Vowel duration, syllable quantity and stress in Dutch

Carlos Gussenhoven
Centre for Language Studies, University of Nijmegen
c.gussenhoven@let.kun.nl

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1.0 Introduction

A persistent conundrum in the analysis of Dutch word prosodic structure has been the fact that closed syllables require a foot head, while long vowels apparently fail to project a foot (van der Hulst 1984, Kager 1989:261, Zonneveld, Trommelen, Jessen, Rice, Bruce & Árnason 1999:499, among others). This type of selective quantity-sensitivity is highly marked: in quantity-sensitive languages, long vowels are heavy (bimoraic), and will be in a stressed syllable, while in addition such a language may require closed syllables to be heavy, and be stressed. The latter option was termed as WEIGHT-BY-POSITION by Hayes (1989). In (1), this well-known typology is given.

(1)

	Type A	Type B	?Dutch
short vowel (V):	μ	μ	μ
long vowel (VV):	μ μ	μ μ	μ
closed rhyme (VC):	μ	μ μ	μ μ

There have been three responses to the apparent quantity-weight mismatch in Dutch. Lahiri & Koreman (1988) proposed that weight and quantity are represented separately: while weight is counted in moras, quantity is counted in X-slots. As a result, the light long vowels of Dutch can be represented as just that: one mora dominating two X-slots.[i] Second, Kager (1989:261) suggested that weight, which in other languages is determined by the branchingness of the syllable peak (short vowel *vs*. long vowel, diphthong, short vowel plus C) is determined by 'melodic complexity', or the number of segment root nodes associated to moras after the first mora in the rhyme (leading to light monophtong *vs* heavy vowel plus coda or diphthong). A third response is that by van Oostendorp (1995), who assumes that so-called long vowels are not in fact represented as long, but differ from short vowels in lacking the vocalic feature [lax]. The specification of the duration of Dutch vowels will in his view be provided during the phonetic implementation.

It is argued that none of the above solutions is tenable, and that the solution to the problem lies in a re-evaluation of the phonetic facts. Unlike what appears to be generally assumed, the long tense vowels of Dutch are only longer than short vowels in stressed syllables, i.e., in the head of the foot. This suggests that Dutch stressed syllables are bimoraic, while unstressed syllables are monomoraic. The dependence of vowel length on stress will allow us to assume, with van Oostendorp (1995), that there are no underlying moraic representations for Dutch syllables. Bimoraicity (and restricted occurrences of trimoraicity) are the result of (a) WEIGHT-BY-POSITION (the projection of moras by coda consonants) or (b) STRESS-TO-WEIGHT (a bimoraicity requirement on those syllables that are stressed by regular footing). The analysis presented here differs from van Oostendorp (1995) in that quantity is part of the phonological representation of Dutch vowels in the present treatment, while van Oostendorp persists with mora-less representations up to the surface representation. Indeed, it will be shown that moraic representations of vowels are part of the lexical phonology of Dutch, and moreover, that a description of the prosodic structure of Dutch words is impossible if the moraic structure is left unspecified.

In section 2, the new facts about Dutch vowel duration are given, together with a brief description of the experiment that yielded them. Section 3 gives the facts of vowel quantity in Dutch and shows that it is partially determined in the lexical phonology, so that the specification of the duration of vowels cannot be left to the phonetic implementation. Section 4 describes the regular stress patterns of Dutch, drawing on the analyses in Nouveau (1994) and van Oostendorp (1997), while Section 5 shows that the success of this description crucially depends on the analysis of the moraic structure of the part of the word before the main stress. A conclusion is offered in section 6.

2.0 Duration and distribution of the vowels of Dutch

Table I lists the vowels of Dutch that can appear in a stressed syllable nucleus (e.g. Moulton 1962, Gussenhoven 1992, Booij 1995). There is a set of lax, short vowels, a set of tense vowels of which the [-high] vowels are long, a set of tense or lax, oral or nasal, long 'marginal' vowels, which only occur in recent loans and onomatopoeic words, and finally, there are three diphthongs, as shown in Table I[ii].

Table I. The vowels of Dutch that can appear in stressed syllables.
The vowel [ə] (not listed) only appears in unstressed syllables.

Short (lax)	**Long or short (tense)**	**Long**	**Diphthong**
ɪ ʏ ɛ ɔ ɑ	i y u eː øː oː aː	iː yː uː ɛː œː ɔː ɛ̃ː ɔ̃ː ɑː ɑ̃ː	ɛi œy ʌu

The heaviness of VC-rhymes is not obvious, but can be seen in trisyllabic words. Dutch has quantitity-sensitive trochees, built from right to left. The atypical 'fact' that closed syllables are heavy and open syllables with long vowels light can be seen by comparing words of the type *almanak* 'almanac' with words like *Gibraltar* 'id.' Both of these have a closed final syllable, but they differ in the structure of the penult. The closed penult cannot be skipped, leading to [xiˈbrɑltɑr], while the open penult is regularly skipped, causing main stress on the antepenult. The above interpretation of vowel quantity thus gives rise to the belief that long vowels, like [aː] in [ˈɑlmaːˌnɑk], are light, even though closed syllables are heavy.

