take the fortis fricative at the end of *tuf* 'tuff' [tuf] (25b): Being a fricative, it contains two positions (a head and its sister); and since it is fortis the head m-commands its sister. All positions are used up, and since a position can be *either* controlled *or* m-commanded but not both, no control relationship (coming from the preceding nucleus) can be established. We expect that such words do not have stød, and indeed they do not.

[39] I would like to thank the anonymous reviewer who set me off on this way of thinking about things.

[40] I remind the reader that the notions fortis/lenis are somewhat vague (cf. footnote 4) and that their application to Danish has been contested (cf. footnote 17). Given that final stops in Danish are neither voiced nor aspirated their classification as lenis seems justified, though. Danish fricatives are treated as fortis in Basbøll & Wagner (1985). (With the exception of [v], which, however, has usually disappeared from final position.) Note also that it is difficult to find words ending in the fortis fricative [ç]; *march* [maːç] *march* is one of the few but it has a long vowel. The lack of stød in that word is connected to the lost rhotic, cf. footnote 14.

Words ending in lenis stops (25a), on the other hand, do have an empty (thus controllable) position because they are lenis. But plosives already contain a control relationship by definition (section 5.4), and so the addition of another one coming from the preceding nuclear head would simply not change anything. The plosive stays a plosive.

Let us finally consider words ending in sonorants. For this we can go back to *pen* 'pen' [pɛnˀ], which we looked at in (12a) in section 3.2. There we assumed that the consonant can be controlled because it is a sonorant. According to the proposal made in this section control can be established because the consonant is lenis (like all sonorants in Danish) and therefore contains an empty position that can be controlled. Under either approach we correctly predict stød.

The alternative outlined in this section basically amounts to two claims. Firstly, the distinction between sonorants/obstruents is not the relevant distinction that we need to look at for Danish. Instead, what counts is whether a consonant contains an empty position or not. Under such a reinterpretation, Danish gets a little bit closer still to both Estonian and English, where the availability of empty positions was also crucial, but for the distribution of overlength. What was given as a difference between Danish versus English/Estonian in (8a) might actually be yet another parallel. The second claim is that control is the default, but that there are various factors that can block it: If there is no specifier as in *ven* 'friend' (section 3.2), if the specifier is not accessible as in paroxytones (section 4.1), or if there is no position that could be controlled (as in fortis fricatives). In all the other cases control is established, and that is why we get stød on sonorants, while in plosive-final words (25a) it just so happens that a control relationship between the nucleus and the final stop can be established, but that there is no audible effect. In this regard, there are similarities (in spirit, though not in theoretical machinery) to a recent proposal by Vazquez-Larruscaín (2021), who assumes that obstruents are moraic and hence potential targets for stød, but that stød is incompatible with obstruents and therefore fails to be realised in this context.

There are two implications of this proposal. Firstly, it casts even further doubt on the relevance of the mora. The sonorant/obstruent distinction formed the basis for deciding which consonants can count as moraic. Once that basis is gone, there is even less reason to uphold the claim that moraic structure is relevant. Secondly, in sections 3.2 and 3.3 we saw that for sonorant-final oxytones the specifier could be present in some words (*pen* 'pen' with stød) and absent in others (*ven* 'friend' without), while for obstruent-final oxytones it simply did not matter if the specifier was present. The reason for this discrepancy could lie in acquisition: Under the proposal made in this section, control could apply freely with both sonorants and obstruents, provided there is a specifier. In the case of *pen* and *ven* the child would have a clear indication for whether the specifier was present or absent: stød. In a word like *hat* 'hat' there could be a specifier and thus control, or no specifier or no control. In either case, there would be no stød. For the child, either option would be a possible representation.

Let me finally add that I see two potential problems for the proposal in this section, which might require a retreat to the more generally accepted reliance on sonorants and obstruents. For one thing, since the sonorant/obstruent divide is not exactly well-understood within GP, as we saw at the beginning of this section, it might be too rash to dismiss it out of hand. After all, we might just be lucky that the partitioning created by the fortis/lenis distinction in Danish coincides with that needed for stød. Secondly, final plosives as in *hat* ‘hat’ now involve two control relationships, one fully contained inside the consonant, and one from the nuclear head to the (specifier of the) consonant. Having two control relationships in the same consonant is a novelty in the theory, and as such its implications will need to be considered carefully. Both points, however, will have to await further developments in the theory of GP 2.0.

6 Conclusion

As this article has tried to show, parallels between length-related phenomena in English and Estonian on the one hand and Danish stød on the other suggest that the same mechanisms explaining one will also be needed to shed light on the other. The reanalysis in terms of GP 2.0 brings out those commonalities, while still accounting for differences. Not only does it link two apparently disparate phenomena, it also derives distributional restrictions peculiar to stød basic assumptions of the theory.

As already mentioned in the introduction, this is not the first analysis of Danish stød within GP, though. Larsen (1994) presented an analysis within Strict CV (Lowenstamm 1996; Scheer 1996; 2004; 2012), another variant of GP. In his analysis, stød is treated as the default insertion of the element **H** in an empty position that fails to be licensed. There are several differences between his account and the one presented here, most notably that his is an account tailor-made for Danish, without any strong connection to other languages or phenomena such as length. He does propose an extension of the (universal) Empty Category Principle, which regulates the interpretation of empty positions, but it remains unclear what the advantages are beyond Danish. Also, due to assumptions internal to his analysis, he needs to assume the existence of virtual clusters in words like *sind* [sen^ʔ] ‘mind’, i.e. clusters that exist underlyingly but then get reduced to their first member. This raises issues about acquisition, since those clusters can only sometimes be inferred from morphologically related forms. In many cases there is no indication except for etymological knowledge or spelling, neither of which the child has access to. Nothing of the sort is needed for our account, where the internal structure of a nuclear projection explains why stød can occur in certain positions.

While there are many further details about stød (and length) that await clarification within our model, a first step towards unifying two seemingly unrelated phenomena has been made.

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