

THE PROSODIC WORD: AN ENDLESS DOMAIN?

*Karijn Helsloot**

Abstract

Recently, constraints on the size of metrical domains receive much attention from phonologists. Proposals have been made regarding the minimal and maximal size of the syllable and the foot, as well as regarding the minimal size of the prosodic word. Here, we center on the maximal size of the prosodic word, as it occurs in Italian. Firstly, non-phonetic facts will be presented which argue in favor of a prosodic word maximality constraint. Secondly, we focus on phonetic correlates of primary word stress and secondary word stress in Italian. Thirdly, duration measurements as well as the results of a pilot perception test will be presented. Although these tests sometimes give rise to highly diverging results, evidence is provided in support of a two-foot maximum on prosodic words.

1. Introduction

From the late seventies on, metrical/prosodic phonology developed the so-called prosodic hierarchy which formalizes how phonological domains are ordered with respect to one another. Among the individualized domains are the syllable (σ), the foot (Σ), the prosodic word (ω), the phonological phrase (φ), and the intonation phrase (I). Syllables are parsed into feet, feet into words, words into phonological phrases, and phonological phrases into intonation phrases (cf. Liberman & Prince 1977, Selkirk 1980, 1986, Nespor & Vogel 1986). The hierarchy is generally argued to fall apart into two subdomains, that is, a metrical and a non-metrical one. The boundary falls between the level of the foot and the level of the prosodic word (cf. Inkelas 1989, McCarthy & Prince 1993b). Syllables and feet are metrically organized, but the prosodic word and the higher ordered domains are not. To exemplify this point, we focus on the foot and the prosodic word. The foot is said to be metrically constrained as it dominates minimally two and maximally three syllables (cf. Prince 1980, 1983, Hayes 1980, 1991, McCarthy & Prince 1986, 1990, 1993a, Kager 1989).¹ The prosodic word, in contrast, is seen as a domain constrained by a minimal size (corresponding to the basic foot structure of a language), but not by a maximal size: "There is no theory placing comparable limits on the expansion of Prosodic Word, and indeed there could not be, if

* Department of Italian Literature and Linguistics, University of Amsterdam, Holland Institute of Generative Linguistics.

¹ The discussion concerning foot inventory has been sharpened recently: only binary branching feet exist; ternary branching feet either do not exist at all, or must be considered to constitute expansions of binary branching feet (cf. Kager 1993, McCarthy & Prince 1993b, Prince & Smolensky 1993). To avoid an abundance of theoretical complexities, we assume that Italian feet can be binary as well as ternary branching in the present work.

only because there is no upper bound on the length of a Prosodic Word" (McCarthy & Prince, 1993b:5). Contrary to this claim, it is my intention here to provide evidence that indeed there is an upper bound on the length of the prosodic word. More specifically, I will argue that the prosodic word, just as the foot, is a metrically constrained domain. The claims that will be made originate from a statistical analysis of Italian free verse data, and as such refer crucially to Italian word structures. The verse data comprises the poetry of Giuseppe Ungaretti (1888-1970) and of Eugenio Montale (1896-1981) (see Helsloot, in preparation).

Almost 5,000 lines of verse were parsed into phonological phrases. The parsing has been executed by means of the syntax-based definition of φ -formation provided by Nespor & Vogel (1986:168). Although this definition is based on the assumption that syntactic structure determines the prosodic output, it emerged from the analysis that the φ is a genuine metrical domain. That is, the phonological phrase appeared to be a domain with a minimal as well as a maximal size, ranging from one to three feet (see Helsloot 1993ab, in preparation). Considering the prosodic hierarchy, according to which the level of the φ dominates the level of the ω , we thus expect that ω 's are also subject to a constraint on maximality. More concretely, instead of an n-ary branching tree representation of the prosodic hierarchy, as given in (1), the results of the parsing argue in favor of a binary branching representation, as given in (2).

(1) n-ary representation (cf. Nespor & Vogel 1986):



(2) binary representation:



The representations in (2) are valid for Italian: φ 's and ω 's are righthanded, which means that the rightmost ω and the rightmost Σ are the most prominent in their domain.

In section 2, morphological as well as statistical facts will be presented which strengthen the need to formulate a constraint on ω -maximality. In section 3, we focus on the phonetic correlates attributed to levels of word stress in Italian, and in section 4, these correlates will be examined on the basis of a set of test sentences including 'oversized' words. The conclusions are discussed in section 5.

2. Word Maximality in Italian

In light of the morphology-phonology interface, we assume that lexical words differ from grammatical words insofar as the former are always lexically stressed, while the latter are not. Here, we refer only to the class of lexical words. Underived lexical words in Italian are prosodically characterized by a maximal size of two feet (cf. Vogel & Scalise, 1982):²

² Prosodic constraints on the size of morphological categories occur systematically in a variety of languages. See Kager 1993, in preparation.

- (3) underived words $\approx \Sigma\Sigma$ (maximal)
 a. [tèmpera]Σ[túra]Σ' 'temperature'
 b. [ìnte]Σ[résse]Σ' 'interest'

The head-foot of the word is marked Σ', the dependent-foot Σ. The head syllable of Σ' receives the diacritic ´, the head syllable of Σ the diacritic ` . The fact that underived words in Italian do not exceed an upper bound of two feet can be put forward as an argument in favor of maximality constraints on prosodic structure. Derived words, however, may give rise to a metrical representation of more than two feet, as is exemplified in (4).

- (4) a. [ràppre]Σ[sènta]Σ[tìva]Σ[ménte]Σ' 'representatively'
 b. [rèla]Σ[tìviz]Σ[záre]Σ' 'relativize'
 c. [àltera]Σ[bìli]Σ[tá]Σ' 'alterability'

The point we want to address here concerns the actual degree of stress associated with the various syllables. More concretely, the question is whether all secondary stressed syllables surface with identical degrees of prominence. Or, vice versa, whether we need a more subtle discrimination, considering the 'supramaximal' size of the three and four foot words in (4) with respect to the two-foot maximum of underived words.