In reality, the duration of [eː,øː,oː,aː] in unstressed positions is equivalent to that of short vowels. Using reiterant speech, Rietveld, Kerkhoff & Gussenhoven (1999) investigated the duration of [aː] and [i] in all conceivable word prosodic contexts. While [i,y,u] are tense, and have the same distribution as 'long' tense vowels, their duration happens to be identical to that of short lax vowels: the vowels of [zɪt] 'sit' and [zit] 'see-3SG' have equivalent durations, which may be only 50% of the duration of the vowel in [zaːt] 'seed' (Nooteboom 1972:66). In order to identify the prosodic positions in which the duration contrast between short [i] and long [aː] is made, nine word prosodic patterns were identified, which between them include all conceivable word prosodic positions.[iii] The effects of word stress (as opposed to secondary stress), stress (as opposed to no stress), serial position (initial, non-peripheral, and final syllable in foot, and ditto foot in word) on the duration of each of the two vowels could thus be determined. A list of words illustrating these patterns is given in (2) (S = word stress, s = secondary stress, w = unstressed).

(2)	ˌroːdoːˈdɛndrɔn	s w S w	'rhododendron'
	ˌpaːraːˈdɛis	s w S	'paradise'
	ˌpaːsifiˈkaːsi	s w w S w	'pacification'
	ˌloːkoːmoːˈtif	s w w S	'locomotive'

ˌmini(ˌ)maːliˈzaːsi	s w s w S w	‘minimalization’
ˈoːliˌfɑnt	S w s	‘elephant’
ˈoːliˌfɑntə	S w s w (derived word)	‘elephants’
piˈraːt	w S	‘pirate’
piˈaːnoː	w S w	‘piano’

To exclude confounding segmental factors, the experiment made use of reiterant CV syllables, as produced by four speakers, with alternating occurrences of two out of the three consonants /k/, /s/, /m/ for the C-position, in all possible permutations. Because the reiterant words were pronounced in a carrier sentence of the type *Ik DOE (...) niet*, ‘I do (...) not’, where the word *do* was realized with a pitch accent, the data abstract away from accentual lengthening and utterance-final lengthening (Cambier-Langeveld 2000). Forty-eight (12 reiterant versions x 4 speakers) realizations were obtained for each of the nine prosodic patterns. The results showed that there was never a significant difference between the durations of the two vowels in positions outside the foot head, while in all cases in which [aː] occurred in the foot head it was significantly longer than [i]. The contexts in which a significant duration contrast was absent included the word-initial syllable before the word stress, as well as the word-final syllable after the word-stress, as, respectively, in the first and last syllables of [piˈaːnoː] ‘piano’. From now on, therefore, the vowels in the second column of Table I will be given as long only if they are, i.e., in the head of the foot, and a word like *piano* will thus be given as [piˈaːno].

3.0 Making the moraic structure reflect the phonetic facts

Since phonological representations of vowel quantity are reflected in phonetic duration (Duanmu 1994, Hubbard 1995, Broselow, Chen & Huffman 1997), it is proposed that the ‘long’ vowels in the second column of Table I are bimoraic in stressed position and monomoraic in unstressed position. This means, first, that Dutch ranks a STRESS-TO-WEIGHT PRINCIPLE (SWP) high, cf. (3)[iv]. In addition, since closed syllables attract stress, it also ranks WEIGHT-TO-STRESS PRINCIPLE (WSP) high, cf. (4).

(3) STRESS-TO-WEIGHT PRINCIPLE (SWP): Foot heads are (minimally) bimoraic

(4) WEIGHT-TO-STRESS PRINCIPLE (WSP): Bimoraic syllables are foot heads

WSP is not only relevant to closed syllables. As observed by Zonneveld (1993), the truly long vowels (cf. Table I, third column) do not tolerate being in an unstressed position: *(Rio de) Janeiro* [ʒaˈnɛːro], *[ˈʒaːnɛːˌroː][v]. Neither could the diphthongs (cf. Table I, fourth column) appear in unstressed penults: *Khomeiny* [koˈmɛini], *[ˈkoːmɛiˌni]. These truly long vowels must be represented in the lexicon with two moras, while diphthongs are bimoraic by virtue of the fact that they contain two segments in the nucleus. These facts thus make Dutch an unexceptional ‘Type B’ language.

Broselow, Chen & Huffman (1997) assume a default markedness constraint SYLMON (5), whereby syllables are monomoraic (cf. NOLONGVOWEL in Kager, this issue). This will make sure that ‘long’ vowels are in fact short in weak positions.

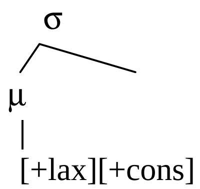
(5) SYLMON: Syllables are monomoraic

Tableau (6) illustrates how these constraints characterize [ˈbaːta] as the correct form of the brand name *Bata*. The trochee, assumed in (6), causes the first vowel be bimoraic by SWP, while the weak syllable defaults to a monomoraic [a], since bimoraic [aː] in weak position violates WSP.

(6) bata	WSP	SWP	SYLMON
☞ a. (ˈbaːta)			*
b.(ˈbata)		*!	
c.(ˈbaːtaː)	*!		**

The bimoraicity of syllables with short lax vowels is ensured by the fact that such a vowel is obligatorily followed by a tautosyllabic consonant. Constraint LAX+C (cf. (7)), a reformulation of part of a constraint proposed by van Oostendorp (1995), requires a lax vowel to be monomoraic and be followed by a consonant in the same syllable.[vi]

(7) Lax+C:



The moraicity of the coda consonant is ensured by high-ranking WEIGHT-by POSITION (WbP), given in (8) (Hayes 1989).