The literature on secondary stress in Italian is rather vast, but judgments concerning stress location as well as degree of prominence are far from homogeneous (cf. Malagoli 1947, Camilli 1965, Agard & Di Pietro 1965, Hall 1971, Muljačić 1972, Bertinetto 1976, Vogel & Scalise 1982). Secondary stress location appears to be sensitive to the regional background of speakers, the familiarity of a word, the morphological composition, as well as to the phrasal context of the word (cf. Vogel & Scalise 1982). Regarding degree of prominence, attention has been paid to primary stressed versus unstressed syllables (cf. Bertinetto 1976, 1981, Marotta 1985), but I am unaware of any analysis which deals with variation of prominence among secondary stressed syllables.

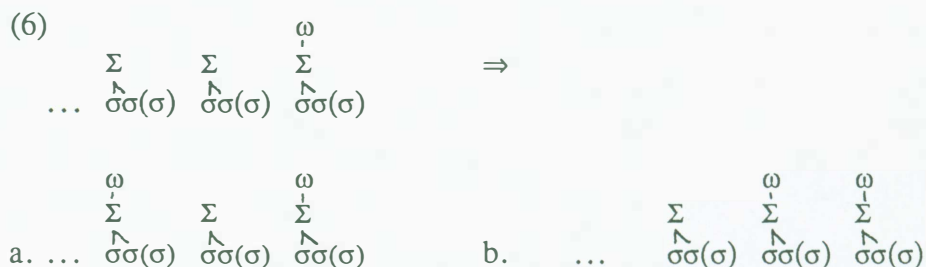
Besides the morpho-phonological distinction between underived words on the one hand, and derived words on the other, examination of frequency distributions may also shed light on constraints on prosodic structure. We focus here on the frequency distribution of 'oversized' derived words in the free verse data. The database contains about 15,000 lexical words. Only nine of these 15,000 words require or allow a three-foot parsing. One of them is necessarily parsed into three feet, the other eight can also be parsed into two feet. Consider the examples in (5). (5a) and (5b) allow a three-foot as well as a two-foot parsing, but (5c) allows only a three-foot parsing.

- (5) a. [àccom]Σ[pàgne]Σ[rá]Σ' ac[còm]pagnè]Σ[rá]Σ³ '(he)will
 accompany'
 b. [ìmmo]Σ[bìli]Σ[tá]Σ' im[mò]bili]Σ[tá]Σ' 'immobility'
 c. [ìnconsa]Σ[pèvo]Σ[lézza]Σ' in[cò]nsa]Σ[pèvo]Σ[lézza]Σ' 'unconsciousness'

³ Following recent proposals, we place a ban on nonbranching unstressed feet (cf. Prince 1980, McCarthy & Prince 1986, 1990, 1993ab, Kager 1992abc, Hayes 1991). Hence, the initial syllables of the three right-listed words are left unparsed; the word final syllables, in contrast, are stress-bearing, and thus may form a foot on their own. At the surface, however, unparsed syllables will be licensed by a superordinate node. For example, the unfooted initial syllables of the words in (5) may be parsed into a preceding foot at the phrasal level (cf. Helsloot 1993, in preparation).

Lexical words which require a parsing into more than three feet are totally absent from the corpus.

In sum, the above observations lead to the hypothesis that prosodic words are constrained by a structural maximum of two feet. Consequently, whenever derivation gives rise to a lexical output of more than two feet, we expect two instead of one syllable to surface as stress-bearing. This hypothesis is visualized by the representations in (6): the lexical output ...ΣΣΣ' surfaces as either (6a) or (6b).



The next section introduces the phonetic correlates of primary and secondary word stress in Italian.

3. Phonetic Correlates of Italian Prosodic Words

Duration is considered to be the most fundamental phonetic correlate of primary stress in Italian (cf. Fava & Magno Caldognetto 1976, Bertinetto 1976, 1981, Vogel 1982, Marotta 1985, Nespor & Vogel 1986). The strong hypothesis says that only vowels in open non-final syllables undergo lengthening if stress-bearing (cf. Vogel 1982, Nespor & Vogel 1986). Hence, *méla* 'apple' becomes *me:la*, and *árabo* 'arab' becomes *a:rabo*, but the final vowel of *cittá* 'city' remains short, as well as the vowel *i* in *mírto* 'myrtle'. The weak hypothesis is not characterized by such outspoken conditions on syllable structure and syllable position but recognizes a gradient scale between short vowels on the one extreme, and long vowels on the other (cf. Bertinetto 1976, Fava & Magno Caldognetto 1976, Marotta 1985). Thus, vowels in stressed open syllables in final position (like *cittá*) are generally longer than vowels in unstressed open syllables, but they are not as long as vowels in stressed open syllables in non-final position (like *méla*). Similarly, stressed closed syllables with a coronal in coda position (like *mírto*) surface with longer vowels than stressed closed syllables with an obstruent in coda position (like *cóppia* 'couple') (cf. Fava & Magno Caldognetto 1976). Finally, vowel lengthening is somewhat less observed in stressed antepenults (like *arabo*) than in stressed penults (like *méla*) (cf. Marotta 1985). From these results we may conclude that vowel lengthening is a ω -head related phenomenon, whose absolute value may be affected by internal syllable structure as well as by internal foot structure. In contrast to the strong hypothesis, however, we claim that syllable structure as well as foot structure are not able to block vowel lengthening.

In addition to duration, correlates like fundamental frequency and intensity presumably contribute to the realization of stress prominence, but the facts are rather inconsistent (cf. Bertinetto 1976, Fava & Magno Caldognetto 1976).⁴ With respect to secondary stress, it appears that this type of stress is perceptually true in the sense that native speakers have intuitions about its presence as well as its location, but intrinsic

⁴ Italian speakers are able to distinguish among minimal pairs like *áncora* 'anchor' - *ancóra* 'still'. If the main stress on the first syllable in *áncora* does not cause any lengthening, as argued by the strong hypothesis, some other correlate must be available to produce and perceive the intended stress pattern.

correlates have not been identified until now. To exemplify these findings I report some data here collected by Bertinetto (1976). A comparison of vowel durations in two-foot words evidences that only primary stressed vowels are lengthened. The tables below reproduce the durations of the vowels in the word *pomodoro*, which is footed as [pòmo]Σ[dóro]Σ'. Table 1 refers to isolated pronunciations, Table 2 to contextual pronunciations.