(8) WEIGHT-by POSITION (WbP): A consonant in the coda projects a mora

As shown by van der Hulst (1985), a consonant after a short lax vowel is ambisyllabic in Dutch if it is required to be in the onset of the next syllable by constraints like ONSET (9). For instance, a word like *Hetty* , a girl's name, has an ambisyllabic [t], transcribed [t.t]

(9) ONSET: A syllable has an onset

In (10), SWP >> SYLMON, together with high-ranked ONSET, causes the [t] to be ambisyllabic, and the first syllable to be bimoraic as a result. Lengthening of [ɛ], as in candidate c., is correctly prevented by LAX+C.

(10) hɛti	ONSET	WSP	SWP	LAX+C	SYLMON
☞a. (ˈhɛt.ti)					*
b. (ˈhɛ.ti)			*!	*	
c. (ˈhɛː.ti)				*!	*
d. (ˈhɛt.i)	*!				*
e. (ˈhɛːt.ti)				*!	**

Our account does not so far explain why words like [laːt] ‘late’ have long vowels: the bimoraicity of the syllable would already be guaranteed by the coda [t]. It is suggested that the long tense vowel in these forms results from the effect of a constraint that maximizes the sonority of the syllable peak: if other constraints don’t prevent this, the moraic part of the syllable will be [-cons]. The relevant constraint, given as SonPeak (11), can be seen as part of the family of HNuc (Prince & Smolensky 1993: 134). SonPeak must be ranked below Lax+C, to prevent short lax vowels from lengthening.

(11) SonPeak:

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μ
|
[-cons]
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(12) lɑt	Onset	WSP/SWP	Lax+C	SonPeak	SylMon
☞ 1a. lɑt				*	*
1b. lɑːt			*!		**
lat					
2a. lat				*!	
☞ 2b. laːt					**

Finally, the diphthongs (column 4 of Table I) and the truly long (marginal) vowels will behave like long vowels: both elements of the diphthong are [-cons]. If these long vowels are lax, they escape shortening by Lax+C, thanks to high-ranking FaithMora (13), which preserves the lexical mora structure.

(13) FaithMora: Preserve mora structure

The rankings FaithMora >> Lax+C, and Onset, WSP/SWP, Lax+C >> SonPeak >> SylMon account for the quantity of Dutch vowels, with the exception of short tense [i,y,u], which are short even in stressed position. In the next section we will see how the quantity of these vowels must in part be accounted for in the lexical phonology, which provides us with an argument for rejecting the (implicit) assumption of van Oostendorp (1995) that the duration of Dutch vowels is purely a result of the phonetic implementation[vii].

3.1 Short tense vowels

The quantity of Dutch [i,y,u] is partly determined by the segmental context: when appearing before [r] in the same foot, these vowels are long. This is shown in (14), which compares words in which [i] appears before [r] in the same foot with words in which this vowel appears in prosodically identical words, but in which it is not followed by [r] (Gussenhoven 1993).

(14)	a.	*wier*	[ʋiːr]	‘algae'	*wiek*	[ʋik]	‘wing’
	b.	*Olivier*	[ˈoːliˌfiːr]	‘Oliver'	*kolibri*	[ˈkoːliˌbri]	‘id.’
	c.	*giro*	[ˈxiːro]	‘id.’	*kilo*	[ˈkilo]	‘id.’
	d.	*pierement*	[ˌpiːrəˈmɛnt]	‘barrel organ’	*lineaal*	[ˌliniˈaːl]	‘ruler’
	e.	*fakir*	[ˈfaːkiːr]	‘id.’ -	*kievit*	[ˈkivit]	‘peewee’

When [r] is in the next foot over, the high vowels are short, as in *piraat* [piˈraːt] 'pirate', c*orduroy* [ˈkɔrdyˌrɔj] 'id.', *admiraal* [ˌɑtmiˈraːl] 'admiral'. The constraint HIGHV-μ (15) reflects the widespread tendency for high vowels to be shorter than non-high vowels, and can be motivated on articulatory grounds: the greater distance between the tongue body and the roof of the mouth in the case of non-high vowels is generally believed to cause this effect (cf. Laver 1994:435).

(15) HIGHV-μ: High vowels are monomoraic

To ensure that [i,y,u] are long before [r] in the same foot, we postulate PRE-r-μμ (16). The articulatory motivation for this constraint is probably to be found in the conflict between a vocalic tongue posture (a convex dorsum and a tongue blade curling down into the lower jaw) and the tongue posture for a coronal [r], for which the front is held in a concave shape behind a tongue tip which curls up. The articulatory transition from a vocalic posture to that required for [r] will thus take more effort than a transition to the position for post-vocalic [t,s,n,l], for which the front of the tongue may, but need not be concave. Evidently, PRE-r-μμ >> HIGHV-μ, for otherwise high vowels could never be bimoraic in Dutch.

(16) PRE-r-μμ: Tense vowels are bimoraic before [r] in the same foot

Tableau (17) shows how this works for short and long occurrences of high tense vowels. Candidate 1c., in which the intervocalic onset consonant is ambisyllabic, is ruled out by SONPEAK, which for this reason must be ranked above WSP/SWP. That is, we cannot satisfy WSP/SWP by filling a second nucleus with the following consonant. All through, as will be clear, we are assuming high-ranked segmental faithfulness, so that candidates with added or deleted segments need not be considered.