Table 1. Vowel durations in msec. of *pomodoro* 'tomato' (from Bertinetto 1976:218)

	<i>po > o</i>	<i>mo > o</i>	<i>dó > o</i>	<i>ro > o</i>
1.	75	75	210	65
2.	100	100	235	125
3.	60	85	280	135
4.	65	90	275	90

Table 2. Vowel durations in msec. of *pomodoro* in context *Io dico pomodoro* 'I say tomato' (from Bertinetto 1976:218)

	<i>po > o</i>	<i>mo > o</i>	<i>dó > o</i>	<i>ro > o</i>
1.	60	70	135	55
2.	60	85	185	105
3.	50	80	250	140
4.	65	95	260	65

The vowel *o* of the primary stressed syllable *dó* is two to three times longer than the other *o*'s in the word. Considering the first foot, i.e., [pòmo]Σ, we do not observe considerable durational differences between the first and the second vowel. More than that, the *o* of *po* is more often shorter than longer than the *o* of *mo*. Bertinetto (1976:210) attributes this fact to the pre-stressed position of *mo*. Moreover, it appears that syllables immediately preceding main stressed syllables rather consistently surface as longer than unstressed syllables in other positions.

In Table 3 and 4 vowel durations are given of *ripeteranno*, i.e., of a word with main word stress on a closed non-final syllable. The tables show that the *a* of the stressed syllable *rán* is about twice as long as all other vowels in the word.

Table 3. Vowel durations in msec. of *ripeteranno* '(they) will repeat' (from Bertinetto 1976:228)

	<i>ri > i</i>	<i>pe > e</i>	<i>te > e</i>	<i>rán > a</i>	<i>no > o</i>
1.	80	60	95	170	65
2.	75	95	85	185	95
3.	60	60	90	205	55
4.	50	50	95	190	60

Table 4. Vowel durations in msec. of *ripeteranno* in context *Luigi e Marco ripeteranno la prova* 'Luigi and Marco will repeat the test' (from Bertinetto 1976:228)

	<i>ri > i</i>	<i>pe > e</i>	<i>te > e</i>	<i>rán > a</i>	<i>no > o</i>
1.	80	50	70	110	65
2.	50	65	65	120	55
3.	40	60	65	165	50
4.	55	45	55	100	55

Again, we do not observe significant duration differences between the vowels in the first dependent foot of the word, i.e., in *ripete*. *Ripeteranno* can be parsed either as [rìpete]Σ[ránno]Σ' or as ri[pète]Σ[ránno]Σ'. On the basis of the above data it is not possible to decide whether the first or the latter parsing has been assigned.

Table 5 and 6 represent vowel durations regarding a word with main stress on the final syllable. Pronounced in isolation, the stress-bearing vowel is approximately twice as long as the other vowels in the word (see Table 5). In context, this length difference has disappeared with respect to informant 1.; the other informants, however, still give rise to considerably length differences between the final stressed vowel and the preceding unstressed ones (see Table 6).

Table 5. Vowel durations in msec. of *trepidò* '(he) trembled' (from Bertinetto 1976:230)

	<i>tre > e</i>	<i>pi > i</i>	<i>dó > o</i>
1.	85	65	125
2.	60	70	180
3.	70	55	175
4.	65	65	210

Table 6. Vowel durations in msec. of *trepidò* in context *La donna trepidò per suo figlio* 'The woman trembled for her son' (from Bertinetto 1976:230)

	<i>tre > e</i>	<i>pi > i</i>	<i>dó > o</i>
1.	80	50	80
2.	60	65	110
3.	50	50	100
4.	50	65	85

As in the previous cases, dependent foot structure appears not to be accompanied by vowel lengthening. Only the head syllable of the head foot surfaces with a lengthened vowel: [trèpi]Σ[dó:]Σ'.

To summarize, the above reported data from Bertinetto (1976) indicate that primary stressed syllables are phonetically realized with long vowels. Vowel lengthening in head syllables of dependent feet (i.e., in secondary stressed syllables) is unattested. These results fit well in the observed relation between duration and iambic patterns of rhythm, on the one hand, and between loudness and pitch and trochaic patterns of rhythm, on the other hand (cf. Allen 1974). Since Italian gives rise to a trochaic pattern at the level of the foot, we expect that duration is phonetically subordinate at this level. At the word- and phrase-level, however, Italian gives rise to an iambic pattern, with the

most prominent syllable near the right edge of these domains. Thus, at these levels we indeed do expect duration to constitute a main phonetic correlate. Let us pass on now to our main objective, i.e., to examine words which pattern with more than two feet.

4. Vowel Lengthening and Prosodic Word Maximality

Sentences have been constructed in which three-foot words occur. To avoid interpretational difficulties, the 'oversized' lexical forms occurring in the verse data were only partially incorporated into the test sentences. The sentences have been submitted to five Standard Italian speakers, coming from different parts of Italy. The only male informant, A, comes from South-Calabria; the informants B and C come from Rome, D from Palermo, and E from Vicenza. The informants varied in age between the 20 and 30 years. After practice reading the sentences, the subjects were asked to read the sentences aloud. The rate of speech with which the sentences are pronounced varies from normal to fast. The recordings, digitized with a frequency of 10 kHz on a μ VaxII computer (12 bit resolution of D-A Converter), provided the basis for measurements of vowel durations. Duration has been measured by means of the program SESAM. The analysis is intended to verify the hypothesis on ω maximality. More concretely, if the prosodic word is constrained by a maximal size of two feet, we expect to find vowel lengthening effects in syllables other than the lexically stressed one whenever a derivation produces an output of more than two feet. The analysis is comparative of nature: 1) durations of target vowels are compared with durations of vowels occurring in the same phrase, and 2) duration distributions in one speaker are compared with duration distributions in another speaker. Only relative duration differences are taken in consideration.