(17) rita	PRE-r-μμ	HIGHV-μ	SONPEAK	WSP/SWP	SYLMON
☞ 1a. ˈri.ta				*	
1b. ˈriː.ta		*!			*
1c. ˈrit.ta			*!		*
xiro					
☞ 2a. ˈxiː.ro		*			*
2b. ˈxi.ro	*!			*	
2c. ˈxir.ro	*!		*		*

We give the main constraint rankings established so far, with the generalizations they account for:

WSP/SWP >> SYLMON: Stressed syllables are bimoraic, unstressed syllables monomoraic;
PRE-R-μμ >> HIGHV-μ : High tense vowels are long before [r] in the same foot, but short otherwise;
LAX+C >> SONPEAK: Lax vowels are short, despite their occurrence in bimoraic syllables, and thus must be followed by C in the rhyme (i.e. don't maximize a lax vocalic peak);

SONPEAK >> SYLMON:	Tense long vowels are long even before a coda C (i.e., don't minimize moraic structure at the expense of a vocalic peak);
SONPEAK >> SWP	Do not make consonants ambisyllabic merely to have bimoraicity in stressed syllables;
FAITHMORA >> LAX+C	Don't shorten long lax (marginal) vowels.

At this point it might be objected that the durational phenomena we have dealt with could be accounted for in the phonetic implementation. That is, we could have a single articulatory instruction, to be carried out with reference to a phonological representation without quantity distinctions: "make non-lax vowels long when stressed, but not when they are high, except when [r] appears in the same foot." This course of action is unavailable, however, because the quantity of high tense vowels is subject to a lexical process, creating (apparent) exceptions. Crucially, this means that moraic structure must be represented in the lexical phonology.

3.2 Why vowel duration is represented in the phonology

There are five irregular past tense forms which have short [i] before [r] in the same foot. In (18), an example is given.

(18) *wierp* [ʋirp] 'threw' (cf. *vier-t* [fiːrt] 'celebrate+3SG-PRES')

As Booij (1995: 94) points out, these forms end in a cluster of [r] and a labial obstruent, and no other words do. A phonological account that exploits this observation might assume, first, that all coda consonants project a mora, except post-consonantal [t,s], and second, that there is a constraint *μμμμ (19), undominated in Dutch, disallowing tetramoraic syllables. The first assumption is widely supported in work on Dutch phonology (cf. Booij 1995:26). The second is evidently supported by the typology of quantity, trimoraic syllables already being rare, and by perceptual limits on duration contrasts.

(19) *μμμμ : Syllables are maximally three moras long.

As shown in (20), to represent *wierp* with a long vowel would mean violating undominated *μμμμ. The form [fiːrt] escapes shortening, because coronal [t] fails to project a mora. The correctness of this solution is underscored by examples like *Ataturk* [ˈaːtaˌtyrk] 'id.' and *kirsch* [kirʃ] 'id.' (Paul Boersma, p.c.), which have short pre-[r] vowels, as expected.

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(20) a.  *    μ μ μ μ            b.    μ μ μ
              \/  | |                  \/  |\
            ʋ  i   r p               f  i   r  t
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While these facts already look pretty phonological, the clinching reason why it is not possible to translate the effect of *μμμμ into a phonetic implementation rule is that the short [i] of the past tense forms survives an inflectional affixation process that removes the labial obstruent from the coda. The structure that arises can be compared with phonologically underived forms, as in (21), to show that long [iː] appears in phonologically comparable contexts.

(21) *wierpen* [ˈʋir.pən] 'threw+PLUR' - *Kierkegaard* [ˈkiːr.kəˌxaːrt] 'id'

This means that vowel quantity differences are involved in lexical representations. The facts of (21) are consistent with a lexical phonology version of Optimality Theory (Orgun 1996, Kiparsky 1998): *wierp* is subjected to the constraint grammar at the stem-level, and its output is evaluated as the input of the constraint hierarchy at the word-level, where the moraic structure specified at the stem-level is preserved.

4.0 Dutch stress

In this section, we consider the implications of our representation for a description of regular Dutch stress. The description essentially follows Nouveau (1994) and van Oostendorp (1997), but crucially differs in that it describes the foot structure of the whole word, not just of the foot with main stress. It appears that this description cannot deal correctly with regular main stress if we fail to consider the prosodic status of the section of the word before the main stress. Crucially, the assumption must be made that, in Dutch, quantity-sensitivity is restricted to the right-hand part of the word, and that before the main stress WEIGHT-BY-POSITION is not in effect.

4.1 The regular stress pattern

The basic facts about Dutch stress are summarized in (22) and (23) (van der Hulst 1984, Kager 1989, Nouveau 1994, van Oostendorp 1997, among others). The examples in (22) show the simplest case: main stress falls on the penult.

(22) a. a.ˈxaː.ta ‘Agatha’
b. a.ˈmɑn.da ‘Amanda’
c. ˈaː.rɔn ‘Aaron’[viii]

Penultimate stress systematically fails to appear in three situations. Trivially, this occurs when the word in monosyllabic, as in (23a). Second, when the word is minimally trisyllabic, has an open penult and a final closed syllable, word stress is on the antepenult, as illustrated in (23b). Third, as shown in (23c), superheavy syllables, which can appear in word-final position only, attract main stress.