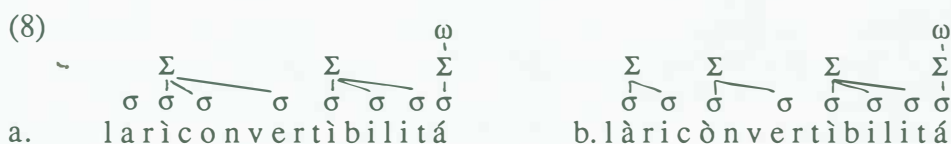
In addition to these duration measurements, a perception test has been carried out. The test was submitted to two Italian native speakers (IS1 and IS2) and to one Dutch native speaker (DS) unacquainted with Italian. IS1 comes from Sardinia and IS2 from Trento. The listeners were asked to indicate whether or not they could hear one or more stressed syllables in the target string with the exclusion of the lexically assigned main stress. For each target string a series of options were presented, one of which had to be marked as corresponding to the specific realization. Perceived parsings divergent from one of the presented options were added to the list. To avoid interference deriving from the graphic representation normal interspacings were deleted. Each realization of a sentence was first presented two times. Subsequently, subjects were allowed to listen as often as they wished.

The italicized segments in (7) form the target string of the first test sentence.

- (7) *La riconvertibilit  del programma funziona male.*
'The reconvertibility of the program works badly.'

Foot-parsing of the target string may give rise to a variety of metrical representations. In (8), the two most natural parsings are presented.⁵ Lexical word-stress is fixed on the final syllable of the noun.

⁵ Other parsings are theoretically also possible, like [l  ri][c nverti][b li][t ] or [l  ricon][v rti][b li][t ]. Here, we will not deal with the constraints determining which one of the parsings will be chosen.



According to the maximal- ω hypothesis, these three- or four-foot lexical inputs will surface with two main stresses, instead of one. In other words, we expect to find duration differences providing evidence in support of a representation in which at least one of the dependent feet in (8) are dominated by a prosodic word node. Such representations are given in (9). Duration measurements of the vowels are given in Table 7.

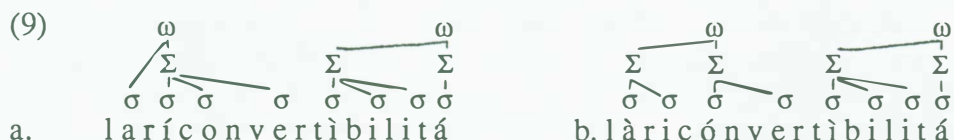


Table 7. Vowel durations in msec. of *la riconvertibilità* 'the reconvertibility' in context *La riconvertibilità del programma funziona male*.

	<i>la > a</i>	<i>ri > i</i>	<i>con > o</i>	<i>ver > e</i>	<i>ti > i</i>	<i>bi > i</i>	<i>li > i</i>	<i>tá > a</i>
A	75	60	51	45	35	?	?	63
B	71	36	25	38	15	14	26	51
C	63	75	42	34	41	21	32	66
D	62	44	31	47	17	22	65	72
E	56	20	54	46	15	18	40	68

In comparing the duration of the initial vowel *a* of *la* with the word final stressed *a* of *tá*, it appears that both vowels have more or less the same length. In effect, as we will see in short, in 20% of the cases (3:15) the listeners perceived the syllable *la* as stress-bearing. In comparing the durations of the vowels of the first, second and third syllable, i.e., of *la*, *ri* and *con*, it results that only informant C produced an *i* which is longer than the *a* of *la*. In addition, C produced a clear durational distinction between the second and the third vowel, i.e., the *i* of *ri* is almost twice as long as the *o* of *con*. These findings seem to indicate that the syllable *ri* surfaces as stressed. Now let us focus on Table 2 which presents the perception results with respect to input C.

Table 8. Perceived locations of postlexically assigned main stress with respect to input C.

	lariconvertibilita	lariconvertibilita	lariconvertibilita
DS			+
IS1	+		
IS2	+		

IS1 and IS2 perceived the second syllable *ri* as stress-bearing; DS the first syllable *la*. Hence, the metrical representations corresponding to these perceptions are (9a) above, for IS1 and IS2, and (10) below, for DS.



These perception results seem to suggest that active knowledge of Italian is at play here. After all, Italian speakers know that the first syllable *la* is a determiner, and that grammatical words like determiners are generally unstressed. The Dutch listener, in contrast, was scarcely or not affected at all by this linguistic knowledge. However, Table 3, representing the perceived parsings with respect to input A, shows that linguistic information has no overriding power. Here, IS2 perceives the determiner *la* as stress-bearing.

Table 9. Perceived locations of postlexically assigned main stress with respect to input A.

	lariconvertibilita	lariconvertibilita	lariconvertibilita
DS	+		
IS1		+	
IS2			+

As Table 9 shows, each listener perceived another syllable as stress-bearing regarding the same input A. Turning back to Table 7, we do not observe any considerable duration differences between the involved vowels in A. On the basis of this pilot study, however, it is not possible to establish why listeners have selected either one syllable or another as stress-bearing.

Let me now present the results of the perception test with respect to inputs B and E, and compare them with the produced durations. To start with B, the three listeners unanimously perceived the syllable *con* as stress-bearing:

Table 10. Perceived locations of postlexically assigned main stress with respect to input B.

	lariconvertibilita	lariconvertibilita	lariconvertibilita
DS		+	
IS1		+	
IS2		+	

On the basis of the duration measurements, however, there is no indication why *con* has been perceived as stress-bearing. More than that, the vowel *o* is shorter than any of its surrounding vowels (cf. 71:36:25:38 msec.). Consider Figure 1.

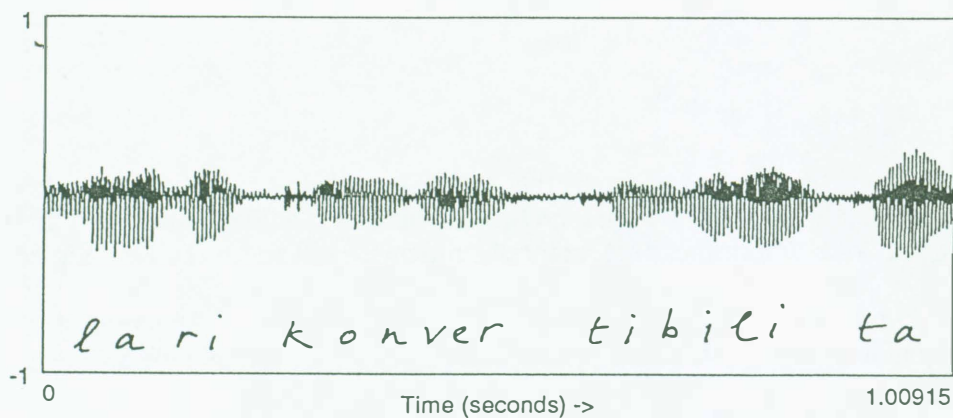


Fig. 1 Oscillogram of target string produced by informant B.

What remains to be checked is whether fundamental frequency has contributed positively regarding the actual perception.

To complicate the situation a bit more, consider Figure 2, which refers to the realization of informant E.

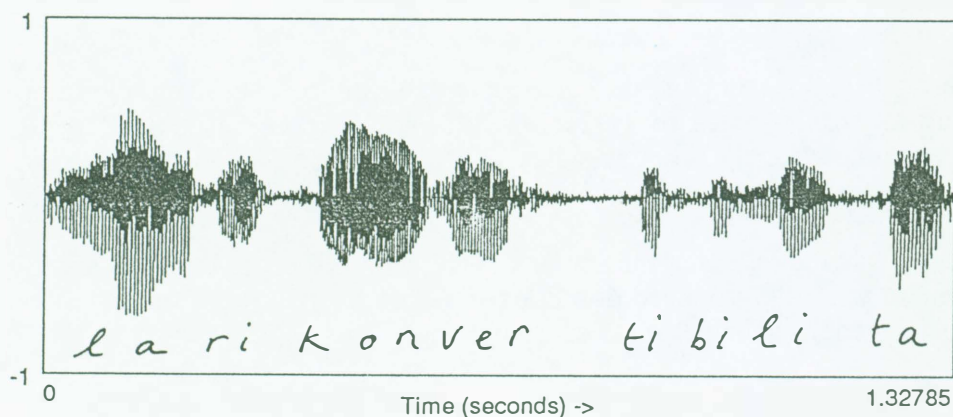


Fig. 2. Oscillogram of target string produced by informant E.

As results from Figure 2, as well as from the durations in Table 1, the first and third syllable, *la* and *con*, are considerably longer than the second syllable *ri*. However, both IS1 and IS2, perceive *ri* as the only stress-bearing syllable in addition to the main stressed syllable *ta*. Listener DS, however, perceived *la* as stress-bearing:

Table 11. Perceived locations of postlexically assigned main stress with respect to input E.

	lariconvertibilita	lariconvertibilita	lariconvertibilita
DS			+
IS1	+		
IS2	+		

To summarize, examination of the produced as well as perceived target string shows that duration is not an uncontroversial indicator acting in support of a constraint on ω -maximality. That is, until now the phonetic correlate typically attributed to main stress in Italian, i.e., vowel lengthening, cannot be identified as being of decisive importance with respect to stresses that are not lexically assigned. In support, however, of a

constraint on ω maximality is the fact that listeners indeed perceive another syllable as being stressed. More strongly, in addition to the lexically assigned word stress, they perceive in general only one syllable as stress-bearing. Hence, not all dependent-foot heads are perceived as being stressed, but only just one.

Before we continue to examine the next test sentence, it is appropriate to discuss here Nespor & Vogel's (1986) proposal regarding the prosodic status of prefixes in Italian. On the basis of the fact that the segmental process *Intervocalic s-Voicing* does not apply between a vowel-ending prefix and a following sV-initial stem, the authors argue that all vowel-ending prefixes in Italian necessarily constitute a prosodic word on their own (p. 129). Hence, according to this proposal, the prefix *ri-*, as it occurs in *ri-convertibilit *, always forms a proper ω , regardless of any constraint on ω maximality.⁶ As we just saw, however, the production as well as the perception data shed doubt on this special prosodic status of vowel-ending prefixes. The next sentences justify this doubt.⁷

In (11), we have two sentences which initiate with the vowel-ending prefix *pre-*.

(11)

a. *Prevedibilmente* non lo mangia.

'It is foreseeable that he will not eat it.'

b. *Prevedo* che domani torner .

'I foresee that he will come back tomorrow.'

The syllable *ve* constitutes the second syllable in both sentences. In (11b), *ve* has a lexically assigned word stress, and bears also phrasal stress; in (11a), *ve* lacks these stresses. The prefix *pre* may receive secondary stress (i.e., may constitute the head syllable of a dependent foot) in (11a), but will be stressless (i.e., constitutes the dependent syllable of a foot/word) in (11b). The corresponding lexical metrical representations are given in (12).

(12)



Let us consider now the durations of the vowels occurring in the target strings. Firstly, notice that both sentences contain exactly ten syllables, and that the overall durations of the sentences differ only slightly (see the final rows in Table 12 and 13). Hence, sentence structure factors influencing phonetic realization are minimized.

⁶ According to Nespor & Vogel (1986), the vowel-ending prefix constitutes a foot as well as a prosodic word on its own: $[[ri]\Sigma']_{\omega}[[conver][tibili][t ]\Sigma']_{\omega}$. This parsing differs crucially, however, from the parsing presented in (9a).

⁷ Various additional facts make ω -status assignment to vowel-ending prefixes extremely doubtful. Besides the asymmetric treatment between vowel-ending prefixes on the one hand, and consonant-ending prefixes on the other, prefixes in Italian have no intrinsic main stress, they do not automatically trigger vowel lengthening nor the consonant-doubling process *Raddoppiamento Sintattico* (cf. Hulsloot 1993a, in preparation).

Table 12. Vowel durations in msec. of *prevedibilmente* in context *Prevedibilmente non lo mangia*.

	<i>pre > e</i>	<i>ve > e</i>	<i>di > i</i>	<i>bil > i</i>	<i>men > e</i>	<i>te > e</i>	sent.ms.
A	70	30	29	41	60	42	1615
B	52	30	58	53	61	33	1765
C	49	29	55	44	61	27	1584
D	48	32	75	38	53	46	1811
E	55	24	27	47	75	27	1832

Table 13. Vowel durations in msec. of *prevedo che* in context *Prevedo che domani tornerà*.