(23) a. ˈlaː ‘drawer’, ˈkɑt ‘cat’
b. ˈmaː.ra.ˌtɔn ‘marathon’ (*but*: pa.ˈlɛm.bɑŋ ‘place name’)
c. ˌɑt.mi.ˈraːl ‘admiral’, ˌleː.di.ˈkɑnt ‘bed’

A treatment in OT was presented by Nouveau (1994:184ff), and modified by van Oostendorp (1997). The analysis below differs from this earlier analysis in that the representation of long vowels is bimoraic in stressed syllables, rather than monomoraic, but otherwise essentially follows the older analysis in the characterization of regular main stress. All constraints are from Prince & Smolensky (1993), McCarthy & Prince (1993) unless indicated otherwise.

In section 3, we already took the effect of RHYTHMTROCHEE (24) for granted. NONFIN (28) is interpreted to ban main stress on the final syllable, as in Nouveau (1994), while F’RIGHT (29) will see to it that a foot with main stress is rightmost in the word.[ix]

(24) RHYTHMTROCHEE: Feet are left-dominant

(25) NONFIN: Main stress is not on the word-final syllable

(26) F'RIGHT: Align(Pw,Rt,F',Rt), or: the right edge of the word coincides with the right edge of a strong foot

NOCLASH (27) forbids adjacent stressed syllables (i.e. adjacent foot heads). High-ranking NOCLASH ensures that monosyllabic feet can only exist word-finally (cf. Gussenhoven 1993).

(27) NOCLASH: Foot heads are not adjacent

Finally, FOOTBIN requires that feet are binary, either at the moraic level or at the syllable level, i.e., violations are incurred by trisyllabic feet and monomoraic feet. In effect, because high-ranking WSP/SWP already weeds out all monomoraic foot heads, FOOTBIN'S only role in our analysis is to ban ternary feet.

(28) FOOTBIN: Feet are neither monomoraic nor trisyllabic

Cases like *Agatha*, with three open syllables, are derived straightforwardly: the winning candidate manages to obey all four constraints. Candidate b. is ruled out by NOCLASH, and forces the pre-stress initial syllable to be unfooted, i.e. directly attached to the Pword node. This is in accordance with the finding in Rietveld at al. (1999) that no quantity contrast exists in such syllables. Candidates c., d., e. and f. each founder on one of the other three constraints, as shown in Tableau (29). (Constraint FOOTBIN will only reappear in section 5.)

(29) axata	FootBin	NoClash	NonFin	WSP/SWP	F'Right
☞a. aˈ(xaː.ta)					
b. (aː)ˈ(xaː.ta)		*!			
c. ˈ(aːxa)ta					*!
d. ˈ(aːxa)(taː)					*!
e. (aːxa)ˈ(taː)			*!		
f. ˈ(aːxata)	*!				

The same result obtains if the penult is closed, as in [a.ˈmɑn.da], the only difference being that the equivalents of candidates c. and d. are taken out by WSP as well as F'RIGHT. The ranking of WSP/SWP becomes critical in words with final closed syllables. To stay with trisyllabic words, type (23b) provides evidence that Dutch is quantity-sensitive, as shown in Tableau (31). The winning candidate 1a. violates F'RIGHT, which constraint ranks below WSP/SWP: it alone incurs no WSP/SWP violation, as both foot heads are bimoraic and the only weak syllable is monomoraic. Words like [pa.ˈlɛm.bɑŋ] 'Palembang', which in addition have a closed penultimate syllable, incur WSP/SWP violations regardless of whether the main stress is on the penult or the antepenult (cf. candidates 2a. and 2b. in particular), and avoiding such a violation, as in candidate 2a., is therefore pointless. The decision falls to F'RIGHT. Candidates 1d., 2d. and 2e. are excluded by NOCLASH.

(31) maratɔn	NoClash	NonFin	WSP/SWP	F'Right
☞ 1a. ˈ(maː.ra)(tɔn)				*
1b. ma ˈ(raː.tɔn)			*!	
1c. ˈ(maː.ra)tɔn			*!	
1d. (maː) ˈ(raː.tɔn)	*!		!	
palɛmbɑŋ				
2a. ˈ(paː.lɛm)(bɑŋ)			*	*!
☞ 2b. pa. ˈ(lɛm.bɑŋ)			*	
2c.ˈ(paː.lɛm)bɑŋ			*!*	
2d. (paː) ˈ(lɛm.bɑŋ)	*!		*	
2e.(paː) ˈ(lɛm)(bɑŋ)	*!*			*

Penultimate stress in disyllables with a closed final syllable is due to NoClash and NonFin, both of which rank above WSP/SWP. In Tableau (31), [ˈaː.rɔn] shows that the language will prefer to incur a WSP violation to violating NonFin (cf. candidates a. and b.).