	<i>pre > e</i>	<i>ve > e</i>	<i>ke > e</i>	sentencems.
A	36	85	29	1573
B	38	58	20	1335
C	29	60	23	1413
D	38	97	22	1681
E	37	113	23	1701

Regarding the vowel durations of the syllables *pre* and *ve*, it strikes that their relative durations are reversed in Table 12 in comparison to Table 13: *pre* is always longer than *ve* in Table 12, but always shorter in Table 13. If all vowel-ending prefixes in Italian constitute a ω , as proposed by Nespov & Vogel (1986), we should not find such divergent durational differences with respect to the syllable *pre*.

Concentrating now on the 'oversized' word *prevedibilmente*, on the basis of mere durational factors it is hard to decide whether or not the length of the *e* of *pre* results from a postlexically assigned stress. In fact, with the exception of A, the length of the *e* of *pre* and the length of the *i* of *bil* scarcely differ. However, it should be wrong to conclude that either both syllables are stressed, or both are unstressed. Conform the findings of Bertinetto 1976, the relative long duration of the *i* in *bil* might be due to its pre-stressed position.⁸ To determine whether one of the two dependent feet in (12a) surface as a prosodic word head, we focus now on the first syllable *pre* and the third syllable *di*. It strikes that the informants A and E give rise to productions in which the *i* is about half of the length of the *e*. This same pattern cannot be observed with respect to the inputs B, C and D. Neither is the reverse situation true, i.e., in B, C and D, the *e* is not about half of the length of the *i*: durational differences between the two vowels are far less perspicuous here. On the basis of these durational facts we suspect that the listeners perceived the inputs A and E as (13a), and the inputs B, C and D as (13b).

- (13)
- a. $\begin{array}{c} \omega \\ | \\ \Sigma \\ / \quad \backslash \\ \sigma \quad \sigma \end{array} \quad \begin{array}{c} \omega \\ | \\ \Sigma \\ / \quad \backslash \\ \sigma \quad \sigma \end{array} \quad \begin{array}{c} \omega \\ | \\ \Sigma \\ / \quad \backslash \\ \sigma \quad \sigma \end{array}$
prèvedìbilménte
- b. $\begin{array}{c} \omega \\ | \\ \Sigma \\ / \quad \backslash \\ \sigma \quad \sigma \end{array} \quad \begin{array}{c} \omega \\ | \\ \Sigma \\ / \quad \backslash \\ \sigma \quad \sigma \end{array} \quad \begin{array}{c} \omega \\ | \\ \Sigma \\ / \quad \backslash \\ \sigma \quad \sigma \end{array}$
prèvedìbilménte

⁸ Consider also the tendency observed in languages with left-headed or trochaic foot patterns that pre-stressed syllables do not undergo shortening. That is, such languages may give rise to anticipatory shortening but not to backward shortening (cf. Vayra, Fowler & Avesani 1987:267).

Table 14 and 15 present the actual results.

Table 14. Perceived locations of postlexically assigned main stress with respect to input A.

	prevedibilmente	prevedibilmente
DS		+
IS1		+
IS2		+

Table 15. Perceived locations of postlexically assigned main stress with respect to input E.

	prevedibilmente	prevedibilmente
DS	+	
IS1	+	
IS2		+

Contrary to what the duration measurements seem to suggest with respect to A, the three listeners perceived *di* and not *pre* as stress-bearing. Regarding input E, both DS and IS1 indeed did perceive the first syllable *pre* as stress-bearing, but IS2 did not so. Figure 3, referring to input E, shows that the first syllable *pre* is considerably longer than the third syllable *di*.

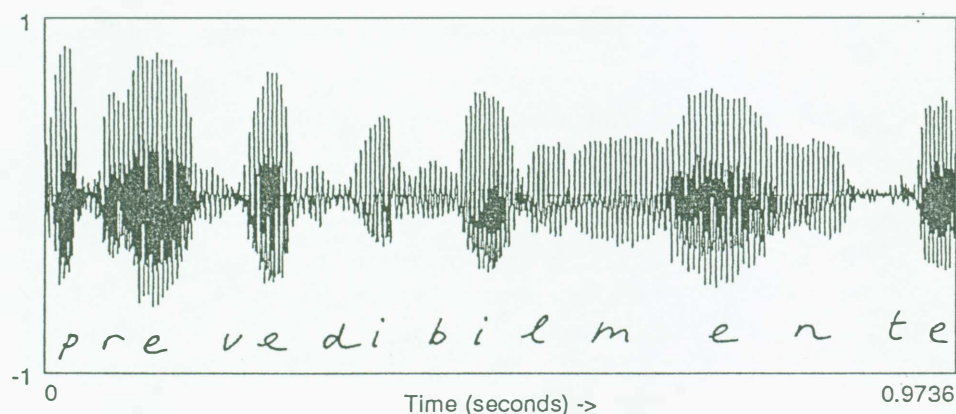


Fig. 3 Oscillogram of target string produced by informant E.

Figure 4, referring to input D, shows that now syllable *di* is relatively long in comparison to its surrounding *i*-syllables.

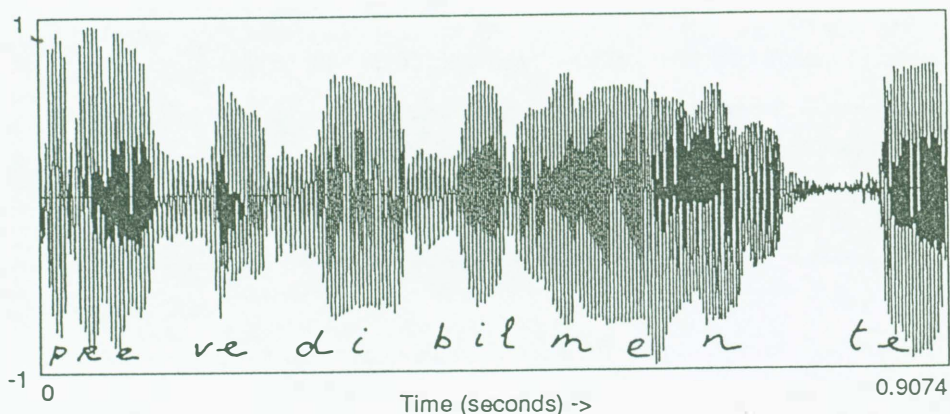


Fig. 4 Oscillogram of target string produced by informant D.