(31) arɔn	NoClash	NonFin	WSP/SWP	F'Right
☞a. ˈ(aː.rɔn)			*	
b. a.ˈ(rɔn)		*!		
c. ˈ(aː).(rɔn)	*!			*
d. (aː).ˈ(rɔn)	*!	*		

To continue with the examples in (23), monosyllabic words (cf. 23a) have stress because of the constraint Lex ≈ Pwd (not given as a numbered item), which requires every morphological word to be footed. Superheavy syllables (cf. 23c) only occur word-finally. The relevant contextual constraint allowing this ('No trimoraic syllable unless at right word edge') is here taken for granted. Superheavy syllables attract the word stress because trimoraic syllables are disfavoured in weak positions, in the foot as well as in the word. This constraint, the Superheavy-to-Stress-Principle (32), can best be seen as belonging to the same family as WSP, i.e., as a stricter version of the latter (cf. Prince 1990). Nouveau (1994) and van Oostendorp (1997) achieve the effect of SHSP by postulating a degenerate or abstract final syllable for the final consonant, which makes these words escape the censures of NonFin; the effect is that of final consonant extrametricality.

(32) Superheavy-to-Stress Principle (SHSP): Trimoraic syllables are strong foot heads

Ranking SHSP above NonFin will have the desired effect, as shown in Tableau (33).

(33) kapital	NoClash	SHSP	NonFin	WSP/SWP	F'Right
☞a. (kaː.pi).ˈ(taːl)			*		
b. ˈ(kaː.pi).(taːl)		*!			*
c. kaˈ(pi.taːl)		*!		**	

In this section, the following generalizations were achieved:

LEX ≈ PWD undominated: Monosyllables have word stress;
SHSP >> NONFIN: Final superheavy syllables have word stress;
NONFIN >>WSP/SWP: No word stress on a final closed syllable in disyllables;
NONFIN >> F'RIGHT: No word stress on a final closed syllable in trisyllables;
WSP/SWP >> F'RIGHT: Trisyllables with final closed syllable and open penult have antepenultimate stress (i.e., don't make a disyllabic final foot with heavy weak syllable)

5.0 Whole-word foot structure

The description of Dutch stress presented in the previous section would appear to be seriously under threat once words with closed initial pre-stress syllables like *armada* [ɑrˈmaːda] 'id.', are considered. If the attested candidate a. in Tableau (34) is disregarded for the moment, high ranking NOCLASH would incorrectly characterize *[ˈɑrmaˌdaː], candidate e., as the optimal form. Candidate b. violates NOCLASH, and candidate c. violates NONFIN. The choice between candidates d. and e. would be decided by WSP/SWP, which will not tolerate an unfooted bimoraic syllable. Importantly, in order to characterize the attested candidate a. as optimal, we must remove the foot from the initial syllable, so as to satisfy NOCLASH, and declare it monomoraic, so as to satisfy WSP/SWP.[x]

(34) ɑrmada	NoClash	NonFin	WSP/SWP	F'Right
☞ a. µ ɑr.ˈ(maː.da)				
b. (ɑr).ˈ(maː.da)	*!			
c. (ɑr.ma).ˈ(daː)		*!		
d. µµ ɑr.ˈ(maː.da)			*!	
e. ˈ(ɑr.ma)(daː)				!*

The inevitable conclusion that closed word-initial pre-stress syllables are monomoraic in Dutch is supported by three independent arguments. The first is based on duration measurements of such syllables. The best comparison we can make is with the first syllable of a word-initial weak foot. If, for example, the duration of [kɑn] in *cantorij* [ˌkɑntoˈrɛi] 'church choir'[xi] were to be shorter than that of [kɑn] in *kantoren* [kɑnˈtoːrən], this would be strong evidence that *kantoren* has an unfooted first syllable, for if it were footed, it would either have to be equal in duration to the first syllable of *cantorij*, or, in view of the fact that there are widespread tendencies to shorten the foot head as more syllables occur in the foot, longer. In a production experiment with four speakers, it was consistently the case that the pre-stress syllable was shorter than the segmentally identical head of a disyllabic foot before the main stress (Hofhuis, in preparation), which is strong evidence that closed pre-stress syllables are not footed. The second argument was presented in Gussenhoven (1993) and concerns the fact that the Dutch intonational pattern known as the ‘chanted call’, which potentially produces a new pitch level on every post-nuclear foot, systematically fails to produce such a pitch level on word-initial pre-stress syllables, whether closed or open, but may produce one on (binary) feet before the word stress. This is again consistent with the assumption that pre-stress syllables are unfooted. The third argument is distributional, and directly supports the monomoraic status of these syllables. Monomoraicity predicts that one type of segment should be systematically excluded, *viz*. the ‘marginal’ long vowels (cf. Table I, third column). Rhymes consisting of strings of different segments can be accommodated, however marked multiple association of segments with a single mora may be, but the combination of a single mora and a long vowel amounts to a contradiction in terms. Interestingly, while words like *crêmerie* [ˌkrɛː.mə.ˈri] ‘creamery’ can exist, in which [ɛː] occurs in a foot head, words like *[ɛː.ˈtɑp.pə] are impossible (cf. *étappe* [e.ˈtɑp.pə] ‘leg (sport)’, *pneumatisch* [pnœy.ˈmaː.tis] ‘pneumatic’). In conclusion, not only open, but also closed word-initial pre-stress syllables are monomoraic and unfooted, as argued in Gussenhoven (1993), which explains the fact that candidate a. in Tableau (34) is optimal.

5.1 Accounting for monomoraic closed syllables

If closed word-initial pre-stress syllables are monomoraic, WEIGHT-BY-POSITION (WbP), the constraint that requires coda consonants to project a mora, must not be operative in that syllable. In fact, to the left of the main stress there is little or no evidence for the working of WbP at all (cf. Booij 1995:106, Zonneveld et al. 1999:504). Indeed, van der Hulst & Kooij (1992) proposed that main stress in Dutch results from quantity-sensitive footing from the right, but that the rest of the word is subsequently footed quantity-insensitively from the left[xii]. The weightlessness of syllables before the word stress can be observed in words that contain a string of three syllables of which the first is open and the second closed. If the second syllable attracted stress, the three-syllable stretch would be realized as an unfooted syllable followed by a binary foot. The words in (35) belie that expectation: the secondary stress is on the first syllable[xiii].

(35) ˌ*aristo*ˈ*cratisch* ‘aristocratic’, ˌ*decompo*ˈ*sitie* ‘decomposition’, ˌ*enunci*ˈ*atie* ‘enunciation’, ˌ*evange*ˈ*list* ‘id.’, ˌ*emanci*ˈ*patie* ‘emancipation’, ˌ*identi*ˈ*teit*, ‘identity’, ˌ*paterna*ˈ*listisch* ‘paternalistic’, ˌ*potenti*ˈ*eel* ‘potential’, ˌ*protestan*ˈ*tisme* ‘protestantism’, ˌ*tubercu*ˈ*losis* ‘id.’

Evidently, quantity-sensitivity only obtains in the stretch from the main stress to the word end. Constraint WbP’(36) expresses this.

(36) WbP’: From the main stress onward, a coda consonant projects a mora

The pattern illustrated in (35) suggests that Dutch ranks ALL-FT-LEFT (37) high, which constraint imposes a violation for every syllable by which the left edge of any foot fails to coincide with the left edge of the word. With PARSE-σ (38), which requires that syllables be parsed into feet, ranked above ALL-FT-LEFT, exhaustive footing is achieved (Prince & Smolensky 1993)[xiv]. Tableau (39) shows this for *enunciatie.* The tableau dispenses with NOCLASH, F’RIGHT, SHSP and NONFIN, which all relevant candidates satisfy: the point is that the low ranking of generic WbP allows the second syllable to escape the censure of WSP/SWP, which, had it been bimoraic, would have had to be a foot head, causing candidate d. to be the most harmonic. As it is, the competition is decided by ALL-FT-LEFT, which the winning candidate a. best-satisfies, and the fact that the syllable [nʏn] is in a weak position and therefore violates WbP is no longer relevant to the outcome.

(37) ALL-FT-LEFT, or Align(Ft,Lt;Pwd,Lt): The left edge of every foot coincides with the left edge of the Pword

(38) PARSE-σ: Syllables are parsed into feet

(39) enʏnsiasi	FOOTBIN	WbP’	WSP/SWP	PARSE-σ	ALL-FT-LEFT	WbP
☞a. (eː.nʏn).si.ˈ(aː.si)				*	***	*
b. (eː.nʏn.si).ˈ(aː.si)	*!				***	*
c. e.nʏn.si.ˈ(aː.si)				**!*	***	*
d. e(nʏn.si).ˈ(aː.si)				*	***!*	

6.0 Conclusion

We have presented a consistent and coherent account of the duration of the vowels of Dutch, the moraic structure of its syllables, and its foot structure. Unlike what has generally been assumed, Dutch is an unexceptional ‘Type B’ language: truly long vowels and diphthongs (cf. columns 3 and 4 in Table I, p. 2) attract stress in the same way that closed syllables do. The reason why the language has been characterized as atypically requiring long vowels to be light and closed syllables to be heavy is that earlier researchers failed to accommodate the fact that the long vowels concerned only acquire bimoraicity (and length) as a result of their being in a stressed location, as determined by the regular foot structure of Dutch. By attributing their length to the working of STRESS-TO-WEIGHT, a phonetically realistic representation of vowel quantity has become possible. Moreover, there has been no need to represent [i,y,u], which are short even in stressed positions, as bimoraic, either underlyingly or on the surface (unless they are long, when occurring before [r] in the same foot).

This renders the solutions to the special status of quantity-sensitivity in Dutch provided by Lahiri & Koreman (separate representation of weight and length) and Kager (counting segments in the rhyme rather than moras) unnecessary. Our solution confirms the representation proposed by van Oostendorp (1995): the difference between [ɑ] and [aː], for instance, should be captured by including [lax] in the representation of the former vowel, with quantity is not present in underlying representations. However, it disagrees with van Oostendorp’s analysis in requiring quantity, i.e. moraic structure, to present in the surface representation, a position enforced by the fact that quantity differences are in part morphologically determined.

Exceptionally long lax vowels (cf. column 3 in Table 1) are accounted for by lexical specification of bimoraicity, which is respected due to the high ranking of FAITHMORA. Interestingly, as pointed out by Sharon Inkelas, this analysis predicts that there are no exceptionally short tense vowels (other than [i,y.u]): marking [a] as monomoraic will not prevent this vowel from being long in stressed positions, due to SWP/WSP.

The relevance of moraic structure was further underscored by the foot structure of the word before the main stress foot, where crucially WEIGHT-BY-POSITION must be suspended. Failing to do so predicts incorrect main stress in words like *ar*ˈ*mada*, which contain a closed word-initial pre-stress syllable. It is interactions like these that show that prosodic analyses of isolated aspects of a language (*sc*. main stress), especially if these analyses take liberties with the facts relating to other aspects (*sc*. secondary stress, vowel duration, vowel reduction), should be presented with great reservation.[xv]

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[i] Separate representation of weight and quantity may well be required in other languages on other grounds. The point here is that Dutch does not provide evidence for this separation.