Again, the perception test shows that the listeners have diverging opinions with respect to which one of the syllables is stress-bearing. Moreover, IS1 even perceives the second syllable *ve* as being stressed. Consider Table 10.

Table 16. Perceived locations of postlexically assigned main stress with respect to input D.

	prevedibilmente	prevedibilmente	prevedibilmente
DS	+		
IS1			+
IS2		+	

Similar divergent opinions result also from the inputs B and C: either *pre* or *di* are perceived as stress-bearing.

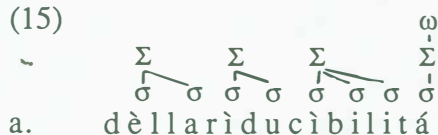
In sum, duration appears not to be the appropriate correlate by means of which postlexically assigned stresses are characterized. Whether another phonetic correlate contributes positively in the production, is a matter of further investigation. For the present discussion it counts that 1) the listeners perceive another syllable as stress-bearing, in addition to the lexically assigned word stress, and that 2) the listeners perceive precisely one other syllable as stress-bearing, in addition to the lexically assigned word stress. This latter fact indicates that not all heads of dependent feet are perceived as stress-bearing.

The final test sentence to be discussed here confirms these findings. Consider (14).

- (14) Stavamo parlando *della riducibilit * del fenonemo ai suoi minimi termini.
 'We were talking about the ultimate reducibility of the phenomenon.'

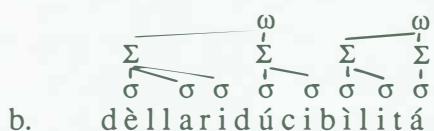
The target string *della riducibilit * can be metrically parsed as in (15). That is, there is one lexically assigned main stress, on the word final syllable *ta*, and there are three feet which are dependent on the head foot on their right.

(15)



The ω -maximality hypothesis states that lexical inputs like these give rise to phrasal outputs in which the second dependent foot behaves as a head foot:

(16)



Consider Table 17, presenting the durations of the vowels in the target string.

Table 17. Vowel durations in msec. of *della ridicibilità* in context *Stavamo parlando della ridicibilità del fenomeno ai suoi minimi termini*.

	<i>del>e</i>	<i>la>a</i>	<i>ri>i</i>	<i>du>u</i>	<i>ci>i</i>	<i>bi>i</i>	<i>li>i</i>	<i>tá>a</i>
A	39	101	28	64	24	\ 36	/	67
B	71	74	29	82	35	30	47	88
C	35	58	17	36	49	27	?	62
D	62	75	27	67	24	\ 52	/	83
E	40	79	29	65	12	\ 53	/	52

Again, the syllable *la* surfaces with a vowel which often is considerably longer than its surrounding vowels. Linguistically, however, there is no doubt concerning the unstressable status of this syllable: inflected prepositions, like *della* 'of the', have secondary stress on the first syllable, not on the second. Besides an intrinsic length property of the low vowel *a*, the morpheme boundary between the inflected preposition and the noun may be due to this sort of pre-boundary lengthening. Concentrating on the syllable *ri* and the adjacent syllable *du*, we observe that all informants give rise to an output in which the *u* is at least two times longer than the *i*. Consequently, we expect that *du* will be perceived as stress-bearing. Again, the perception test disturbs such a straightforward picture. Let us first take input B, where the *u* is almost three times longer than the *i* or *ri*. Notice, in addition, that only B has realized both the *bi* and *li*

syllables. The other informants realized these two syllables as a single syllable with the vowel often scarcely produced.⁹

Table 18. Perceived locations of postlexically assigned main stress with respect to input B.

	della ridicibilita	della ridicibilita	della ridicibilita	della ridicibilita
DS			+	
IS1				+
IS2	+			

Only DS perceives the syllable *du* as stress-bearing; IS2 perceives the first syllable *del* as well as the syllable *ci* as stress-bearing, while IS1 perceives *la* as the only stress-bearing syllable. Consider now input E. On the basis of duration measurements we expect that either *la* or *du* will be perceived as stress-bearing. The durations of the first five syllables are related to each other as 40:79:29:65:12, with the bold values corresponding to *la* and *du*, respectively.

Table 19. Perceived locations of postlexically assigned main stress with respect to input E.

	della ridicibilita	della ridicibilita	della ridicibilita	della ridicibilita
DS	+			
IS1	+			
IS2		+		

Remarkably, all three listeners perceive one of the short vowels as stress-bearing. DS and IS1 associate the stress with the first syllable *del* as well as with the fifth syllable *ci*, but IS2 with the third syllable *ri*.

In sum, while duration is the main phonetic correlate of lexically assigned word stress in Italian, postlexically assigned word stresses are not characterized by duration. Whether intensity or fundamental frequency contribute positively with respect to producing and perceiving postlexically assigned word stresses is a matter which deserves further investigation.

5. Conclusions

In the preceding sections, we tried to provide evidence in support of the hypothesis that prosodic words in Italian are constrained by a two-foot maximum. The formulation of the hypothesis evolved from a statistical analysis of Italian free verse data. Morphological structure as well as frequency distributions of words larger than two feet in the verse corpus additionally supported the hypothesis. The constraint on ω -maximality implies that lexical inputs overriding the two-foot maximum surface prosodically as if they contain two prosodic word heads instead of one. The perception test confirmed the hypothesis insofar as listeners perceived lexically unstressed syllables as being stress-bearing postlexically. The test indicated that we cannot attribute these stresses to the simple fact that the stress-bearing syllables constitute the

⁹ Vowel reduction is a typical phenomenon of stress-timed languages like English or Dutch, but not of syllable-timed ones, like Italian. See Den Os (1988) for a critical analysis with respect to the syllable-timed character of Italian.

head syllable of a dependent foot, since not all head syllables of a dependent foot were perceived as stress-bearing. The production tests, which centered on duration measurements of vowels, have shown that duration is not a fundamental property of stress-bearing dependent-foot heads. This in contrast with syllables that are lexically assigned as stress-bearing, hence constitute head-foot heads. The reason that duration does not seem to play a role with respect to postlexically assigned stresses, presumably derives from the fact that these postlexically assigned stresses always occur to the left of the lexically assigned stress. Since Italian is characterized by right-headed word domains and right-headed phrase domains, at these levels, the language gives rise to iambic patterns of rhythm. Iambic patterns are typically associated with durational distinctions. At the level of the foot, Italian appears to be left-headed, and thus gives rise to a trochaic pattern of rhythm. Trochaic patterns are typically associated with distinctions of loudness and pitch. We thus expect that in a sequence of two prosodic words, $\omega_1\omega_2$, ω_2 is characterized by duration and ω_1 by loudness and/or pitch. Additional investigation is required to confirm these complex relations between prosodic level on the one hand, and phonetic property on the other. The diverging opinions among the listeners regarding the location of the postlexically assigned stresses additionally underline the complex relationship between phonological representation and phonetic facts.

Acknowledgments

I am particularly grateful to Astrid van Wieringen from the Institute of Phonetic Sciences of the University of Amsterdam for her patience and kindness in teaching me to use the speech editing programs. I also wish to thank Louis Pols, René Kager, Els den Os and Roberto Bolognesi for general discussions and/or comments on previous versions of this work. Special thanks to the eight informants.

References

- Agard, F.B. & R.J. Di Pietro (1965): *The sounds of English and Italian*, Chicago-London.
- Allen, G.D. (1975): "Speech rhythm: Its relation to performance universals and articulatory timing", *Journal of Phonetics* 3:75-86.
- Bertinetto, P.M. (1976): "L'accento secondario nella fonologia italiana. Analisis teorica e sperimentale", *Studi di Fonetica e Fonologia*, 189-236, Roma, Bulzoni.
- Bertinetto, P.M. (1981): *Strutture Prosodiche dell'Italiano*, L'Accademia della Crusca, Firenze.
- Fava, E. & E. Magno Caldognetto (1976): "Studio sperimentale delle caratteristiche elettroacustiche delle vocali toniche e atone in bisillabi italiani", *Studi di Fonetica e Fonologia*:35-80. Roma, Bulzoni.
- Hall, R.A. (1971): *La struttura dell'italiano*, Roma.
- Hayes, B. (1991): *Metrical Stress Theory. Principles and case studies*, Ms., to be published by Chicago University Press.
- Helsloot, C.J. (1993a): "Phrasal Metrical Templates. An analysis based on Italian free verse", Ms., to appear in *Proceedings of HILP-1*, 1993, Leiden.
- Helsloot, C.J. (1993b): *De fonologische frase als metrisch templaar*, handout of talk presented at Department of General Linguistics, University of Amsterdam, September 1993.
- Helsloot, C.J. (in preparation): *Metrical Phrasal Phonology. A templatic theory based on Italian twentieth century poetry*, Ph.D. Thesis, University of Amsterdam, HIL.
- Inkelas, S. (1989): *Prosodic Constituency in the Lexicon*, Ph.D. Thesis, Stanford University.
- Kager, R. (1989): *A Metrical theory of Stress and Destressing in English and Dutch*. Ph.D. Thesis, Dordrecht:ICG.

- Kager, R. (1993): "On defining complex templates", Ms., to appear in *Proceedings of the Twelfth West Coast Conference on Formal Linguistics*.
- Kager, R. (in preparation): *Root Prosody and Templatic Complexity*, Ms., Utrecht University.
- Lieberman, M. & A. Prince (1977): "On stress and linguistic rhythm", *Linguistic Inquiry* 8: 249-336.
- Malagoli, G. (1947): *L'accentazione italiana*, Firenze.
- Marotta, G. (1985): *Modelli e misure ritmiche: la durata vocalica in italiano*, Zanichelli, Bologna.
- McCarthy, J. & A. Prince (1986): *Prosodic Morphology*, Ms.
- McCarthy, J. & A. Prince (1990): "Foot and word in prosodic morphology: The Arabic Broken Plural", *NLLT* 8:209-283.
- McCarthy, J. & A. Prince (1993a): *Prosodic Morphology I: constraint interaction and satisfaction*, Ms., University of Massachusetts, Amherst, and Rutgers University, New Brunswick, NJ.
- McCarthy, J. & A. Prince (1993b): *Generalized Alignment*, Ms.
- Muljačić, Z. (1972): *Fonologia della lingua italiana*, Il Mulino, Bologna.
- Nespor, M. & I. Vogel (1986): *Prosodic Phonology*, Foris Publications, Dordrecht.
- Os, E. den (1988): *Rhythm and Tempo in Dutch and Italian; a Contrastive Study*. Ph.D. Thesis, University of Utrecht.
- Prince, A. (1980): "A Metrical Theory for Estonian Quantity", *Linguistic Inquiry* 11: 511-562.
- Prince, A. & P. Smolensky (1993): *Optimality Theory: Constraint Interaction in Generative Grammar*, Ms., Rutgers University and University of Colorado.
- Selkirk, E. (1980): "Prosodic domains in phonology: Sanskrit revisited", in M. Aronoff and M.-L. Kean (eds.), *Juncture (Studia linguistica et philologica 7)*, pp. 107-129, Saratoga, California: Anna Libri.
- Selkirk, E. (1986): "On Derived Domains in Sentence Phonology", *Phonology Yearbook* 3:371-405.
- Vayra, M., C.A. Fowler & C. Avesani (1987): "Word-Level Coarticulation and Shortening in Italian and English Speech", *Studi di Grammatica Italiana XIII*:249-69.
- Vogel, I. (1982): *La sillaba come unità fonologica*, Zanichelli, Bologna.
- Vogel, I. & S. Scalise (1982): "Secondary Stress in Italian", *Lingua* 58:213-242.