[ii] The marginal nasal vowels (third column) are generally given without the length mark, but as Ton Broeders pointed out to me, these vowels are in fact long.

[iii] Because Rietveld at al. used reiterant speech containing the two vowels CV syllables, differences in syllable structure are ignored.

[iv] *Pace* Prince (1990), who argues that SWP does not exist, and that the tendency is for the heads of trochees to shorten, as in Hayes 1987. However, Prince admits that what looks like the effect of SWP may be seen in languages with dynamic stress. It should be pointed out that Dutch *also* has Trochaic Shortening, though it is variable and confined to disyllabic feet to the left of the main stress, as in [ˌpo(ː)liˈtik] or substandardly [ˌpɔləˈtik] 'politics'. René Kager points out that an effect similar to SWP is obtained by HNUC as presented in a handout to his Metrical Phonology class at the University of Utrecht of 29 November 1996: 'The best main stress is the heaviest syllable'. As in van Oostendorp (1997) he assumes that length is coded by an underlying tenseness feature, and HNUC is held responsible for the bimoraicity of main stressed vowels. The analysis is unrelated, however, to the durational distinction between nonhigh and high tense vowels. His restriction to main stress may be due to the existence of (variable) Trochaic Shortening mentioned above. However, this process should not be equated with the categorical occurrence of short vowels in unfooted syllables and in weak syllables.

[v] Trommelen and Zonneveld (1989) assume that [ɛː] is the surface form of underlying [ɛi] before [r], observing that the latter combination does not occur and that all occurrences of [ɛː] before a full-voweled syllable precede [r]. However, there are counterexamples in both directions: *theta* [ˈtɛːta] 'id.' and *Teixeira(de Mattos)* [tɛkˈsɛira] (proper name).

[vi] van Oostendorp also makes the complementary assumption that vowels that are not lax, i.e. our 'long' tense vowels, have no coda, in spite of the fact that they apparently do (e.g. *laat* 'late'). This assumption not made here.

[vii] Zonneveld et al. (1999:500) make the notion of such a phonetic implementation rule explicit, but reject the analysis, and go on to defend the solution presented in Lahiri & Koreman (1988)

[viii] The biblical name is often pronounced [aˈaːrɔn], as pointed out by Marieke Polinder.

[ix] Both Nouveau and van Oostendorp have a constraint that requires the main stress to be on the last syllable of the word, while the present analysis assumes this constraint aligns the main stressed foot with the right word edge. No empirical differences result form this difference in interpretation.

[x] As is well-known, in most standard varieties of English, a closed word-initial pre-stress syllable, if it does not represent a Latinate prefix, is not in fact an appendix, but a foot head (Chomsky & Halle 1968). Compare the weak initial syllables in *equipment*, *excell* with the footed initial syllable in *anthology*, or *cadet*, *contain* with *canteen.* In Dutch all pre-stress initial syllables, whether closed or open and whether or not prefix, are unfooted (Gussenhoven 1993). German agrees with Dutch in making all such syllables footless (Féry, to appear).

[xi] This word has a suffixal [ɛi], which attracts main stress, cf. simplex [ˈsɛldəˌrɛi] 'celery', which has the regular pattern of words with final heavy and penultimate light syllables (cf. section 3).

[xii] The notion of different directions for main stress assignment and secondary stress assignment already occurs in Booij (1983) with reference to Kenneth Pike's work on Auca (without differentiation for quantity-sensitivity).

xiii There are words like this which, in addition to the pattern exemplified in (35), may alternatively be pronounced with secondary stress on the second, closed syllable *karakteriˈstiek* ‘characteristic’, *gerontoloˈgie* ‘gerontologie’, *appendiˈcitis* ‘id.’, *electriciˈteit* ‘electricity’, *amontiˈllado* ‘id.’. A case for quantity-sensitivity cannot easily be made on the basis of these words, the more so since, as pointed out by Booij (1995:106), there are words like *piraterij* [piˌraːtəˈrɛi], which show that a light second syllable may have secondary stress. That example also shows that the situation is more complex, since the reason for the location of the secondary stress on the second syllable in this word would seem to be that [a] is opener, more sonorous, than [i]; and as pointed out by Haike Jacobs, the word *caleidoscoop* [kaˌlɛidəsˈkoːp] ‘kaleidoscope’ illustrates that diphthongs can attract the foot in competition with [a] (cf. variable *amontiˈllado*).

xiv Words with more that two feet, like *minimalisatie* (cf. (2)) are rare in Dutch, but the fact that in careful pronunciation the third and fourth syllables are pronounced [maːli], not *[mali], shows that we need a constraint aligning Ft with ω, not a constraint aligning ω with Ft.

xv Many descriptions restrict themselves to the location of the main stress. Thus, Nouveau (1994: 192, 198) leaves the final syllable of *Amanda* [aˈmɑnda] unfooted, just as the final syllable in a case like *Canada* [ˈkaːnaˌdaː] (an exceptional pattern to be accounted for by prespecification of a foot, cf van Oostendorp 1997), analysing them as a(mɑ́n)da and (kána)da, respectively; van Oostendorp (1997) additionally leaves the foot structure to the left of the main stress unanalysed and untranscribed.